A-0004

Establishement Of Soil Reference And Information Centre For Natural Resource Management. M.S. Badrinath, Dept. of Soil Science & Agril. Chemistry, College of Agriculture, University of Agricultural Sciences, GKVK, Bangalore - INDIA.

Soil is one of the most precious natural resources of the earth gifted to mankind. Present pressure for producing more food fuel and fodder to meet the demand in a developing country like India is causing damage to soil and environment. Several factors including faulty land use planning could be the reasons. Knowledge of soils through University Soil Reference Collection (USREC) shall be good and meaningfull tool for documentation, research and training about our own soils. USREC houses a large collection of soil monoliths with related data and documents, soil briefs generates and transfers information on soils by lecturing and publishing monographs utilizing the data base created. Soil genesis, classification and correlation mapping, soil data bases and land evaluation are all part and parcel of the USREC for the benefit of targeted groups such as students, farmers, planners and persons interested in sustainable agriculture. This will contribute to a better understanding of the state soils potential in a changing environment. USREC acts as a clearing house of the State Soil Reference Base (SSRB) through participation in the projects for the assessment of human induced soil degradation and for the establishment of a state inventory of emission of green house gasses. The soil reference database includes the information of the profiles of the exposition as well as that of other profiles, representing all soil types within a state and their variations. In addition, a soil reference, soil collection will have sample information on the assessment of soil/land qualities and management aspects. USREC will answers questions of what can be done with a specific soil, what kind of measurements and improvements have to be taken for sustainable use and how to cope with the fragility of the soil/land for specific land area.

M.S. Badrinath

A-0005

Regional-scale analysis of spatial community of soil microbial biomass (Cmic) and soil basal CO2 respiration across the north-east German agricultural landscape. Stephan J. Wirth ,ZALF – Centre for Agricultural Landscape and Land Use Research Institute of Microbial Ecology and Soil Biology, Muncheberg, F.R. Germany

Soil carbon decomposition processes are controlled by the activities of soil micro-organisms, thus regulating nutrient cycling in soils on a biochemical level. As a part of a ZALF Research Group, entitled "Biological parameters of soils and plant phyllospheres along a transect across the North-east German Lowland: studies of the spatial continuum and spatial co-variance structure with special reference to selected site properties", a survey of soil biochemical and physio-chemical properties was performed along a regional, one-dimensional transet across the North-east German Lowland (total length: 151 km, medium lag distance: 1.7km, autumn 1996), thus including 89 cereal crop cultivation sites. At each site, five nested samples were collected (0-15 cm, lag distance: 2m). Soil microbial biomass (Cmic) was determined with a substrate-induced respiration method using as automated infra-red gas analysis system at 20 C. Soil basal respiration (CO2-respiration without the addition of substrate) was measured hourly under continuous aeration flow via automated infra-red gas analysis (8-18 h, 20 C). Additionally, soil physico-chemical properties were analyzed, i.e., soil organic carbon content (Corg), total soil nitrogen content (Nt), soil pH and texture. Soil microbial biomass displayed an increasing spatial trend for the southern to the northern end of the transect (over-all mean: 474 ?g Cmic g^-1 soil, range : 119-1020?g Cmic g^-1 soil). Correspondingly, an increasing trend was detected for soil basal respiration (over-all mean: 0.46 ?g CO2-C g^-1 h^-1), as well as for Corg (over-all mean: 0.90%, range : 0.12-1.45%), and Nt (over-all mean: 0.08%, range: 0.04-0.18%), respectively. Regression analyses across the transect revealed closest relationships between Cmic and Nt contents (r^2=0.653), but less clear relations with other soil parameters under study. Semivariography was applied to analyze spatial continuity of soil microbial biomass, soil basal respiration, and soil physico-chemical properties across the transect. As a result, soil microbial biomass displayed a range at the regional scale (ca. 10km), corresponding to spatial trends and autocorrelation lengths identified for Nt and soil clay content, respectively. In contrast, soil basal CO2 respiration displayed a pure nugget effect.

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A-0011

USLE-M and the modeling of within catchment erosion. P.I.A. Kinnell, The Centre for Resource and Environmental Studies, The Australian National University, Canberra, Australia

The modeling of the temporal and spatial variation of erosion within catchments is of interest in the management of land and water quality. Because of its relative simplicity, and the relative ease by which parameter values can be derived, the Universal Soil Loss Equation (USLE), or the revised version of it (RUSLE), is used to predict within catchment erosion in event based models like the Agricultural Non-Point Source Pollution model (AGNPS) and the continuous simulation version of it (AnnAGNPS). However, the USLE and RUSLE, were not designed for this task and this can lead to concern about the outputs of such models. The USLE-M, a new modification of the USLE which is based on the rainfall erosivity index for an event being described by the product of the runoff ratio and the EI_{30} index, the event erosivity index in the USLE, is better suited to this purpose. The USLE-M is better than the USLE at predicting event erosion and, because it considers runoff as a factor in determining event erosivity, provides a basis for considering the impact of landscape position on erosion which is ignored in models like AGNPS. The ability of USLE-M to provide a better representation of within catchment erosion is illustrated with an example from Australia.

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A-0012

Intensification Patterns in West African Agriculture: Social and Cultural Conditions and Constraints. Volker Stamm, German Agency for Technical Co-operation (GTZ), Eschborn

We consider conservation technologies as forming a special aspect of the process of agricultural intensification; in this contribution, the problem of their social and cultural conditions and constraints is addressed. We discuss, in a historical perspective, factors influencing the choice of more extensive or more intensive farming methods. Based on case studies from Burkina Faso, Benin and Nigeria, we refuse the current opinion assuming a strong tendency towards more intensive practices under demographic pressure and defend the position that scarcity of soil resources may represent a challenge for peasant societies, but that their response may take significantly different forms, reaching from intensification, maintaining unsustainable extensive methods to abandoning more or less agricultural activities. The option chosen depends largely on the historical background and the social orientations of the rural communities concerned; a key factor seems to be the importance they give to cultivation in their scale of cultural values. Thus we further develop the arguments presented in our 1996 ISCO contribution.

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A-0013

Management Of Ferrolysed Soil By Rice Straw Incorporation. Dr. A.T.M. Farid, Principal Scientific Officer, Division of Soil Science, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-Bangladesh

Most scientists do not recommend rice straw incorporation because of high cellulose material and low nitrogen content. This was rather found suitable for management of ferrolysed soils in Bangladesh when incorporated @ 5-6 MT ha^-1 twice in a year as residue. Ferrolysis is a typical land degradation process active in Bangladesh soil involving a sequence of alternate reduction and oxidation cycles of iron with the resultant effect of clay destruction and formation of impervious soil layer. Rice straw is more resistant to biodegradation and contains low nitrogen. As Bangladesh possesses more congenial environment for decomposition and mineralisation, green biomass quickly perishes with the net effect of low organic matter content in the soil. So green manuring of cultivation of legume crops like black gram/green gram gives very short-term effect in respect of organic matter and nitrogen. But it has been found in a long term experiment that rice straw incorporation as residue following every harvest provides better physical condition of the soil especially more porosity and aeration. This has been probably actuated by the resistant quality of the straw in the soil. Porosity and bulk density measurements led to conclusion.

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A-0018

The Regulatory program to Achieve Land Conservation on the Hilly-Rolling Relief of Lithuania. Dr. hab. Kaltinenai, Research Station of Lithuanian Institute of Agriculture, Kaltinenai, Silale District, Lithuania

The soil conservation and sustainable land use are among the top subjects of natural and international environmental and development policy (Fleishhauer et al., 1996). Our presentation at the 9th ISCO Conference persuaded that soil loss due to water erosion on the hilly-rolling relief of Western Lithuania was 28.8-82.4 under potatoes, 11.7-26.4 under spring barley and 3.5-8.3 m^3 ha^{-1} under winter ryes. Only the quick-growing grasses completely stopped soil erosion. In turn the natural fertility of slightly, moderately and severely eroded soil decreased by 22, 39 and 62%, respectively (Jankauskas, Jankauskiene, 1998). The regulatory program to achieve land conservation on the hilly-rolling was prepared using research data of the experiments carried out in the Kaltinenai Research Station and Vezaiciai branch of Lithuanian Agricultural Institute (Jankauskas, 1996). Most of experimental results were obtained by methods of field experiments set up on the slopes, hilltops and foot slopes. The prevailing soils were Dystric and Gleyic Podzoluvisols loamy sand or clay loam with primary excessive acidity (pH_{kcl} to 5.5), low amount of mobile P_2O_5 (50-100 mg kg^{-1}) and medium or higher than medium amount of mobile K_2O (100-200mg kg^{-1}). The erosion-preventive grouping of erodible hilly-rolling terrain contain 5 groups of relief in depending on slopes gradient and texture soil. The requirements for pricking out of groups and recommended antierosion measures were formed using research data of

field experiments: 1-selection of different maturity of grass-stands; 2-the different erosion-preventive crop rotations; 3-antierosion soil tillage and 4-antierosion liming fertilizing. The annual productivity of fertile hay meadow stand during the 6 year period was 6937-7752 feed units (FU) per ha. The productivity of pasture grassland was 5666-6533 FU ha^{-1} (Norgailiene, Zableckiene, 1994). According to average research data of 12 year the amount of metabolizable energy accumulated by the erosion-preventive grass-grain crop rotations under optimum ground and fertilizer treatment was 14.1-32.7% higher than in the field crop rotation and 11.8-27.7% higher than in the grain-grass crop rotation. Only erosion-preventive grass-grain rotations decreased losses of soil due to water erosion by 76.8-80.8% in comparison with field crop rotation. The minimizing of soil tillage system and antierosion liming-fertilizing enabled further decreasing of soil loss and increasing of plant productivity.

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A-0019

Mulching Practice in a Semi-Arid Zone of Nigeria for Soil Erosion Control and Grain Yield of Maize. A.C. Odunze, K.B. Adeoye, Department of Soil Science Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria and Aina, Department of Soil Science, Obafemi Awolowo University, Ile-Ife, Nigeria

Water erosion is a major factor degrading soils of the Nigerian Semi-Arid ecoregions, and making agriculture less sustainable. For example, soil erosion in the Northern Guinea Savanna ecozones of Nigeria are prominent during the early part of the rainfed crop production season, when most soil and runoff losses from cultivated lands, sediments and runoffs were collected in 94 liter capacity drums. These were computed for efficiency in soil loss and runoff control between the mulch treatments. This study was carried out in Zaria (between 7° 30' and 7º 50' North and Latitudes 11º 00' and 11º 10' East) in 1993 and 1994. Results obtained show that generally, higher sediment yields were received in July, than in August and September under all the treatments in 1993. In 1994, higher sediment yields were received under all the legume live-mulch and Nil-mulch treatments in July. Also, straw mulch showed 77 and 87 percent efficiencies in the control of sediments over the Nil-mulch treatment, and was followed by Macrotyloma live-much (41and 47% respectively) in July 1993 and 1994. Stylosanthes live-mulch showed the least efficiency (8.33 and 18.92% in respective years) in sediment control. Straw mulch also showed 64.6 and 37.02 percent efficiencies in runoff control, and was followed by Macrotyloma live-mulch) 14.31 and 26.07% respectively. Predicted optimum soil loss and suitable land use management practices that would ensure sustained productivity of the soil are suggested.

A.C. Odunze

A-0022

The Study Of Investigation And Preventing Technologies Of The Slope Land Development And Slope Stability. Hsin Hsiung Chen, Department of Forestry, National Taiwan University, Taipei, Taiwan

In last decade, the land use on slope land of Taiwan has trended to multiple use. Excepting the developments of community and golf courses, agricultural activities, for example, betel palm, tea and vegetable of high mountain area, and temperate orchard, were active. Those activities have changed the face of slope land in Taiwan. Additionally, they have seriously impacted the conservation of water recourse and the stability of slope land. The purpose of this study was focussed on the investigation of the landslide mechanism of road construction, which was thought to be the most serious cause of landslide different land use types. The 27th and 28th compartments of Experiment Forest NTU and the new-central-island-highway at 107-108 K were selected as the study areas. The results could be expected as the future.

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A-0023

Soil Conservation and Restoration of Siwalik Hills Between the Rivers Ganga and Yamuna for Ecologically Sustainable Development and Biodiversity Protection. R.K.Gupta, Centre for Research on Ecology, Environmental Applications, Training and Education, DehraDun, India

Siwalik hills, between rivers Ganga and Yamuna, covering an area of about 2,144 sq.km, forms the first hill ranges south of the Himalayan mountains. These hills are characterised with high density of human and livestock population, high intensity of summer rainfall, weak geology and highly erodible soils. It is estimated that the soil loss from the region is about 91.4-114.8x10^5 tonnes per year. Geo-coded IRS-1B Liss II, FCC data products, were used to delineate various physiographic soil classes, forest and land cover types. This was followed by groundtruth verification surveys. Thematic maps at 1:50,000 scale were prepared. Erosion susceptibility classes(ESC) based on soil texture, structure, slope, soil depth and landuse were delineated and mapped at 1:100,000 scale into five ESC ranging from least, slightly, moderately, severely and very severely erodible classes. Land suitability class covers represents the present landuse area in each class, soil mapping units, constraints for development (ESC, soil depth, structure, texture, slope etc.) and the soil and water conservation measures to be adopted. Socio-economic surveys on participatory basis led to the delineation of eight paired watersheds, covering both the northern and the southern slopes of these hills, to serve as model watersheds, each having peculiar ecological and socio-economic conditions for the technological acceptability. The study, thus, provides the basis for a data based, holistic, ecologically sustainable, participatory management approach for the restoration of fragile Siwalik hills in the region.

R.K.Gupta

A-0028

The Approach to Classification of Soil with the Account a Toxic of Heavy Metals. Tatiana Koroleva, A. Zakirov, Institute of Ecology, Kazan State University, Kazan, Russia

The information on levels of concentration of polluting substance is initial in all further estimations of possible concentration, dynamics of accumulation and consequences of pollution. Therefore reliability received prognosis estimations are largely connected to an estimation of reliability of the information and choice of an optimum procedure of the data analysis. On the basis of variety “answer-back reactions” of soil on acting in them technogenic flows of substance probably to establish determined principles of classification of soil according to their ability to clean itself and level of accumulation toxic substances, in particular, heavy metals. These principles should take into account character of accumulation, migrations and transformations of polluting substances in various zone types of soil. Depending on properties of soil the technogenic substance test these or that transformations. Parameters of normal functioning of soil system are biological efficiency. These criteria should be used for development of classification of soil according to ability of accumulation of heavy metals. The collect of data is rather complicated technically, stretch in time and enough expensive. Therefore the problem of classification of soil according to accumulation of heavy metals is actual. It would allow to transfer the data with already investigated objects on unexplored. The formalized classification should be based on revealed in on unhomogeneous analyze of data set. In too time revealing and the estimation unhomogeneous is an independent task for an estimation and forecast of a condition ecosystem as a whole or separate its parts. The set of attributes, describing a condition ecosystem, can be very large. Collected within the framework of any project on research of an environment data and their organization should be directed on creation whole of an image of territory and to reflect its change at economic or other influence. As a whole of all these attributes describe a general picture of functioning ecosystem in conditions indefinition. To note peculiarities of a condition or functioning ecosystem, it is necessary to select diagnostic attributes. The primary analysis unhomogeneous of meanings of attributes will allow to reveal as the most diagnostic attributes, and ranges them by significative changes. It will allow to lower the requirements to accuracy and quantity of measurements. For revealing unhomogeneous, really reflecting danger of heavy metals for biological objects, it is necessary to use instead of Evklid metric of space of heavy metals concentration to other metric. This metric must take into account nonlinear dependence between concentration of heavy metals and a degree of heavy metals danger for biological objects.

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A-0029

Mathematical Model Based on Fuzzy Sets for Resoiling. Dr. Ludmila L. Frolova, Kazan State University, Dept. of Ecology, Kazan State University, Kazan, Russia,

At present, the problem of rehabilitation of soil degradation is becoming very important. There are many causes of soil degradation. For example, soil degradation caused by acidification, salinisation, water and wind erosion, bogging, remnants of the mining and the oil industry and so on. There are many technologies and methods for its restoration. It is dependent from an aims and the data of analysis (agrophysical and agrochemical). Suggested mathematical model based on Fuzzy sets can describe the natural object such as soil. It is possible because soil indicators (for instance such as apparent density (g/cm3), bulk density (g/cm3), porosity (%), loss on HCL leaching (%), air-dry moisture (%), wilting moisture (%), capillary moisture capacity (%), grain size, particle size (mm), gumus (%), extractable bases (mg.eq/100g soil), hydrolytic acidity(mg.eq/100g soil), pH, ion CL (%), SO_4, Ca, Mg and so on) have a fuzzy boundaries of measures. First of all it is necessary to define indicators (biotic & abiotic) and the restoration technologies depending of them. Before execution of resoiling program it is necessary the monitoring: to make the measures of soil indicators and to evaluate of data representative. Then the mathematical model calculates the Rank of preferable technology between [0,1]. Using mathematical model based on Fuzzy sets allows to recommend the effective ecological method in soil remediation.

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A-0037

Rural Women and Sustainable Agriculture Trails in Pakistan. Mrs. Farzana Panhwar, 157-C, Unit No.2, Latifabad (Sindh), Pakistan

In the rural areas of Pakistan, agriculture land is owned by men and they use family labour including women for producing crops. Women are not paid but are fed, clothed

and provided dowery by father at time of marriage, ornaments by husband and when widowed shelter by sons. They usually transact no cash from cradle to grave and are not mourned as men are. Their mud-covered graves are leveled up by occasional rain run off. In recent years some families educate them so that chances of marriage in well to do families are ensured. Sindh Rural Women's Uplift Group tried to help women by engaging a number of them between 10-15 on the farm under the guidance of women Farm Supervisors, paid same salaries as men and gave them similar jobs to perform. Their output was more than men when both parties knew that daily, weekly and monthly out put of two groups of men and women were being compared. The women were the best in case of mowing, grasses for mulch, collecting fallen leaves, twigs, bark and etc. Their full time employment in sustainable agriculture in the past 2 years, in preference to men has changed the life pattern of a group of 12 women consisting of one couple of parents, their daughters, daughter-in-laws and nieces. In two years since starting of operations household life pattern of these families has changed. In the beginning men took away all the salaries of women but gradually women have asserted and now they are better clothed and say that they will send their children to the school. Man's little attitude toward the social set-up in the house has changed some what and are a little more considerate but, time may bring about further changes. Women in Pakistan agriculture, can perform the following functions as good as men: Transplanting of vegetables rice, and bare root plants. Intercultivation of vegetable removal of weeds and unwanted growth. Picking of cotton, small fruits, vegetables, berries of all types, harvesting of wheat, rice and other crops.

Mrs. Farzana Panhwar,

A-0042

Bringing Groundwater to Life. Catherine E. Burwell, USDA-CSREES and Purdue University, Rome City, IN USA

The National Extension Water Quality Database is an on-line tool for locating water quality and waste management educational resources generated by the Cooperative Extension System. It can be accessed at http://hermes.ecn.purdue.edu/water. It is a cooperative effort of USDA-CSREES and Purdue Unversity Cooperative Extension Service. The database includes over 3000 citations and more than 1500 full-text documents. The majority of listings are publications, factsheets, and bulletins, however, there is also a collection of audiovisual materials such as videotapes, slides, and computer application software. The educational materials are grouped into eight major categories, including: conservation, drinking water quality, nutrient management, pest management, testing, waste management, wells, and public policy. Each of these categories are further divided into smaller sub-categories. Users have the option to search the database using any search words present in the document or abstract, or to browse the categories to view the depth of information on a major issue. Also included are state listings of entries in the database. Users also have the option to contact state water quality coordinators and specialists to ask specific questions they may have. The National Extension Water Quality Database is a resource designed to increase the public's understanding and knowledge of human and animal interactions and water quality and quantity. Searching the database will provide nearly 600 matches to conservation, more than 450 to Best Management Practices, and more than 150 to Public policy. Major categories are reserved for groundwater and drinking water quality.

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A-0049

Effect of Population Resettlement on Sustainable Land Use --- A Case Study in Desertification Areas in Ningxia of Northwestern China. Wang Yi-ming, Ningxia Office of Territorial Management and Regional Planning, Yinchuan, PR China

Located at the upper reaches of the Yellow River, the Ningxia Hui Autonomous Region (Ningxia in short) is one of the typical desertification areas in northwestern China. Around 3.77 million hectares (or 72.8% of the total territory of Ningxia) are suffering from land deterioration. Ningxia can be classified into the following 3 geographical units: Yellow River Irrigated Area in the Ningxia Plain: The plain is located in northern Ningxia with the Yellow River flowing through with an annual runoff around 32.5 billion cubic meters. The precipitation is less than 200 mm annually. With the construction of irrigation systems, this area has been developed into a promising oasis for agricultural commodities. This is the most important agricultural area in Ningxia. By the end of 1995, the population density amounted to 204 people/km^2. Dry and Sand-blown Area in mid-Ningxia: The annual precipitation at this windy and desert area varies from 200 to 300 mm annually. This area is characterized by vast land with deficient water resources. Overgrazing and unregulated reclamation and fire-wood cutting have resulted in a serious deterioration of the desert steppe. Of the 1.26 million hectares of desertification, 440,000 hectares are moving sand dunes or semi-fixed sand dunes. The population density only amounted to 25 people/km^2. Loess Hilly Area in southern Ningxia: This area is suffering from variety of natural calamities such as water erosion, soil loss, drought, rain-storms, hails etc. The annual precipitation varies from 300 to 500 mm. Of the 1.84 million hectares of water-eroded area, 840,000 hectares are at an erosion modulus more than 5000 tons/year/km^2. Due to population overgrowth, the density has reached 108 people/km^2. The land has been over burdened. A vicious circle has formulated among population, resources and environment. The agricultural production is low and unstable. The educational situation is lagging behind. The farmers are living in poverty. Therefore, it has been ranked as one of the most poverty-stricken areas in China [(1)]. With the help of the National Central Government, a poverty alleviation program has been planned and implemented by Ningxia Government at a combination of the development of newly-reclaimed pump-irrigated areas with the resettlement of population. From 1983 to 1995, more than 150,000 poverty-stricken farmers were migrated from the overpopulated villages in the hilly areas in southern Ningxia to the newly-reclaimed pump-irrigated areas in mid- and northern Ningxia. The achievement in the regional development and population resettlement has accelerated the sustainable land use in the mid- and southern Ningxia.

Wang Yi-ming

A-0050

Studies Land Applications of Corn Stover for Spring Corn in Dry Farmland Region of North China. Wang Xiaobin, Soil & Fertilizer Institute, Biejing, P.R. China

The recycling and use of nutrients from crop residues (such as corn stover) has been considered for soil improvement, water conservation and crop production in dry farming areas. Studies on land application of corn-stover were conducted in an area where spring corn accounts for over 50% of the total area under food crops, in Shouyang, Shanxi, located in the semi-humid arid region of North China. Corn stover has mostly been burned as waste except for around 40% which has been used as fodder for cattle. The nutrient level of most of the soil in the area is low, fertilizer directly or indirectly (in the form of cattle manure is still under question. Field experiments on application of corn stover and/or cattle manure combined with chemical fertilizers were carried out in Shouyang Dryland Farming Experimental Station. Five years studies showed that N uptake by corn increased mainly with the incorporation of corn stover and fertilizers N; P uptake was influenced by the combined application of chemical fertilizer and organic fertilizer (in the form of corn stover or cattle manure.) The increased available N and P content in tilth layer was mainly influenced by the application of cattle manure and chemical fertilizer, respectively. When rates of fertilizer N exceeded 105-kg ha^{-1}, the potential N leaching from the root zone increased with increasing N application. The organic matter content in the soils treated with corn stover or cattle manure were kept in balance in the experimental conditions. Corn yield and water use efficiency were influenced significantly not only by fertilizer N but also by incorporate corn stover. The results suggested that the highest N, 6000-kg corn stover, and 1500-kg cattle manure per hectare. The experiments supply information on nutrient recycling and use of corn stover as sources of fodder and organic fertilizer. This information is also useful in balancing application of organic fertilizer for sustainable development of agriculture.

A-0052

From Component Technology to Watershed Management: Evolution in the Design of a Project Addressing Poverty, Food Security and Natural Resource Management through Farmer Participation. Mohammad Jabbar and Mohamed Saleem, International Livestock Research Institute, Addis Ababa, Ethiopia

Poverty, low productivity and resource degradation are major problems of the smallholder mixed farming systems that dominate in the highlands of East Africa. These Problems are most severe in Ethiopia, which occupy over 60% of the highlands of East Africa. In the mid 1980's, a project was launched by a consortium of international and national research institutions to address some of these problems. Using systems approach, problems, constraints and opportunities were identified and component technologies were designed to solve some of these problems. Indigenous knowledge was incorporated in some of the technology designs. After on-station tests, on-farm tests with individual farmers were conducted and adoption pathways and related factors were studied. Experiences from these studies indicated the need for devising strategies for watershed level management of natural resources with participation of the local communities. A pilot watershed management project was launched in 1994 to design and test approaches to community participatory resource management, their requirements and limitations. Important lessons have been learned from this pilot project. In order to assess the impact of technology and policy interventions on ecological and socioeconomic sustainability of the production systems and human welfare, conventional systems approach to research and project development appear to be adequate. The project design is currently being revised to incorporate 'agroecosystem health' as a framework for assessing sustainability and human welfare based on community-determined criteria and indicators.

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A-0053

Toward a better pastoral communities grazing and water management in the Ferlo/Senegal. Horst Oebel, PAPF (Projet Autopromotion Pastorale dans le Ferlo), Saint Louis/Senegal

Grazing and water availability in dry season is a determining factor for extensive cattle farming in the pastoral and forestry reserve of the six borings in northern Senegal. Water from borings is the only water supply source in the area. It comes from the ground water

with more than 200 metres deep drawn by engines and collected in some pond or water towers. The grazing availability depends on the rain quantity in rainy season (from July to September) that vary between 200 and 400 mm. From October bushfires are destroying every year thousands hectares of grazing land. Until the years' 80 the State, by the means of technical services took care of borings operation and maintenance and set up a huge fire door in the Ferlo. Presently pastoral communities are responsible of water and grazing management. The PAPF (Projet Autopromotion Pastorale dans le Ferlo) supports the borings surrounding populations in their efforts. In relation with some NGO on the spot, more suitable and cheaper techniques for the fire doors rehabilitation were tested. The training of management committees and borings rehabilitation are priories in a management and education programme of the infrastructures. A particular care is taken of woman's role for her involvement in the works management.

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A-0056

The Effect of Loss of Value of Indigenous Knowledge on the Protection and Management of Sacred Forests (MPUNGI and MSHITU), and Local Forests in North Pare Mountains. Kilavo C.H. Mndeme, Forestry Adviser, HIMA – LUDEWA, Ludewa, Iringa, Tanzania

The contribution of sacred forests and local forests to the environmental conservation have been remarked and appreciate by the inhabitants of North Pare Mountains dating back from 18th century. Most of these forests, out of 276 registered in two divisions, traditionally are respected due to their importance for worshipping, holding traditional ceremonies, acting as training institutions for youths and other related ritual purposes and beliefs. These forests have been subjected to severe encroachment and indiscriminate tree cutting triggered by high population growth coupled with the change of political regimes, introduction of foreign religions (Muslim and Christianity) and other intercultural influence. Since these sacred and local forests (under village councils) are considered potential in terms of biodiversity (Fauna and Flora) conservation, efforts are being made by the Tanzania Forestry Action Plan Project in North Pare Mountains to restore the situation through people's participation. This is implemented by reviving customary laws, empowering the sacred forest owners and enforcing of traditional and cultural ways of protecting these forests. The achievements realized so far are through holding meetings, conducting of forest walks together with forest owners, respective village government leaders, elders and influential individuals are given and discussed. A joint forest management plan has been developed for 276 sacred forests and implementation started. Recommendations basing on the above achievements are outlined in lengthy.

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A-0062

Use of Some Natural Pasture Plant Species for Erosion Control in Southern Turkey. Mehmet AYDIN and IsmailCELIK

An investigation on the use of common natural pasture plants, *Rosmarinus officinalis* and *Putoria calabrica* for water erosion control in Southern Turkey was carried out for 3 years (1995-97). The slope of the experimental field is 30% and the size of plots was 7 m in length along the slope and 3 m in width. During the experiment, total precipitation was 1859 mm. 57 out of 92 rainfall events were erosive due to runoff. The amounts of soil and water loss by runoff were found to be 30.1, 91.8 and 194.2 ton/ha; 113, 372 and 488 mm for *Rosmarinus officinalis,* Putoria *calabrica* and bare soil plots, respectively. Results suggested that both of the plants can be used for controlling soil erosion. Moreover, it was found that soil lost in *Rosmarinus officinalis* plot was 67% and 85% less than those of *Putoria calabrica* and bare soil plots.

Mehmet Aydin

A-0063

The Content and Uptake of Mercury by Some Crops Under Conditions of Sewage Application. Tadeusz Filipek, Jolanta Olek, Department of Agricultural Chemistry, University of Agriculture, Lublin, Poland

Urbanization and industrial activity cause permanent increase of the amount of sewage. Purification technologies of sewage do not eliminate totally biogenic elements. Toxic substances and heavy metals from the sewage. The utilization of purified sewage for plant watering and fertilizing could be a profitable solution of decreasing of surface water eutrophication. The application of sewage into agroecosystem is not only an important source of water and nutrients for crops production but also contribution to soil pollution with toxic elements. Mercury is one of the most toxic metals that can be sorbed by organic and mineral colloids in soil accumulative layers. Soil pollution with that element is of the great importance because it is a potential source of the metal for crops and on thus it can be the reason of its accumulation in animal and human organisms due to particular trophic chain stages. The aim of the model, field experiment was working out an integrated municipal sewage purification system, connected with irrigation of industrial plants. We wanted to work out methods of decreasing of biogenic and toxic elements input into surface waters. Field experiments were carried out on organic (muck and muck –peat) soils located in Bystrzyca river valley. The soil contained average: 33% organic matter, 1.62% total N, 668.5 mg/kg easily hydrolyzing N. It was of a neutral reaction, very high level of availability phosphorus and very low content of potassium and magnesium. The field (about 8 hectares) divided into 7 blocks and in each block contained 3 drained basis. One of the following plants was cultivated in each block: poplar (Populus nigra), willow (Salix americana), corn (Zea Mays), hemp (Cannabis sativa), spring rape (Brassica napus ssp. oleifera) and two grass mixtures. Every plant was cultivated in 3 objects: A- "0" – control, B- optimal doses of sewage, C – double doses of sewage. In the paper accumulation of mercury in organic soil and crops due to the application of purified sewage will be presented.

Tadeusz Filipek

A-0064

Modification of Soils by Termites : A Case Study from a part of Nellore Mica Schist Belt, Andhra Pradesh, India. Dr. A. Nagaraju, Associate Professor of Geology, Sri Venkateswara University, Tirupati – India

The Nellore mica belt lies within a zone striking north - northwest to south - southwest for more than 95 km between the latitudes 14° and 15°. The width of the belt ranges from about 12 to 16 km and lies between the east longitudes 79° 40' and 80° 0'. This belt is sickle shaped, tapering in the south - east and north - northeast ends. This belt is famous for its mica deposits. In this mica belt, a part (Lat 14° 10' and 14° 19' and Long. 79° 40' and 79° 45' E) is studied from the point of view of distribution of termite mounds. This is included in the Survey of India toposheet No. 57 N/11 and N/12. It is about 200 sq km in aerial extent. This area is covered by igneous and metamorphic complex primarily consisting of hornblende schist, amphibolite, muscovite - biotite schist, quartzite and pegmatite. Termites build conspicuous earthen mounds which constitute an important feature of the landscape in tropical and sub tropical regions. Termites descend through covered runways and subterranean galleries ramified over wide tract and sample the sub-surface geological formations for construction material. They move and mix large quantities of soil from different horizons during mound building. Detailed studies on ecological, geological aspects of mounds have been discussed by earlier workers. The physical and chemical properties of these biologically reworked soils are different from their surrounding areas from where the materials are derived for mound construction. Earlier studies have shown that the mound building termites have a considerable influence on many soil properties. They contribute to the homogenisation and regeneration of an entirely new soil type. In this area, the termite mounds are found in association with different types of vegetation, soil and rock. They are developed on various topographical conditions, viz., altitude, slopes, valleys, plains and on the bunds of agricultural fields. They primarily occur as conical, elongated, rounded or even irregular shapes. In the present work, the termite soils and its adjacent surface soils are studied to examine the enrichment of different chemical elements in termite mounds with that of the surrounding soils. A biogeochemical parameter called "Biological Absorption Coefficient" (BAC) [Ratio of concentration of the element in the termite mound (CTS) to that of its adjoining soils (CSS)] of these mound is computed which helps in the evaluation of the mounds in biogeochemical orientation surveys. These studies reveal that the mounds exhibit enrichment for Cu, Zn, Co, Ba, Cr, Li, Ni, Be, V, Y, Ce and La. The differential selection of clay rich material, and / or the incorporation of faecal material into the mound structure, also results in higher mineral element concentration in the mounds than the surrounding soil. Generally, the termite mounds are showing higher organic matter content than the surrounding surface soils. Therefore, these soils can be crushed and used as fertiliser for crops. From this study, it may be concluded that the mound - building termites and their associated microorganisms control the translocation of different trace element, thereby playing a significant role in the biogeochemical cycling of elements in the tropics. They will also play an important role in cycling nutrients and sustaining plant growth in this semi-arid tropical landscape.

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A-0065

Contour hedgerows of Calliandra calothyrsus Meissn. For soil and water conservation in the Blue Mountains of Jamaica. M A McDonald [1], P A Stevens [2] and J R Healey[1], School of Agricultural and Forest Sciences, University of Wales, Bangor, Gwynedd, Wales, UK; [2]Institute of Terrestrial Ecology, Bangor Research Unit, Gwynedd, Wales, UK

The context for this study was the urgent need to find a stable and sustainable alternative to shifting cultivation on steeplands in the tropics. In Jamaica, as in other mountainous regions, it has been accepted that cultivation will continue on many areas of sloping land, and ways must be found to make this environmentally acceptable. Suitable measures must provide small-holder farmers with the participation of members of the local farming community in the Blue Mountains of Jamaica to investigate the use of contour hedgerows of *Calliandra calothyrsus* Meissn. For the control of erosion and maintenance of soil fertility. The use of contour hedgerows on steep hillslopes (24-32°) reduced erosion by 55% and water runoff by 2.5 times in comparison with conventionally farmed land with physical soil barriers. Agricultural productivity was also higher in the plots with contour hedgerows, maize cob and grain weights were up to 45% and 63% higher per plant respectively. Despite the loss in land available for crops, yield per area was not significantly reduced by the introduction of hedgerows. The nutrient losses from the conventionally farmed plots indicated low sustainability with a significant reduction in

nitrogen, phosphorus, organic matter and base cation soil content. The contour hedgerow system obviously has potential for sloping lands such as encountered in this study, but its adoption by farmers depended on the simplification of its establishment and its development into flexible system to suit their specific farming conditions. In this project hedgerows of nitrogen-fixing trees proved popular, but they were usually intermixed with hedgerows of species giving a direct economic return.

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A-0066

Preliminary Results of WEPP Model use in the Ukraine for the Development of Constructions for Soil Erosion Prevention. M. Kotova, Institute for Soil Science and Agrochemsitry Research, Kharkiv, Ukraine

Arrangement of erosion prevention for agrolandscapes should be based on the project developed with qualitative engineering methods. As a qualitative ground the model of soil erosion that conforms to special requirements should serve. Potentially, WEPP model complies with the most of these requirements since it is theoretical model in origin; this allows to reduce substantial efforts and time expended on obtaining of empirical data and relations, for instance, in comparison with USLE. To test the possibility of WEPP model use in the conditions of the Ukraine an experimental plot was arranged at the territory of Donetsk Erosion Control Experimental Station. The experimental plot is located at a watershed of the area of 700 ha where detailed soil examination was made. Soils of the watershed are represented by Mollisols common at a steppe area. Then, prediction of soil loss caused by water erosion was calculated with the help of hill slope and watershed version of the model. Soil erodibility parameters (Ki, Kr, τ_c) were determined from the coefficient of aggregation (K_a) using original procedure. Later, τ_c was determined theoretically from values of erosive velocities, and K_r was determined from agrophysical parameters of soils at experimental plot (13 varieties). Experimentally determined erodibility parameters are in agreement with theoretical relations. It is impossible in the Ukraine to take full advantage of CLIGEN model for climate prediction due to unavailability of sufficient set and amount of climate data. Therefore, modeling was carried out on the basis of single event simulation representing rainfall of rare occurrence. For this purpose the territory of the Ukraine was divided into 13 large areas having different conditions of rainfall risk. For each area mathematical equation was deduced describing rainfall typical for this area. Parameters of minimum rainfall intensity and duration of precipitation were determined for each area for rainfalls having different probability of occurrence. All this allows to calculate hydrograph of the rainfall with specific probability of occurrence that is used directly by WEPP model on a single event simulation. Analysis of predicted and experimental data on soil loss due to erosion approved possibility of WEPP model application in the Ukraine for the development of erosionally preventive arrangement.

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A-0068

Spatial Variability and Temporal Dynamics of soil Erodibility Parameters on Mollisols (by the example of the Ukraine). S. Yu. Bulygin, Institute for Soil Science and Agrochemistry Research, Kharkiv, Ukraine

On adaptation of theoretical model of erosion the primary objective is formalizing of soil factor describing by parameters of soil erodibility. In WEPP model it is characterized by parameters K_i K_r (respectively interrill and rill erodibility), and τ_c (critical hydraulic shear). The theoretical nature of WEPP model is inconsistent with empirical statistical relations which are presently used to determine soil erodibility parameters. Theoretical relation should be developed between the parameters of soil erodibility and soil properties inherited genetically and gained technologically. To use WEPP or any other contemporary erosion model in a soil conservation practice, temporal variability of soil erodibility parameters should be studied. In this case study some approaches to theoretical determination of soil erodibility parameters were devised on the basis of soil agrophysical properties, namely: water stability, microaggregation, cohesion between aggregates. Experimental data supporting theoretical relations were obtained. Relations were established between agrophysical soil parameters and microbiological indices, humus content, texture, soil location in a landscape. The results of the investigation of temporal variability of soil erodibility parameters display their considerable variations during agricultural year. As a hypothesis, the suggestion has been made their soil erodibility parameters are maximal in the late winter and minimal in the late summer. These parameters vary over a broad ranges, hence their values sometimes twice or more times differ from average annual values. This may cause grave errors in the development of a soil conserving projects. Seasonal variations of soil erodibility parameters are superimposed by land use technological peculiarities. The range of variation of soil erodibility of soil parameters, when using long-term qualitatively different agricultural practices on the same soil, exceeds the one on different varieties of Mollisols, when using the same agricultural practice. Soil properties determining their erodibility, including genetically inherited properties, can be regulated technologically. Therefore, soil-ecological expertise of agricultural technologies should be made. The results of the expertise should be decisive criteria on selection of specific technological practice for specific soils. The ratio between content of inaggregated primary soil particles at investigated territory and on a control agricultural background (perennial grass of 3 years old or more) can be used as the criterion for estimation. This ratio should not exceed 1:3 (<<golden selection>>) and would serve as an index of entropy in soil system. Therefore, despite a theoretical character of WEPP model, when it is used in a practice of soil conserving arrangement of agrolandscapes, a stage of preliminary examination of the territory is necessary.

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A-0070

Analysis and simulation of cereal yields response to conserved water and nitrogen in soil previously under pastures. J.A.M.Yunusa [1,4], W.D. Bellotti, A.D. Moore[2,4], J.A. Baddock[3,4] and C.M. Penfold[1], [1]Department of Agronomy & Farming Systems, The University of Adelaide, Australia; [2]CSIRO Plant Industry, Glen Osmond, [3]CSIRO Land and Water, Glen Osmond, Australia; [4]CRC for Soil and Land Management, Glen Osmond, Australia

A rotation of pasture-barely was initiated in 1995; the pastures consisted of either an annual legume or barley grass. At the start of the wheat season, the status of soil nitrogen and stored soil water were greater in previous pasture legume plots compared to previous grass pasture plots. These improvements in both nitrogen and water status in the soil in the sol increased the yields of the following the wheat on the previous legume plots. To separate the effects of increased nitrogen availability on wheat yields in plots previously under the pasture legume from the other intrinsic benefits of rotation, nitrogen fertilizer was applied under to wheat at sowing; however, this failed to increase the yield of wheat even on the previous grass pasture plots. Simulation modeling of the soil water and nitrogen dynamics indicated that the measured wheat yields were close to the potential for the seasonal rainfalls, and the conserved soil water, compared to conserved soil nitrogen, during the pasture phase, was a greater determinant of the wheat field in the following season. In the third year of the rotation, the benefits of pastures were not evident in the second crop in the sequence, which was barley. The variability in cereal yields in the rotation are analyzed on the basis of the distribution of water and nitrogen in the soil profile, and of the seasonal rainfalls.

J.A.M.Yunusa

A-0074

Effect of Population Resettlement on Sustainable Land Use A Case Study in Desertification Areas in Northwestern China. Wang Yiming, Ningxia Office of Territorial Management and Regional Planning, Yinchuan, PR China

The Ningxia Hui Autonomous Region is one of the typical desertification areas in northwestern China. About 4.04 million ha, or 78 % of Ningxia's territory, are suffering from land degradation. From 1983 to 1994, a program of population resettlement was conducted. Around 145,000 poverty-stricken farmers were migrated from the overpopulated villages in the soil-erosive hilly areas in southern Ningxia to the newly reclaimed irrigational areas in mid- and northern Ningxia. The previously sandified desert steppe with a small density of population was developed into a promising oasis. Firstly, the local government invested to construct the backbone facilities of lifting irrigation and establish the social infrastructures in the planned area. Secondly, the farmers were organized at their own willingness to resettle in the newly reclaimed area, it should be especially notified that a windbreak network should be conducted. With these pioneer plants, shift sand was fixed, soil fertility was promoted, and the microclimate was improved in favor of agricultural crops. The process of population resettlements was actually that of the rational exploitation of the land resources in the newly reclaimed area. The fundamental experiences to the success of the project could be summarized as: (1) the relationship among population, natural resources and environment was harmonized by population resettlement, (2) the exploitation of the water resources from the Yellow River is combined with the development of the land resources, (3) with government support both in policy and finance, the farmers were encouraged to resettle and construct the newly reclaimed area, (4) a system of technical training and service was set up to help the farmer make a better use of the land. By the end of 1994, seventeen communities were established in the newly reclaimed area, opening-up 32,527 ha farmland. Most of the migrants were significantly improved in economic status. What's more, the desert steppe previously suffering from deterioration was replaced by a productive oasis, while the soil erosion in the loessial hilly areas of southern Ningxia was reduced because of less population and vegetation emigrating areas. The significant benefits achieved in economy, sociology and environment were highly evaluated by specialists from Chinese institutions and from the World Bank and other international institutions. From 1996 to 2000, a bigger problem of lifting irrigation facilities construction and population resettlement will be conducted with the help of the national government. It is expected that additional 86,700 ha in the desert steppe will be reclaimed towards sustainable land use.

A-0075

Erosion and crop productivity relationships for an oxisol in the Eastern Plains of Colombia. F.H. Obando, Universidad de Caldas, Manizales, Colombia

This paper reports progress on the quantification of the erosion and crop productivity relationships for an acid savanna soil of the extensive Eastern Plains of Colombia,

EPOC, with specific reference to an upland rice crop. The effects of water erosion on soil physical properties are also presented. Nine existing 30 m² runoff plots located at La Libertad Research Center of Colombian Corporation for Agricultural Research, CORPOICA, in Meta State, were evaluated to define three contrasting levels of erosion according to soil losses under different prior management systems: bare soil, BS, during ten years, rotation of annual crops, AC, during six years and zero grazing pastures, PA, during six years. All plots were allowed to erode for a further year under bare soil. These plots were distributed as a sistematic nonrandom experimental design. On noneroded soil, growing a secundary savanna with a good cover during last thirty years, three additional 50 m² runoff plots were installed as a control treatment, CT. Total soil losses were 318.13, 40.19 and 15.68 t/ha respectively on BS, AC and PA. After sampling for soil chemical and physical analyses, seedbeds were prepared by hand and the whole plots were sown to an upland rice crop (Orizica Sabana 10) in march 1996. The experimental site is a High Terrace of the EPOC´S Alluvial Plain of Piedmont, with a mean slope of 2%. Rice yield reduction was 63% for BS, 32% for AC and 84% for PA relative to the control treatment, CT. Soil water retention, aggregate stability and water infiltration capacity decrease with increasing erosion, but mechanical resistance to cone penetration, crusting index and bulk density increased. Description of soil profiles revealed the presence of a surface gravelly layer on PA plots which explain the greater yield reduction in spite of less erosion. These preliminary results have demonstrated that EPOC'S savanna soils may be extremely vulnerable to water erosion and rice crop sensitive to loss in soil productivity. From this work, soil research and management have been shifted to sustainable oriented systems including conservation tillage, use of green manures and cover crops. A further research on erosion-induced loss in soil productivity has been started up following a standardized experimental design promoted by UN Food and Agriculture Organization, FAO (1985).

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A-0077

Mbulu District Rural Development Programme (Tanzania): Expeirence on implementing 1996 ISCO Conference conclusions and recommendations. Fredrick Mhina Mngube

The paper discusses the Mbulu District Rural Development Programme's experience on implementation of the 1,2,3,4 and 5 conclusions and recommendations from 1997 to 1998. Mbulu District Rural Development Programme has a major objective of improving the people's standards of living through strengthening the district capacity on sustainable maintenance and utilisation of district resources including land and water. The District programme has specific multi-departmental programme called Land and Water Management which is responsible. To share experiences on success and difficulties obtained within 2 years of implementing 1996 ISCO conclusions and recommendation ; 2.2. To share the modifications made on ISCO 1996 conclusions and recommendations for better sustainable Land use in the district. Therefore the following headings will be discussed based on the Mbulu District Rural Development Programme experience: i. Managing a planning process for the use of land resources with all stakeholders; ii. Creating an enabling environmental; iii. Creating a positive learning environment for sustainable land use; iv. Enhancing action-oriented research; v. Developing sustainable implementation approaches and establishing networks of observation. The programme now operates in 26 villages where the following has been done :-i. Development of village natural resource management systems Initiation of village planning system, an iterative process of careful analysis of available natural resources and their use, identification of priority problems and implementation of possible technical intervention and regulations to improve the situation, and evaluation of results; ii. Design and enforcement of village regulations . Management of natural resources basically involves management of conflicts about the scarce resources (in our case, land and water) between agriculturists and livestock keepers, hunters and woodcutters, poor and rich people. To solve these problems the communities are seat to discuss and establish traditional rules called Sheria za kimila which are controlled by informal leaders. In critical issues the legal village by laws are established by the villages with help from district council; iii. Building up of an appropriate village organization. To build the capacity of the community,the programme has to support the village level to be organised. Hence the community has to decide and to establish some structures e.g village field activities follow up committees in each sub-village . The role of this structure is to make sure that what was agreed are implemented; in case of any problem they have to report to the responsible committees and institutions. It is the philosophy of the L&WMP that the necessary institutions and capacities should be developed gradually through a learning by doing process; iv. Technical interventions: The L&WMP philosophy is to provide appropriate technical interventions, That means acceptable and implementable by the target groups. The technical interventions are determined after problem identification during different evaluations with farmers. This common identification and analysis of problems increases confidence to both extension staff and farmers. The conclusions and Recommendations of ISCO 1996 are important and implementable if all parties mentioned would clearly understand their roles on sustainable land use. However clearly defined Institutional supports are important to support and improve the existing rural capacities towards sustainable land use.

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A-0079

Modeling Agroforestry for Soil Conservation (Application of the SCUAF model). Zipporah Mugonyi (Ms), Soil and Water Conservation Branch, Ministry of Agriculture, Nairobi. Kenya

The Soil Changes under Agroforestry (SCUAF) model version 2 is used to predict relationships between erosion and soil productivity. The potential of agroforestry through soil cover and the role of trees in relation to the barrier function for erosion control are discussed. An agroforestry system containing Calliandra calothyrsus and maize is modeled for a period of 20 years under different environmental and management conditions in Kenya. Climate and slope are the physical environments modeled. Three management parameters modeled are fertilizer (NPK) application, mulch application and terracing. A maize monocrop is used as a control. Results show that hedgerow intercropping leads to an improvement in soil fertility, irrespective of climate (humid highland and subhumid highland). Steeper slopes result in enormous amount of erosion (47 tonnes) compared to gentle slopes (2 tonnes). Erosion on steep slopes is reduced to 0.8 tonnes by terracing. Mulch application as a management option results in decreased erosion and increased plant biomass production. Mulch is easily obtained from the prunings. The use of mulch as fertilizer saves on the cost of buying inorganic fertilizer. The model quantifies how soil erosion and changes in soil depth affects plant biomass production and crop harvest with time. The model also estimates changes in soil organic carbon, plant-soil system nitrogen. This paper shows that the agroforestry system leads to a more sustainable soil conservation system through its role in soil amelioration. The addition of organic matter through mulch as management factor leads to further soil improvement. Through its capacity to combine production with conservation, conservation by means of agroforestry will show more favorable results from economic analysis than conservation by means of earth structures alone.

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A-0081

Sustainable Soil Management: A Framework for Analysis. Jennie Popp, Research Associate, Colorado State University, Winnipeg, Manitoba Canada, Dana Hoag, Professor, Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO USA, and James Ascough, III, Research Hydraulic Engineer, USDA-ARS-NPA, Great Plains Systems Research Unit, Fort Collins, CO USA

Sustainability of our natural resources is one of the most demanded and complex concerns in society today. Society has spent billions on soil conservation, yet it is unclear whether these efforts buy sustainability. From some perspectives, it is not always the most shallow or erodible soils that need protection. Further study about which soils need conservation merits individual consideration. We propose a general framework to examine the sustainability of resource management in objective measurable ways. A resource endowment used in production is modeled as an index of quality. This index, consisting of the most important identifying characteristics of the resource, is placed into a dynamic production model to: 1) ascertain how resource use adjusts to meet the requirements of different definitions of sustainability, and 2) how management decisions change with fluctuations in the resource quality. The economic, social and environmental impacts of management decisions are identified and the path of resource quality change is evaluated with respect to sustainability criteria. This framework is applied to the management of soils for agricultural production purposes. The relationship between production inputs and soil quality may differ across different soil types. Moreover, this relationship may change as the soil quality changes. Whether production remains sustainable as quality declines depends upon soil quality's relationship with output and other inputs. Data for actual soils and corn production inputs were evaluated in a three step simulation, regression and optimization analysis to address the following questions: 1)Do soil conservation policies meet sustainability objectives? 2)What are the impacts of different definitions of sustainability on the economy and the environment? 3)How do sustainability criteria affect optimal soil management? Results show that the decisions to use or conserve soil, and the economic and environmental impacts of these decisions, are highly dependent upon soil type and on how sustainability is defined. In some cases soil can be managed the same under any definition, but in other cases different sustainability concepts were at odds with each other. Generally, the deeper and better the soil, the more obvious and consistent was the solution for sustainability and the more likely is conservation to mean the same thing as sustainability. The results can be used to determine which soils need to be protected most, how risk and uncertainty can make soil conservation more important, and provide other information relevant to soil conservation policy makers.

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A-0082

Impact of Upland Agriculture and Conservation Project (UACP) on Sustainable Agriculture Development in Serang Watershed, Indonesia. Naik Sinukaban, Professor of Soil and Water Conservation, Bogor Agricultural University, Jurusan Tanah – IPB, Jalan Raya Pajajaran, Bogor INDONESIA

The poor economic conditions and low productivity of upland agriculture in marginal land have trapped the farmers in a poverty circle. Several attempts have been made to push the farmers out of the poverty circle. One of these attempts is the introduction of

conservation farming systems suited to those conditions. In Serang watershed these efforts have been introduced through the Upland Agriculture Conservation Project (UACP). This study was to evaluate the performance of the UACP in Serang Watershed (a part of Jratunseluna Watersheds). It is clear from this study that UACP has reduced soil loss drastically (60-90 %) eventhough the erosion rate still higher than tolerable soil loss (TSL= 10-12 ton/ha/yr) and is not compensated for by increased farmers income (10 to 30 %). The reduction of soil loss was ranged from 60 to 90 % and the farmers income increment was ranged from 10 to 30 %. The still high soil loss is mainly due to the low quality of terraces (one of the soil conservation practices in UACP) as a consequence of poor maintenance. Improvement of terrace quality and crop and management practices are certainly required to further decrease soil loss to reach the local TSL. The ability of farmers to maintain the introduced conservation technology is quite variable. There are four types of farmers (A, B, C and D) in the area based on their source of income. Their income was ranged from Rp 409.000 to Rp 1.347.000 per year. It was observed that the type A farmers in particular did not gain enough income to continue to maintain the conservation technology. Therefore, the type A farmers still need financial assistance to maintain the introduced farming systems. All farmers however, still need guidelines and further training to upgrade the conservation technology and improve the soil and crop management practices to enhance the sustainability of the introduced conservation farming systems. Recommendations to increase the sustainability of the introduced farming systems are discussed.

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A-0083

Soil conservation – An essential requirement of the sustainable agriculture system. Gh. Budoi, A. Penescu, D. Marin, C. Ciontu, L. Chira, Faculty of Agronomy, Bucharest, Romania

In the years 1980-1990 in USA the concept of Sustainable Agricultural System (SAS) was consolidated as an alternative to the Conventional Agriculture (Regnauld et al.1990, etc) or Industrial Agriculture (Elhers et al., 1990). The concept of SAS spread very fast all over the world. One of the requirements of SAS is the resource conservation. The soil is without any doubt one of the main resources of the Agriculture. Unfortunately, at present it suffers a heavy deterioration and this for many reasons: erosion, desertification, constructions, excessive or inadequate tillage, ignorance etc. Regarding the tillage it is important to remember the following: “Nature did not provide tillage; these are innovations introduced by man” (Cook, 1962); in Ohio, USA, are the longest continuously maintained No tillage research plot in the world (Dick et al.1997). The present paper describes the results of the researches carried out at the experimental field Moara Domneasca (located at 30 km far from Bucharest). Soil is a typical reddish brown with a clay loamy texture (35% clay and 34% silt). The objectives were to establish the methods for restoring and conserving the soil quality. Data obtained in 1991 compared to those of 1972 show an evident deterioration of the soil quality of the surrounding farms as for instance the decreasing of: a) soil structure stability – from 48% to 24%; b) humus content – from 2.65% to 2.30 %; c) no. of *Lumbricus terrestris* – from 30-40/m-2 to 5-6/m-2, etc. In one experiment, started in 1980, 5 types of crop rotations are studied. One of them includes *Medicago sativa* L. as an important crop to rebuild the soil structure. In the second experiment (arranged in a split plot design) and started in 1991, wheat and maize are cultivated in rotation. The performance of three reduced tillage systems has been researched here (based on paraplow, cizel or disk) as an alternative to moldboard ploughing. Everything is combined with five types of organic and mineral fertilizations. The performed analysis showed for cizel system, an increase in: soil organic carbon, structure stability, Ks, no. of *Lumbricus terrestris*; decrease of Bulk density, etc. The yields are closed to that of moldboard ploughing treatment. It is considered that in the future, when in Romanian agriculture, an adequately system of machines will be available, a minimum tillage will be largely practiced.

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A-0090

Crop Productivity and Surface Soil Properties of a Severely Wind-Eroded Soil. T. M. ZOBECK and J. D. BILBRO, USDA-ARS, Lubbock and Big Spring, TX USA

Wind erosion degrades soil quality by modifying soil properties important for optimum plant growth and productivity. In this study we evaluated soil properties and plant productivity of an Amarillo fine sandy loam soil that had been severely wind-eroded for 9 years, causing a loss of about 10 cm (over 1300 mt ha-1) of the soil surface. Cotton, kenaf, and grain and forage sorghum were grown and soil tests were performed on eroded, depositional, and noneroded sites. Erosion had significantly increased ($P<0.05$) sand content on the depositional area but caused little textural change in the surface of the eroded area compared with the adjacent noneroded site. The eroded area had significantly less Bray P1 and P2 phosphorus than the adjacent noneroded area. Few differences were found for other plant nutrients among the sites. The eroded area also produced significantly lower ($P<0.10$) grain sorghum yields and total biomass for grain sorghum and kenaf than the noneroded site. No significant differences were detected in forage sorghum yields or total biomass. Cotton total biomass was significantly lower on the eroded site than on the depositional and noneroded sites. However, cotton lint yields were not significantly different, probably due to severe insect damage.

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A-0092

Selection procedures of soil conservaiton measures in Indonesian regreening program. Fahmuddin Agus, Center for Soil and Agroclimate Research, Jln. Bogor, Indonesia

Regreening program is the national program of soil conservation on farmers' land with the aim of conserving natural resources and improving farmers' prosperity. Since the initiation of the program in 1976, little success has been gained. Institutional complexity, complicated planning procedures and inappropriate selection procedures of soil conservation measures are among the most prominent factors obstructing the success. This paper focuses the discussion on the field-level selection of soil conservation measures. The selection of soil conservation measures is conducted by each district-level soil conservation agency. The measures, along with background biophysical and farming systems information are documented in the Field Level Conservation Plan. In many cases, selected conservation measures are not directly related with field actual problems. Slope has been over-used as the main criterion for technology selection. Areas having slopes steeper than 40 % are devoted to tree crops (400 or more trees ha-1). For areas with slopes between 25 to 40 %, planting of around 200 trees ha-1 is recommended, and those with slopes lesser than 25 %, 100 trees ha-1 are recommended. Bench terracing or improvement of existing bench terraces is invariably recommended for areas with slopes lesser than 40 %. Bench terrace improvements include planting of fodder grass on terrace risers and lips, reorientation of commonly forward-sloping into backward-sloping bench terraces, digging up new or improving existing waterways, and building several drop structures in the waterways. These recommendations pay little attention to existing farming systems, the number and kinds of existing tree stands, soil properties and farmers' preferences. In a series of collaborative works between researchers and extension workers, we found out that lack of extension workers' ability to match theoretical principles with field actual and farmers' problems lead to excessive and improper recommendations. Long-term and stepwise efforts must be taken by the government to rectify this problem. The short term solution is to conduct intensive field training of extension workers to enable them to do pragmatic approach for problem identification and to facilitate farmers to select alternative measures in an interactive participatory manner.

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A-0093

Factors that cause deterioration of the land in the Province “Los Andes” (North Bolivian Highplateau). Javier G. Villegas, EMAG/QHANA

Province Los Andes is a representative area of the north Bolivian highplateau. It is located in the Department of La Paz, between the city of La Paz and the Titicaca Lake. It covers an extension of 1,658 Km2. In this province inhabit 62,185 people. The inhabitants are mainly of Aymara Race, with a few Quechuas and Mestizos. The economical activities that generate monetary income for the people are basicly of agricultural origin: potatoe, oats, barley, milk, cheese, beef, pork, and llama. There are some farmers devoted to raise trout in natural and artificial lakes. The farming is severely affected by climatological factors such as frost, drought and hail. Local farmers distinguish the following types of soil: a. Sandy soils “*Ch'alla*” (in Aymara language), in these soils are cultivated quinua (*Chenopodium quinoa*), wheat, oats and barley, generating regular production. The effect of the erosion of these soils is minimal, being the wind erosion more likely to happen than the hydrical; b. Black soil “Chiar laka”, in these soils are cultivated potatoes, alfalfa, wheat and oats generating good production. The form of frequent erosion is hydric; c. Saline soil “Collpa”, not useful because of high salt content; d. Clay soils “K'inku”, in these soils are cultivated alfalfa, quinua, generating regular production, because of heavy soils the infiltration of water is reduced; e. Turfy soils “Pacu”, its main characteristic it is the high content of humidity and organic matter, where they cultivate potatoes, wheat and oats. The production is regular and the erosion effect is low. The incorporation of manure is done only with the potatoe production, and in quantities under the planting requirement. The maximum quantity of animal manure application does not go over the two tons per hectare. After the potatoe culture, the farmer later cultivate wheat and oats in the same land. As a consequence of the erosion and the degradation of the soil, the rocky soil increases. It is common to find 50 to 60% of stony grounds. These grounds no longer qualify for agriculture and then increases the pressure over the terrains that still are apt for farming. The farming of pasture fields has increased in the last couple of years, in the mean time the areas of native prairies have been decreased. The production of crops and forages is done under primitive technological conditions. Upon taking place without irrigation, the production that one expects per cultivated unit are very uncertain, since they depend of the distribution of rain during the farming period, and about the consequence of plagues and diseases. Within the cattle raising we have: Livestock for meat and milk based on creole of ancient tradition in the area (brought by the Spaniards during the Colony); the milk cattle raising based on livestock crossbred with Holstein and Swiss Pardo breed; in importance it follows the raising of ovines and pigs. Because of adaptation problems to the considerable high altitude of the region, the pure The Bovine livestock for meat and milk, according to the cryteria of the villagers, is the one of mayor income security that offers them, and besides of least risk than the agriculture. The pressure exerted by the

cattle raising over working the land has reached such a degree, that the practice of the "rest" of the praire, virtually has disapeared. Overgrazing has caused the reduction of the vegetal covering over the ground, generating erosion. One can observe in many sites the presence of laminar erosion, incipient rills and gullies even in flat lands. In the communities of this region one cookes with dried manure, logs of shrubs, and in some other times with peat. The use of gas is done in greater proportion during the rainy season. The use of manure as combustible is totally negative for the fertilization of the soil, the same thing one can say about the use of peat. The collection of log from the few shrubs that exist in the region is also totally negative for its ecology consequences. In spite of all the limitations found for agriculture, it constitutes a challenge for agronomists and scientists to develop innovative and sustainable ways of production.

A-0094

Study on the Model for Predicting Soil Erosion and its Application in Arid Area. Chen YaningXinjiang Institute of Geography, Chinese Academy of Sciences, Urumqi, China

The paper briefly discusses method and principle to set up a model for predicting soil erosion in arid area. First the soil erosion factors are analyzed based on natural environment and field investigation, and next by use of Geography Information System (GIS) all factors including topographic factor (LS), precipitation factor (R), vegetation factor (V) and soil erosionable factor (K) and obtained for building up the model for predicting soil erosion in the research area. According to the soil erosion environment and the analysis of influential factors to soil erosion the model of soil erosion is set up as follows: EUA=A● K● LS● V●D. The parameters of the model is determined with method and theory of grey controlling system. Then, the calculation of soil erosion volume is simulated and the intensity of soil erosion is graded in research area. And finally, the precision of experimental results is analyzed together with data obtained from field investigation.

Chen Yaning

A-0096

Community based Natural Resource Development, A Case Study of Ngara district – North Western Tanzania. Pitio Ndyeshumba, District Rural Development Project, Ngara, Tanzania

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A-0098

Integrated sysems for knowledge management (ISKM) - an approach for achieving sustainable land and water use in the 21st century. Bosch, O.J.H., Allen, W.J., Gibson, R.S. and Hunter, G.G., Landcare Research NZ Ltd., Alexandra

Achieving more sustainable land and water use depends on high quality information and improved use of the information within a collaborative decision-making process. ISKM provides a framework for guiding our actions as we manage real world problem situations. It builds on principles of experiential learning and systems thinking, and is applicable to developing the knowledge and action needed to change real situations constructively. The ISKM framework consists of simple and familiar processes used in other fields of cooperation, and was designed around ~~the~~ five basic actions: One - identify the problem and set a management target; Two - search for information on how to achieve the target; Three - implement the best management practice available; Four - evaluate the outcome; Five - adapt the management if required. To encourage people to carry-out these steps in issues related to natural resource management, the ISKM framework helps to develop appropriate processes for community participation; bring people together to share their knowledge (local and science) and jointly develop best management practices and/or action plans; include monitoring in these action plans to assess and interpret the outcomes of management actions within a management information system to potentially benefit all those that did not have the opportunity to be directly involved; develop feedback loops to maximise the benefits from monitoring and evaluation and hence develop a collaborative learning/self-improving environment. ISKM has been applied to a range of environmental issues: the development of improved management practices for preserving conservation values; weed and pest control in New Zealand; ecto-parasite control on sheep in Australia; and rangeland management in Turkey. The lessons from these projects were used to develop and refine the application of participatory approaches in resource management. Software applications developed through this approach, include computerised management information systems (easily operated stand-alone systems, but also designed for the Internet), a condition assessment and interpretation module, a computerised herbarium to assist with the identification of indicator plant species, and a grazing capacity assessment model. The three latter applications have been combined in a single user-friendly package through a system to help users with interpreting resource and environmental data (REDIS). REDIS also includes a maintenance module, by which the different modules can be customised for direct and easy application in any country, region, or farm. Geographical Information Systems form the basis for extrapolating the assessments from the paddock to the farm, management area or regional level.

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A-0099

Impact of Communication in Adoption of Field Shelterbelt Technology among the Farmer in Indian Thar Desert. R.N. Singh, Central Arid Zone Research Institute, Jodhpur India

Wind erosion is one of the foremost problem in the sustainable development of the Indian Thar Desert located west of Rajasthan State. Studies at the CAZRI, Jodhpur had earlier shown permanent vegetation- tree, shrub and grass-over land surface as central to control wind activities. This paper presents the impact of communication in adoption of field sheterbelt technology among the villages between 1990 and 1997. Since 1990, the author has been educating about the field Shelterbelt technology in a village-Sar of the Indian Thar Desert. The village represents an exclusively dryland agriculture situation dominated by sandy Loam. Average rainfall is 336 mm. Soil moisture holding capacity is 120 mm for 1 m soil profile. The crop failure is common in the area. The formal and informal method of education was adopted to educate the villages three rows tree plantation around boundary of the farmers' fields. Timely and meticulous use of communication channels covering all section of the village society and concentration of effort in a mission mode were the main components of the communication approach adopted in the village. No targets were fixed. The programme was allowed to grow as it progressed. The date and time schedule for discussion with the villagers were not fixed in advance. Villager's convenience were the foremost for scheduling the visit. The villagers readily adopted the practice when they were approached in 1990. The communication was further intensified. The nursery raising was started in the village in 1991 to fulfill great demand of the seedlings. Two three villagers raised nursery confidently each year. In all, 301 villagers adopted it and planted 85,775 seedlings between 1990 and 1997. They planted seedlings with festivity by the family members of all age and sex group. They adopted on row plantation rather three rows plantation. Intimate attachment of the villages with the trees, simple practice and effective communication carried out through a systematic approach are the central of this success story.

R.N. Singh

A-0100

Impact of Upland Agriculture and Conservation Project (UACP) on Sustainable Agriculture Development in Serang Watershed, Indonesia. Naik Sinukaban

The poor economic conditions and low productivity of upland agriculture in marginal land have trapped the farmers in a poverty circle. One of these attempts is the introduction of conservation farming systems suited to those conditions. In Serang watershed these efforts have been introduced through the Upland Agriculture Conservation Project (UACP). This study was to evaluate the performance of the UACP in Serang Watershed (a part of Jratunseluna Watersheds). It is clear from this study that UACP has reduced soil loss drastically (60-90 %) even though the erosion rate still higher than tolerable soil loss (TSL= 10-12 ton/ha/yr) and is not compensated for by increased farmers income (10 to 30%). The reduction of soil loss was ranged from 60 to 90% and the farmers income increment was ranged form 10 to 30%. The soil loss is mainly due to low quality of terraces (one of the soil conservation practices in UACP) as a consequence of poor maintenance. Improvement of terrace quality and crop management are certainly required to further decrease soil loss to reach the local TSL. The ability of farmers to maintain the introduced conservation technology is quite variable. There are four types of farmers (A, B, C and D) in the area based on their source of income. Their income was ranged from Rp 409.000 to Rp 1.347.000 per year. It was observed that the type A farmers in particular did not gain enough income to continue to maintain the conservation technology. Therefore, the type A farmers still need financial assistance to maintain the introduced farming systems. All farmers however, still need guidelines and further training to upgrade the conservation technology and improve the soil and crop management practices to enhance the sustainability of the introduced conservation farming systems. Recommendations to increase the sustainability of the introduced farming systems are discussed.

Naik Sinukaban

A-0101

The Use of Native and Nodulated Mucuna Pruriens and Crotalaria Juncea: An Approach for Conserving Soil Fertility of Cropland. Mandimba Georges Raphael, Laboratoire de Biotechnologie. Institut de Development Rural I.D.R. Brazzaville, Congo

Mucuna Pruriens and *Crotalaria juncea* are native legumes growing in diverse agroclimate environments characterized by spatial and temporal variations in rainfall and by soils of varying physical and chemical properties. M. Pruriens produced 31 nodules per plant, an average of nodule mass of 306 mg per plant and accumulated 227 kg N per ha. *C. juncea* produced 98 nodules per plant, an average of nodule mass of 89 mg per plant and accumulated 114 kg N per ha. The use of M. pruriens as green manure on the grain yield of the succeeding crops of maize is quantified as a fertilizer-N equivalent of as much as 92 kg N- fertilizer per ha, 96 kg N-fertilizer per ha on the grain yield of a short – duration genotyper of soybean FN3 and 84 kg N-fertilizer per ha on the grain yield of a medium – duration genotype of soybean IRAT 274. Similarly, the N

contribution of C. Juncea as green manure on the grain yield of maize is quantified as a fertilizer –N equivalent of as much as 78kg N-fertilizer per ha, 70 kg N-fertilizer per ha on the grain yield of a short –duration genotype of soybean FN3, and 65 kg N-fertilizer per ha on the grain yield of a medium-duration genotype of soybean IRAT 274. Results demonstrate the N contribution of native and nodulated legumes on the soil fertility. This management practice evidences the way for conserving soil fertility in cropping areas.

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A-0103

Geochemistry Of 7be, 137cs, 226ra And 228ra In The Soils Of Karst Ecological Systems In Yunnan-Guizhou Plateau, China And Their Erosion Trace. Bai, Z.G.. Institute of Soils and Fertilizers, Chinese Academy of Agricultural Sciences, Beijing, China, Wan, G.J., Wang, C.S., and Huang, R.G., State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China

The Yunnan-Guizhou Plateau is located on the second step of the eastern Himalaya Mountains, southwestern China. It is an interweaving region of the southeastern Monsoon(the Pacific Ocean) and the southwestern monsoon(the Indian Ocean) with serious soil erosion and violent karstification. It is of note that the soil erosion modulus could not really indicate the degree of the seasonal and partial transport of soil particles, owing to karst landscapes and erosion mechanisms. Particle-reactive nuclides can potentially be used to study the accumulation and/or erosion of soil particles. In this study, an attempt was made to deal with these problems using 7Be, 137Cs, 226Ra and 228Ra. The geochemical speciation of 7Be, 137Cs, 226Ra and 228Ra in the soils was determined. The results showed that more than 85% of 7Be, 137Cs, 226Ra and 228Ra were bound to the Fe-Mn oxide, organic and residual fractions, which indicates that they can move with soil particles and serve as tracers for erosion and/or accumulation of soil particles as well as sediment dating. Differentials of 7Be, 137Cs, 226Ra and 228Ra activities in geochemical speciation in the process of erosion and/or accumulation of the soil particles can be used to trace the erosion states of surface soils. 7Be activities in the soil profiles presented an index decrease with soil depth. Its maximum penetrative depth in the undisturbed soil profiles was 0.3¡«0.6 g/cm2, i.e., 6¡«10mm in situ. Inventory, apparent activity and maximum penetrative depth of 7Be in soil cores as well as relative erosion or accumulation rate can be taken as trace parameters for seasonal soil erosion. The erosion trace model was built and applied to the erosion rates in the Lake Hongfeng Watershed. The estimated seasonal soil erosion rates via the model were examined and coupled with the sedimentation rates of Lake Hongfeng.

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A-0104

Soil Recovering Throughout Afforestation: Case Study in Las Tunas. M.Sc. Jorge Labrada Labrada

A case study for the north territory of the province Las Tunas, in Cuba, with a general background which includes an overview of the main issues - geographical description, geology, hydrogeology, flora and fauna, soils and land use - as well as the history of the area in a past four decades, which can contribute to understand the local problematic of soils in the eastern region of Cuba is presenting out in this paper. The intensification of agriculture, with the increase in mechanization, chemicals' use and irrigation (which had provoke in many cases the appearance of a secondary salinization processes in a vast area), associated with the high deforestation in savannas and overgrazing, are mentioned as sources with jointly with genesis of land degradation processes, socioeconomic dimensions of desertification and processes surrounding agricultural changes and their human implication are also mentioned. It is the aim of this study to contribute towards the establishment and development of a complex a of approaches to the improvement of plant and soil productivity. Among the approaches, afforestation (through the introduction of silvipastoral systems), is seem as a tool for land management system of a soils' fertility recovering for more than 600 Ha of degraded lands in Las Tunas. Some forest restoration schemes are proposed as actions and the primary aim of restoring the soil and disturbed hydrologic networks. Cost - benefit analysis as an useful economic tool for evaluating costs is also presented. The potential advantages of this complex of approaches are focused not only on their environmental impact, resulting for improving in soils' characteristics, increasing it availability for different uses, and also to the social benefits throughout creating options for social development.

M.Sc. Jorge Labrada Labrada

A-0105

Use of Some Natural Pasture Plant Species For Erosion Control in Southern Turkey. Mehmet Aydin, Ismail Çelik, Aytekin Berkman

An investigation on the use of common natural pasture plants, *Rosmarinus officinalis* and *Putoria calabrica* for water erosion control in Southern Turkey was carried out for 3 years (1995-97). The slope of the experimental field is 30% and the size of plots was 7 m in length along the slope and 3 m in width. During the experiment, total precipitation was 1859 mm 57 out of 92 rainfall events were erosive due to runoff. The amount of soil and water losses by runoff were found to be 30.1, 91.8 and 194.2 ton/ha; 113, 372 and 488 mm for *Rosmarinus officinalis*, *Putoria calabrica* and bare soil plots, respectively. Results suggested that both of the plants can be used for controlling soil erosion. Moreover, it was found that soil loss in *Rosmarinus officinalis* plots was 67% and 85% less that those of *Putoria calabrica* and bare soil plots.

Mehmet Aydin

A-0107

Soil restoration and agroforestry with small farmers, Dominican Republic. Mamerto Valerio, Environment & Development in the Caribean, Santo Domingo, Dominican Republic

A-0108

Land Application of Beef Cattle Manure. J.E. Gilley, USDA-ARS, University of Nebraska, Lincoln, NE and B. Eghball, Assistant Professor, Department of Agronomy, University of Nebraska, Lincoln

Beef cattle manure can be used as a source of plant nutrients that otherwise would be provided by inorganic fertilizer. Following land application, areas where manure is applied are frequently tilled to conserve nutrients and minimize surface water quality concerns. However, tillage may also substantially reduce residue cover thus increasing the potential for erosion. A rainfall simulator was used to measure solids (sediment and manure) and nutrient transport from plots where a single application of beef cattle manure had been applied to sorghum and wheat residue under both no-till and tilled conditions to meet corn nutrient requirements. Additional experimental treatments included the application of inorganic fertilizer and an untreated check. Under no-till conditions, total solids transport was 3.9% and 1.1% of the mass of manure applied to sorghum and wheat residue areas, respectively. Application of manure under no-till conditions resulted in a significant increase in the concentration of bioavailable P and ammonium as compared to the tilled condition. However, total and particulate P concentrations in runoff were generally less for the no-till than the tilled plots. Tillage caused a significant increase in the concentration of total P and nitrate, when initial soil nutrient levels were high. Under both no-till and tilled conditions, P-based manure application resulted in dissolved P concentrations < 1 ppm, the critical dissolved P standard. Thus, because of the reduced erosion potential, it is suggested that manure be applied under no-till conditions to meet P-based nutrient requirements, with the addition of supplemental inorganic N fertilizer. Narrow grass hedges can serve to reduce the transport of solids and nutrients in runoff from areas on which beef cattle manure is applied. A study was conducted to determine the effect of 0.72 m wide switchgrass hedges on the transport of sediment following a single application of beef cattle manure under no-till and tilled conditions. Tillage consisted of a single disking operation along the contour on an area used for continuous corn production. Manure was applied at a rate of 46.4 Mg ha^{-1} to meet corn nitrogen fertility requirements. Inorganic fertilizer and an untreated check were also included as additional experimental treatments. Total solids transport above and below the grass hedges on the no-till plots represented 1.3% and 0.6%, respectively, of the mass of applied manure. The narrow grass hedges reduced the concentration of dissolved P and bioavailable P from manure application by 48% each on the no-till plots, and by 13% and 25% on the tilled plots, respectively, as compared with no hedge. When grass hedges were used, runoff nitrate concentration from manure applied to the tilled plots was reduced by 28%. Narrow grass hedges established along the contour can serve to substantially reduce the concentration of solids and nutrients in runoff from both no-till and tilled areas on which manure has been applied.

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A-0109

The Degradation Processes of Ameliorated Sodic Solonetz-Olonchak Soils of Ararat Plain and Elaborating Complex Measures for Their Restoration. V. Nuridjanian, R. Manukian, A. Oghanisian, Research Institute of Soil Science and Agrochemistry. Yerevan, Republic of Armenia

Elaborated agriculture system on ameliorated sodic solonetz-solonchak soils require an observation of hydrotechnical and agromeliorative complex measures. The breaking of hydrological working regime of drainage system brought to an increase of ground water level, mainly brought to hydrocarbonate-natrium chemise of mineralization and to development of secondary salinization and alkalization, which nowadays takes place in ameliorated solonetz-solonchaks and irrigated meadow brown soils which are the basic earth fund of agricultural production of Ararat plain. The soda chemise of ground water affects negatively on soil-plant system in consequence of it the yield of the cultivating crops reduced to 40-50%. It's noticeable that there appear ions in the composition of soil solution of ameliorated solonetz-solonchaks and irrigated meadow brown soils, and connected with it soils are characterized with weak buffer and are easily alkaline. Secondary soil salinization takes place under the influence was also irrigation of weak mineralized alkaline water under ground water hard-outflow conditions. That's why its necessary to control the water-saline regime of mentioned soils the rhythmical work of drainage-collector system, ensuring an optimum ground level, observing of norms and periods of irrigation regimes for cultivating agricultural crops. For restoration of

ameliorative conditions of soils for increasing of their productivity elaborated a complex of measures: to normalize functions of drainage-collector system with purpose of reducing the ground water level below the critical (3,0-3,2m); to implement a chemical amelioration of soils;to observe norms and periods of elaborated irrigating regimes for cultivating agricultural crops. To realize a systematical control on the soil-water plant system in the period of agricultural usage.

V. Nuridjanian

A-0111

Land Degradation in Northwestern Jordan: Causes and Processes. S. A. Khresat, Z. Rawajfih and M. Mohammad , Jordan University of Science and Technology, Irbid, Jordan

Improper farming practices, overgrazing, the conversion of rangelands to croplands in the marginal areas, and uncontrolled expansion of urban and rural settlement at the cost of cultivable land, are among the major causes of land degradation in northwestern Jordan. The purpose of this study was to discuss the major causes of land degradation in northwestern Jordan. Six sites that receive different amounts of annual precipitation and different vegetation types were selected to represent the major agricultural areas in northwestern Jordan. The major soil properties that can be linked to land degradation were studied. Desertification in northwestern Jordan is taking place through loss of soil fertility and productivity, overgrazing, and water and wind erosion. Erosion by wind and water is considered the major cause of land degradation in the area. These soils do not contain much organic matter and their alkaline reactions reduced the availability of phosphorous and macronutrients and consequently led to very low crop yields.

S. A. Khresat

A-0112

Sustainability and Economic Viability of Conservation Tillage Systems for Root Crop Production in Nigeria. A.P. Onwualu, Sustainable Development and Environment Project, Agricultural Engineering Department, University of Nigeria, Nsukka, Nigeria

In eastern Nigeria, agricultural land is fast decreasing in size, due to the use of the land for urbanization and commercial activities. Yet, economic problems are forcing many inhabitants' back to farming, where they practice agricultural intensification and extensification. This involves continuous use of the same piece of land for multiple cropping without replenishment of nutrients (fertilizer is too costly,) and the use of marginal lands . Conservation tillage systems have been developed to reduce the negative impact of this "mining of soil". In this study, Sustainability Indices (SI) and Economic Viability Indices (EVI) were used to evaluate six conservation tillage systems and land use practices for five years (1993-1997) at Nsukka. The six tillage systems evaluated were: (1) traditional (mounds); (2) traditional with organic manure; (3) traditional, organic manure, mulch and erosion check; (4) plough, harrow, ridge; (5) plough, harrow, ridge with organic manure and (6) plough, harrow, ridge, organic manure, mulch and erosion check. Yam, cassava, maize and other vegetables were grown using the multiple cropping system practiced by farmers in the locality. Solid properties were monitored continuously. Other data collected were cost of inputs and outputs including planting materials, implements, labor, crop yield, soil nutrient status, soil loss and moisture status. Farmers were involved in the project as observers. Sustainability was measured by Intertemporal Total Factor Productivity (TFP) which is the rate of change of the index of outputs divided by the index of inputs. Economic viability was measured by interspatial TFP which is the logarithmic difference of the indices of the value of inputs. In each case, natural resource stock and flows were considered in addition to conventional resources. The theoretical basis for this procedure was developed by scientists at the International Institute of Tropical Agriculture, Ibadan. Over the five-year period, the average SI obtained were 0.85,4.16,9.4,0.32.3.51,6.86 for systems 1,2,3,4,5,6 respectively. The corresponding values for EVI were 2.2, 4.95, 7.86, 1.31, 3.62, 6.75 respectively. Thus the tillage systems involving some form of soil conservation and organic manure gave higher sustainability and economic viability than other. These results have been used to convince participating farmers to adopt more soil conservation measures in the area which has improved the profitability of their operations while ensuring that soil fertility is maintained.

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A-0113

Fertilizer use decisions and the rural scale-scale farmers: The case of Lesotho. J.N. Mbata, Department Of Agricultural Economics And Rural Sociology, The National University Of Lesotho, Lesotho. Southern Africa.

The kingdom of Lesotho, an enclave of South Africa is a small mountainous kingdom. With an estimated land area of 30,340 km^2, only about 13% is suitable for arable production. Although, agriculture contributes only about 14% of the Gross National Product (GNP), more than 80% of the population are small-scale farmers and derive their livelihood directly from the sector. However, agricultural production in Lesotho is characterized by very low productivity. The actual yields of the major food crops are low and well below what is both technically and economically feasible. The low yields of crops are generally due to the poor soils which characterize the foothills and the lowlands where most of the production takes place. In addition, empirical evidence shows that a high amount of soil depletion of major plant nutrients due to the extensive extraction cultivation system adopted by the farmers. The use of both organic and inorganic fertilizers for soil regeneration and conservation is low. Although, most farmers are also engaged in livestock production, the organic residues from animals and plants are traditional sources of fuel for most farm families in Lesotho. On the other hand, the actual amount of inorganic fertilizers applied by the farmers are low even when it has been shown that moderate use of fertilizers can increase yields by up to 200-300 percent. This current study therefore develops a logit model to quantitatively assess the determinants of fertilizer adoption decisions by small-scale farmers in rural areas of Lesotho. The results from the study highlight the importance of such sociological factors as farm size and tenure status as well as economic factors like input costs and farm income on the probability of fertilizer adoption by small-scale farmers in Lesotho.

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A-0114

Fodder Dissemination for Soil Conservation in the Central Kenyan Highlands**.** Mick O'Neill, Senior Agronomist, International Centre for Research in Agroforestry (ICRAF), Nairobi, Kenya, Paul Tuwei, Agronomist, George Karanja, Soil Scientist and Barak Okoba, Soil Scientist, Kenya Agricultural Research Institute (KARI), Embu, Kenya

The greatest constraint to improving productivity of the livestock sector in sub-Saharan Africa is the low quality and quantity of feed resources. With milk and meat imports projected to increase dramatically, there is increasing interest in leguminous fodder trees to help solve the feed problem. Successful on-station and on-farm trials carried out by the National Agroforestry Research Project (NAFRP) identified *Calliandra calothyrsus*, a leguminous fodder tree, as a species that could be grown on-farm and used as a substitute for purchased dairy meal to improve the basal fodder diet of napier grass (*Pennisetum purpureum*). Contact farmers were enthusiastic about using calliandra as a dairy meal substitute. Feeding trials confirmed the effectiveness of calliandra as both a supplement to the basal diet and a substitute for dairy meal. Expressed in laymen's terms, using calliandra as a supplement or a substitute increases a farmer's annual income by about US$ 150 a cow a year. The number of farmers using calliandra increased gradually during the early and mid-1990s. In January 1997, NAFRP began to facilitate the dissemination of calliandra and popularize its use by small-scale dairy farmers. Because of the limited size of farms in the highlands of central Kenya (1.9 hectares on average), researchers and farmers focused on integrating calliandra into the existing farming system, rather than planting the trees in pure-stand fodder banks. Niches preferred by farmers (50%) were on soil conservation structures and along the contour of sloping fields. Group or community nurseries were developed and information about the potential benefits of calliandra was disseminated to farmers. Farmer groups received one kilogram of calliandra seeds and basic nursery management instructions. During the two rainy seasons of 1997, nearly 88 500 seedlings from these community-based group nurseries were transplanted into fields of more than 385 farmers. Based on the need for 500 seedlings a cow a year, enough seedlings were transplanted to support more than 177 cows. At a net benefit of US$ 150 a cow a year expected to begin in 1998, this represents a contribution of US$ 26 550 a year into the community. Through NAFRP support, additional group nurseries are developing their own capacities for calliandra production. Preferred niches continue to be along contours thereby maintaining environmental quality and contributing to the sustainable stewardship of the natural resource base.

Mick O'Neill

A-0115

Ecologically Sustainable Soil: the Role of Environmental Policy and Legislation. Dr Ian Hannam, Sustainable Land and Coastal Management Division, Department of Land and Water Conservation, 10 Valentine Avenue, PARRAMATTA 21 2105 NSW AUSTRALIA

This paper raises the issues of ecosystem health, sustainable use of the soil and the role of environmental policy and law in achieving long term ecologically sustainable development. It discusses emerging concepts from the fields of ecology and sustainability that describe how the health of ecological systems are assessed, the relationship of these concepts to sustainability and how environmental policy and law can be specifically developed to help implement sustainability at a national, regional and site level. Sustainability refers to the longevity of a system and health indicates the overall quality of its performance. A key criterion for a healthy ecosystem is that it be sustainable, especially healthy soil. Sustainable soil is a desired land management outcome. A desired model of social decision making, including natural resource law and policy should provide for: stakeholder dialogue and consensus building; evolving, adaptive and quantitative assessment of the soil resource; integrated resource management; and land use regulation. Many environmental laws and policies are being developed to specifically provide for ecosystem health and land use sustainability. A significant feature of the last decade has been an improvement in social decision making systems to adequately mediate between conflicting interests in land resource planning and

land use, and reach a long-term sustainability goal. For many years soil conservation policy and law was the predominant area of law to manage and control soil and land degradation. Since the early 1980's with the upsurge in global sustainability interest, there has been substantial development of global conventions, treaties and strategies for sustainable development (eg, the World Commission on Environment and Development 1987, the United Nations Conference on Environment and Development 1992, the Convention on the Conservation of Biological Diversity 1992, the Commission on Global Governance 1995). These have been used variously around the world to reform natural resource laws and policies and produce new integrated resource management law and policy. The paper outlines significant recent achievements in the development of environmental law and policy which incorporate an ecosystem management and sustainable land use objective, directly benefitting the soil, and outlines a model that can applied in a reform process. Examples will be given of recent developments in Australasia, Asia and Europe.

Dr Ian Hannam

A-0116

GULTEM – The Model to Predict Gully Thermoerosion and Erosion. Aleksey Sidorchuk and Anna Sidorchuk, Geographical Faculty, State University of Moscow, Moscow, Russia

The three-dimensional hydraulic model GULTEM to predict rapid changes of gully morphology at the first period of gully development is presented. It is based on solution of the equations of mass conservation and gully bed deformation for different types of soil (including frozen soil). At the first, quick stage of gully development the following main processes occur: a) During the snowmelt or rainstorm event the flowing water erodes a rectangular channel in the topsoil or at the gully bottom. Change of the gully bottom elevations is controlled mainly by upward detachment of the particles from the bed and by sedimentation on the gully bottom. This process is described by transport equation; b) The vertical walls of this trench can be unstable. Shallow landslides transform a rectangular gully cross – section into trapezoidal along the period between adjacent water flow events if the depth of incision became more than critical value. In this case a model of straight slope stability can be used for prediction of gully sides inclination. The GULTEM was realised on the net of flowlines, evaluated from topographical DEM. The multy-layered soil texture (including top layer with the vegetation cover) was derived from DEMs of the top surfaces of each layer with similar lithology. The runoff due to snowmelt and rainfall was calculated from meteorological information with physical-based hydrological models. The model was verified on the data of gully's morphology and dynamics at Yamal peninsula (north of the Western Siberia, Russia). In this region the human developmental activities accompanied by deterioration of the vegetation and an increase of runoff causes intensive thermoerosion and erosion. To minimise it several methods can be tried: mechanical removal of the snow from gully catchments; vertical drainage of industrial and rainfall waters; covering of disturbed slopes with a peat layer; filling of the gullies with heavy loam and a peat cover; recultivation of vegetation cover. All these measures led to water discharge decrease and critical shear stress of erosion initiation increase. As GULTEM include these parameters, the effectiveness of land conservation measures can be checked by the numerical experiments. The numerical experiments provided with the model can be used to choose the system of land conservation measures and to stabilize buildings and constructions on the catchments with high gully erosion potential.

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A-0117

Evaluating the skill of soil scientists to detrmine morphological soil properties. Rae Ann Papp and Donald F. Post, University of Arizona, Tucson, AZ

Precise and accurate pedon descriptions prepared by field soil scientists using standard techniques and defined terminology are essential to the soil survey program. The confidence limits placed on soil interpretations are directly related to the accuracy by which soil properties are estimated or measured. Accuracy of field measurements are generally defined in terms of the extent to which soil scientist's judgements agree with objective criteria, usually laboratory analyses. For example, soil particle size and bulk density are generally used to predict the hydraulic conductivity of soils. Soil descriptions include other data, such as the stickiness and plasticity, structure, or color of the soil that could be used in algorithms or models to predict soil properties. This paper evaluates the skill and/or accuracy of professional soil scientists and soil morphology students to determine these parameters. If these data are more quantitative and the skill of predicting these erodibility and hydrologic soil groups. Also, it might be possible to place confidence limits on soil interpretations.

A-0119

The NGOs and land and water conservation in arid environment: An experience from Southern Tunisia. OUESSAR M., Institut des Régions Arides (IRA), Médenine, TUNISIA, F. LAFFAT, Association de Sauvegarde de la Nature et Protection de l'Environnement à Douiret (ASNAPED), Douiret, TUNISIA & D. GABRIELS Fund for Scientific Research of Flanders & Dept. Soil Management and Soil Care, Coupure Links Gent, BELGIUM

Localized at the fringes of the Saharan desert and occupying a strategic site on the crests of the Matmata mountains, the village of Douiret has been a focal point of an old Berber culture. The remnants (ksour, troglodyte houses, ...) and many land and water conservation structures still in use (jessour, cisterns, ...) are good indicators of a very rich typical drylands civilization. The Association de Sauvegarde de la Nature et de Protection de l'Environnement à Douiret (ASNAPED) is an NGO that was founded in 1986 in order to promote revitalization of Douiret's economy and way of life. ASNAPED's members include both local inhabitants and outsiders interested in preserving Douiret's ecology, archeology, history, and culture. ASNAPED's first objective was to restore the most important parts of the ancient town, such as the mosque, the primary school (which was transformed into a youth hostel), the retaining walls, and some of the houses. More recently, its strategy has broadened to include overall development of the local economy. Steps are being taken to revitalize the area's traditional agricultural economy. In 1995 and in order to preserve a large fruit trees (olive, fig, date palm, ...) growing zone and the small hydraulic structures and to maintain the hydroecological equilibrium in these regions at the fringe of the desert threatened by the problem of desertification, the ASNAPED launched a project of rehabilitation of damaged *jessour* (small earthen dikes) in a watershed near the village of Douiret and the creation of rainfall collection cisterns. The ASNAPED's role, in this as in its other projects, has been to develop the initial concept, identify funding sources, obtain funding, and direct the project's execution. During the entire process, ASNAPED acts as an intermediary between the project's different partners, such as the local population, governmental authorities, cooperating NGOs and organizations, funding agencies and donors. It was concluded that these indigenous soil and land conservation techniques can continue fully playing their roles if their management system is adapted to the new social and economical realities. It is there a corner stone of a sustainable agricultural development of these regions. The formation of watershed associations is already under experience. Other alternatives are to be studied and tested: private companies, co-operatives, ...

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A-0123

Magnetic treatment of water as a method for soil fertililty conservation. J.G. Bogatin; YBM Magnex International, Inc., Newtown, PA, USA, N.Ph. Bondarenko and E.E. Rokhinson, Agrophysical Research Institute of Russian Academy of Agricultural Sciences, St.-Petersburg, Russia,

One of the ecologically non-polluting ways of affecting natural water with the aim of soil fertility conservation may be the method for magnetohydrodynamic activation of natural water (MHDA NW). It consists in creating the water flows through spacely nonhomogeneous magnetic fields. The magnetic field being chosen as a reagentless physical factor capable of affecting certain physical and chemical processes. As an example we have studied changes in natural water due to magnetic treatment in a commercially available apparatus Magnalawn 2000. Features of a technological reception of magnetic processing natural water are considered. The condition for effective application of MHDA NW are determined. We recommend to use the method for treatment of hard irrigation water with pH > 7.2. Reclamation effect improves conditions of root layers due to: - better permeability of the irrigated water, - leaching out salts harmful for plants, - better dissociation of mineral fertilizers. Irrigation with magnetically treated water is most effective for soils with high soda content. We accumulated a considerable experience in the use of magnetic treatment for intensification of agricultural production. The results of these tests show acceleration of saline soil leaching which results in up to 25% decrease of water consumption. Application of magnetic treatment is found to be most efficient for soils with high concentration of soda. The reagentless and non-polluting MHDA NW-method may serve as a reserve for increasing soil fertility. This method should be of interest from the point of view of saving resources and it can reduce irrigation water rates in arid regions. The method may influence positively as to preservation of the planet water- and soil resources.

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A-0128a

Forest Farming: A component of Social Forestry Project in India Its relevance in arresting Land Degradation and augmenting sustainable Development of the Farming Community. SRI B.L. DAS, A.I.F,C., Ex-Chief Conservator of Forest, Orissa State (India)

Never before in the history of mankind the mere survival of Forest has been under so great a threat and over so wide an area as it is today. It was estimated by the World Resources Institute in Washington that every year about Eleven million ha. of Forests in the Tropics are lost. F.A.O. figures for the state of forestry inventory in the Tropics shows a much higher extent of Forest depletion in the Tropics. The alarming increase in Population has further worsened the situation, so much so, that there is very reasonable fear that depletion in forest area may increase more rapidly, in the next decade. According to a report published in May, 1997 from Washington, the world population will swell to 6.1 billion by 2000 AD from the current 5.8 billion. Taking the case of India, annually about one million ha. of Tropical forest are being lost. Deforestation has already reduced the quality of life of a large section of population due to flooding, Soil Erosion and many other natural Calamities. The position has been further worsened due to unprecedented rate of population growth. The effect of the galloping increase in population growth in the country has its adverse impact on Forests. India has a total Forest area of 77 million ha. out of which only 14.8 M/ha. considered commercially Productive and 45 M/Ha. as a source of small wood supply. Similarly the area under Agriculture is 143 M/ha. out of which 75 M/ha. are highly degraded. Giving an account of Rural Environment 76 percent of the population live in villages. The villages are the backbone of country's economy. But amongst the Rural Community the working age population has a large element of unemployment and makes nil contribution to economic growth. Besides there are also non-working age population. Therefore in the absence of rapid industrial growth the concept of Agro-based development has all through been considered as more appropriate in view of the opportunity it provides to absorb the vast rural labour with more gainful self-employment. Today's agriculture provides for 40% of the national Income and 70% of the employment opportunity. Thus from 70 million tons of Food Production in 1960-61, the country have reached a figure of 191 MT in 1996-97. But this growth in food production is being neutralised by population growth. During the 1997 pre-budget survey it has been estimated that while population growth is 1.6% and live stock 2%, the food production does not exceed 1.7%. The planners are of the opinion that Food Production should achieve a minimum growth of 3.5 to 4% if the population growth projected upto 2016 can be properly fed. The sharp rise in population has also limited the per capital availability of agricultural land from .48 to .14 ha. by 2000 AD. But the most disturbing trend is that, the absolute number of people depending on Agriculture for jobs and income is increasing rapidly with the increase of population. Therefore diversification of job opportunity and shifting of a sizeable percent of farming community and landless agricultural labour to Non-Agricultural pursuit are of utmost importance if the per capital Agriculture land is to be maintained in a good and productive condition. In this context, how Forestry can provide the much needed Non-Farming pursuit to absorb a sizeable position of the vast unemployed Farming community will be the main theme of the paper. The concept of Social Forestry in India is the outcome of this thinking. The concept of' social forestry as different from Traditional Forestry, shows that while traditional forestry admits Commercial Working of Forests supplemented by Plantations of commercially valuable species like Teak (Tectona Grandis) etc. The Social Forestry Programmes are mostly implemented by the villagers and monitored by the Forest Department of different States and N.G.O.s assisted by various Aid giving Agencies like World Bank, S.I.D.A. and C.I.D.A. and DANIDA in which roughly 75% of the project cost is borne by these Agencies and 25% by the concerned State and Central Government. Social benefits/sustainability are easy to perceive but difficult to measure. It may be seen that forest farming has to a great extent solved the fuel-wood problem in many parts of these two states. Small and marginal farmers, their women folk and children who were daily trekking to distant hills in search of fuel wood are no more following the beaten track. The supply of fuel wood is available in their farm lands. Some villages, the undersigned noticed are quite self-sufficient in fuelwood supply and even selling the surplus production to the neighbouring villages. Other social benefits include housing facilities, primary schools and health centres and a network of roads making these villages accessible to National Highways and other communication centres. Watershed management and water harvesting, implies water as a product of land. The quantity, quality and regimen of flow depending on Surface, Sub-surface and Base flows. In the countryside, one can see not too often a farmer making water harvesting structure, with random rubble masonary to feel his crop during dry spells. Even in towns and urban centres, water supply is mainly tapped from ground water rather than from rain water or flood water available in great abundance. Every year India gets an estimated 400 million hectars of rain and snow fall. But so far no real effort has been made to tap this enormous source of water. In most developing countries as in India land degradation is continuing at an alarming rate, due to depletion of Forests, Shifting agriculture, unchecked population growth and rapid industrialisation. Thus water scarcity is felt almost in every village or town and people have to trek long distances every day in search of water and thus millions of man hours are lost only in search of water, which can otherwise be gainfully employed in other spheres of activity, if possibilities are divised to tap rain water and flood flows. This is a point for discussion.

B.L. DAS

A-0132

The Impact of Farmland Leasing on the Use of Conservation Practices. Meredith Soule, Abe Tegene, Keith Wiebe, Economic Research Service, USDA, Washington, D.C. USA

Do owner-operators take better care of the land they farm than do renters? It has been argued that renters have little incentive to maintain soil fertility or control erosion since they do not own the land and thus do not benefit from long-term improvements. The answer to this question is of increasing importance as farmland leasing grows in the U.S. Over fifty percent of farmland in major corn, wheat, and rice-producing states and California was leased in 1992. Recent information on farmers and production practices from the 1996 Agricultural Resources Management Study (ARMS) conducted by the National Agricultural Statistical Service (NASS) provides us with a new opportunity to examine this question with relevant national data. ARMS data distinguishes cash-renters from share-renters, allowing us to test hypotheses about the importance of rental form in determining use of conservation practices. ARMS data also distinguish types of conservation practices, allowing us to distinguish the effect of tenure on the adoption of practices characterized largely by short-term profit concerns (such as conservation tillage) from practices for which the long-term impact on land productivity is a more important concern (such as strip cropping, grassed waterways and contour farming). Statistical analysis of a representative sample of U.S. corn producers shows that cash-renters are less likely to adopt conservation tillage than owner-operators. This is not surprising since owner-operators receive both the short-term profits from conservation tillage as well as the longer-term improvements in land quality. Share renters, however, are as likely as owner-operators to use conservation tillage even though they do not share the long-term benefits of land ownership. Share-renters behave differently from cash-renters because they do not bear the full cost of inputs when inputs are shared and because the landlord may be more involved in production decisions with a share lease than with a cash lease. We also analyzed the decision to use strip cropping, grassed waterways, and contour farming. Both cash and share-renters were less likely than owners to use these practices. Again, the findings confirm the notion that renters are less likely than owner-operators to use conservation practices with long-term benefits. Since evidence suggests that farmland leasing is on the rise in the U.S., the results of this study suggest the need to differentiate between operators by tenure status when developing programs and incentives to encourage increased adoption of conservation practices.

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A-0133

Modifications of the EROSION-2D model for conservation planning and an application in an agricultural watershed within the Belgian loess belt. ir. Jan Biesemans, Prof. Dr. ir. D. Gabriels, Prof. Dr. ir. M. Vanmeirvenne, University Gent, Dept. Soil Management and Soil Care, Coupure Links GENT, BELGIUM

For the design of erosion control measures in agricultural watersheds of the Belgian loess belt, an event based physical erosion-expert-system was developed. The expert system is based on the EROSION-2D model (Schmidt, 1991). The original soil transport function of this model consists of a linear regression between the unit sediment load and an erosion index. This erosion index can be calculated as the sum of the momentum flux of the raindrops and the momentum flux of the runoff water divided by a critical momentumflux, below which no sediment transport occurs. Because this critical momentumflux is difficult to measure, the original soil transport function is replaced by two new transport functions, one for the combined effect of sheet flow and raindrop impact and one for rill and gully flow. Both transport functions are based on the stream power concept. The rill transport function was proposed by Nearing et al. (1997) and was deducted from laboratory flume experiments. The transport function describing the combined effect of sheet flow and raindrop impact is deducted from 133 laboratory rainfall simulator experiments. These experiments indicate a linear relationship between the logarithm of the unit sediment load and the logarithm of the stream power (R^2 = 0.89), for all used soil types. Although these transport functions are valid for all agricultural soil types in the region, event simulations in a small agricultural watershed of 142ha located in the Belgian loess belt, show a large differentiation in soil erosion rates between different soil types. These differences can be explained by the large differences in infiltration properties (governed by the water retention curves) of the soils. It can be concluded that the different soil erosion rates are induced by the infiltration properties of the soil, and once runoff starts the unit sediment load is mainly determined by the properties of the overland flow.

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A-0136

A study on Change of the Landuse Form and its Ecological Effect in the Desert-Steppe area of Ningxia. Wen Yunchao

The central part of Ningxia is a desert-steppe area with a sparse population and fragile ecological position where over-grazing have caused grave degeneration of steppe ecosystem ; however, the south is an area of loess hills with over-population and severe loss of water and erosion of soil. The central desert steppe has been becoming oasis and an area of immigrant from south loess hills owing to the development of new irrigated area by pumping up the water of Yellow River to establish the new immigrant village there. Using government investment and credit of World Bank, the new irrigated area has been developed up to 32527 ha. 145 thousands population are immigrated here from the south loess hills in 1984-1994, a new ecosystem of oasis economic has been established, then the various good effects such as economic ¡¢social and

environmental were obtained, in which the variation of land using form is the prominent. In central desert steppe of Ningxia, except the original pasture and the non-irrigated farming, the irrigated farming horticulture and raise livestock has been developed. The different forms of water utilization including traditional irrigation and irrigation economizing on water were employed, as a result, it has lock shape varied artificial ecosystem. The survey showed that ecological effect are evidently different for the different ecosystem under the control of different landuse forms. Its concrete expression are in three aspects. Comparison of soil fertility; Situation of soil erosion and soil physical property; Procession of soil salinisation and desertification. These research results will provide scientific basis for land and water conservation, for establishing and perfecting artificial ecosystem.

Wen Yunchao

A-0137

Predicting Soil Productivity Loss Due to Erosion in Uruguay Referred to the Average Country Production of Beef and Wool on Natural Pastures. Fernando Garcia-Prechac and Artigas Duran, Dep. De Suelos y Aguas, Fac. de Agronomia de la UDELAR, Av. E. Garzon, Montevideo, Uruguay

USLE and RUSLE were reasonably adjusted and validated in Uruguay to predict soil erosion. Nevertheless, soil mass losses should be expressed in terms of soil productivity or land value losses, in order to guide soil management decision-making, and assess its impact in productive and economic terms. Procedures to do the last in the literature (like EPIC), are not validated in Uruguay, and express soil productivity in terms of crop productivity. Being extensive animal production, based on natural pastures grazing, the main agricultural activity in Uruguay (around 80% of the country territory), soil productivity loss due to soil erosion should be better expressed in these terms. Uruguay has a system of soil productivity assessment at individual farm level, that expresses soil potential animal production of beef and wool as a quantitative Productivity Index (PI), referred to the national average (PI=100). This system was developed 25 years ago overlapping soil maps at 1:20 000 scale, with the official records of production of 721 administrative divisions of the country, and the available experimental information. It was finally adjusted considering the opinion of qualified agronomists working as private consultants or official extensionists. The objective of this system was to guide land taxing, and became so widely accepted that from the 80's up to the present guides the land market. The system recognizes variations in its PI due to past soil erosion. Our work had two objectives. The first one was to quantify the different degrees of erosion recognized by the system, and its relationship with PI. The second one, was to develop a procedure to transform soil erosion rate estimates into PI loss estimates, and to give examples of its use. The linear regression between the numerically coded soil erosion classes (none, slight, moderate, severe, very severe) change, and the PI change had r2=0.77 and the slope indicates 21% of PI change for each soil erosion class change. Using 17 soils representative of the soil country variability, being the dominant soils of mapping units occupying 32% of the territory, soil loss predictions were made for 23 types of use and management, and converted in the time needed to loss 21% of their PI. Predictions ranged between 6 and 3528 years.

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A-0138

Effects of an anionic conditioner on soil structure and water infiltration. Brandsma, R.T., Fullen, M.A. and Hocking, T.J., School of Applied Sciences. The University of Wolverhampton, Wolverhampton, United Kingdom

'Agri-SC', an anionic form of ammonium-laureth-sulfate, has been recommended as a soil conditioner to improve soil structure and increase infiltration rates. To test its effectiveness on U.K. soils, field experiments were conducted on a cultivated Salwick series sandy silt loam soil (Hapludalf) at the Plant and Environment Research Unit of the University of Wolverhampton. In a short term experiment, sixteen 10 m2 plots were treated at 0, 594, 891 and 1188 ml/ha and infiltration rates measured one month later, yielding mean saturated flow rates of 12.2, 12.4, 18.8 and 19.3 cm/hr, respectively. In a longer term experiment, three 19.2 m2 plots were treated at 0, 594 and 1188 ml/ha and infiltration rates measured between 3-7.5 months after application on six different dates and locations. The results showed consistent increases in treated soils throughout each measuring period and on each sampling date. Furthermore, in contrast to the short term experiment, significant increases in mean saturated flow rates over the control soil were found for both application rates (13.0 versus 24.4 and 29.9 cm/hr, at $P < 0.05$ and $P < 0.01$, respectively). Electron micrographs of treated soil aggregates and elemental X-ray analyses of selected areas provided evidence of soil particle binding mechanisms. Distinct 'string' type features, seen as leads binding individual particles, were frequently encountered in 'Agri-SC'-treated samples at magnifications of 1000-1500x. Analyses of the strings showed high levels of S, which was undetected in untreated soil, far greater than the background concentrations of major soil matrix elements. Results suggest that relatively low application rates of 'Agri-SC' can effectively increase infiltration rates in a cultivated sandy silt loam soil. These changes will be directly due to improvements in soil structure and may be beneficial on irrigated land and fine soils with a tendency for waterlogging. Significant increases in infiltration rates on treated soil were measured when the plots were allowed to settle for >3.5 months after cultivation and conditioner application. Thus, effects appear dependent on soil settling and polymer penetration following cultivation and conditioner application, which in turn varies with precipitation and soil type.

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A-0139

Use Of Radio For Dissemination Of Environmental Conservation Technologies In Developing Countries: Experience Of Kenya Agricultural Information Centre. Joseph K Mburu Soil And Water Conservation Engineer And Rose M Kinoti Radio Producer

The numerous incidences of man-induced accelerated destruction, pollution and mismanagement of the environment including land, water and vegetation particularly in the developing countries has been documented extensively. The subject has also been a topic of many a fora at both local and international levels. There is a general consensus that the destruction of the environment is brought about by amongst other factors poverty, civil strive and wars, natural calamities e.g. droughts, imbalances between intensity of utilisation and land potential etc. Other important contributing factors could be inappropriate policies at the macro level, and at the local level disregard of the interrelationship between the various components in the ecosystem and how each one has to be nurtured to ensure reasonable and sustained livelihood. In an effort to enhance the rate of conservation of the environment different strategies have been tried with varied successes. Whereas the classical methods of extension e.g. face to face meetings, residential trainings, farm visits etc continue to play an important part in dissemination of information and technologies on conservation of the environment, more efforts are being put in the use of mass media and other channels. Many of the initiatives are based on the premise that empowering the land users is key to the sustainability of any approach on conservation of the environment. It is then not surprising that more effort in conservation is based on group approach and focuses on community empowerment. In addition with reduced budget for normal extension methods by the public sector the use of multi-media is gaining prominence. One such media which has great potential for developing countries is the radio. The paper highlights the advantages and limitations of use of the radio for passing messages to the grassroot rural population I comparing it with other mass media in terms of appropriateness, cost effectiveness etc. The paper analyzes real examples of several radio programme formats produced by the Kenya Agricultural Information Centre which icludes agriculture and environmental conservation messages and how these are received by the audience. It details how relatively complex technical messages in conservation are treated -to fit into radio formats and to be easily understood by the rural communities. The paper also gives some results of surveys conducted both for a vernacular and national programme on the impact of use of the radio in technology transfer. The paper would make extensive reference to real examples of both 'soap opera' and 'magazine' formats of productions made for both Kenya and Somalia conditions. The paper concludes by making a case for the radio as an appropriate media in dissemination of ideas particularly in communities that are far flung and where illiteracy is high. Also given will be tips on how soil conservationists/ environmentalists can work with radio producers to make high quality, relevant and practical programmes and how to involve target audience to enhance their participation in radio production. This is likely to be of interest to other scientists interested in use of radio as a means of disseminating relevant technologies to the rural population.

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A-0141

Sustaining Agroecosystems through sustenance of agricultural terrace systems. Ek Raj Ojha, PhD, Kathmandu, Nepal

Agroecosystems are most integrated with the existence of humankind since they provide the latter with the basic essentials viz.: food, energy, clothing and shelter. In many parts of the world, agricultural terrace systems form a considerable portion of the overall agroecosystem. They prevail from historical times in areas predominated by a steep terrain and offer sustenance to a large proportion of the population living in, around and even away from them. Agricultural terrace systems are an efficient adoption of steep lands to render crop production possible, expand cropland, check soil erosion, conserve soil moisture and nutrients, improve groundwater storage, ease farm operations, increase crop yields and beautify the landscape. However, their productivity and sustainability depend on many other components of the ecosystem. Just as the health of the ecosystem determines the prosperity of its inhabitants the inhabitants possess the capacity to maintain the ecosystem in a proper state only when they are sufficiently prosperous. Functioning of a regeneration cycle in the ecosystem is thus highly essential. Sadly, many agricultural terrace systems have now been beset with various constraints and problems impeding the growth of a progressive chain of desirable changes. The economic and environmental components, in particular, seem to have been in a vicious cycle of degradation. Under such circumstances, especially when the world population is growing rapidly and the amount of flat, arable land is finite, rehabilitating the degrading terrace systems and using them appropriately have become increasingly important.

Ek Raj Ojha

A-0143

Changes in environmental regulations and the implication on the pineapple industry in Malaysia. M. H. A. Husni, O. H. Ahmed, Department of Soil Science, Faculty of Agriculture, and A.G. Awang Noor, Department of Forest Management, Faculty of Forestry, Universiti Putra Malaysia (UPM), Serdang, Selangor MALAYSIA

In Malaysia, pineapple is largely cultivated on peat. The crop residue is managed through burning. The recent haze problem in South-East Asia has led to increase in the penalty on open burning. Consequently, zero burning has been proposed as an alternative to crop residue burning but the adoption of the practice is still at its infant stage. This paper looks at the implication of increasing the fine on open burning on the pineapple industry in Malaysia. Treatments used were: (1) leaves residue removed and fertilization and (2) leaves residue burnt and fertilization. At maturity, the average weight of fruit for each treatment was determined. The weight was multiplied by plant density (56,250) to estimate the total yield/ha. The product of the total yield/ha and farm-gate price gave the gross revenue of crop production. Cost of labour was based on the wage system practiced by the estate. Farm-gate market prices were used for farm materials and other inputs. Cost of land was based on annual rental value for pineapple plantation. Interest rate of 10% on capital was adopted. Polluter Pay Principle (OECD, 1975), the Malaysian Environmental Quality (Clean Air) Regulations, 1978 and 1998 (amended) and Air Pollutant Index (API) were used to value pollution. Land Expectation Value (LEV) was used to compare the viability of the two practices. Addition of 1.31Mg/ha ash increased the gross revenue of pineapple for the burnt practice by MYR90 (USD22). Pollution and land preparation were the sole contributors of the difference in the total cost of production for the burnt and unburnt practices. Cost of pollution under the fines of MYR10,000 (USD2,444), MYR100,000 (USD24,444) and MYR500,000 (USD122,222) on open burning were estimated at MYR231 (USD56), MYR2,306 (USD564) and MYR11,531 (USD2,819) respectively. Incremental net LEV revealed that the practice of burning under the fine of MYR10,000 is a feasible alternative of the unburnt practice regardless of the inclusion of the cost of pollution. The opposite was true for the fines of MYR100,000 and MYR500,000. Imposition of fine above MYR10,000 calls for zero burning and in the absence of effective and efficient disposal of pineapple residue coupled with the current strictness on open burning, the present and future prospects of the pineapple industry is at a crossroad. Product development and value addition to pineapple residue needs urgent pursuance as additional income can be generated and can compensate the additional cost to be incurred for residue removal, diseases and pests control under the unburnt practice.

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A-0148

Crop residue management increases dryland grain sorghum yields in a semiarid region. Paul W. Unger and R. Louis Baumhardt, Soil Scientists, USDA-Agricultural Research Service, Conservation and Production Research Laboratory, Bushland, Texas, USA

Grain sorghum [*Sorghum bicolor* (L.) Moench] is grown extensively in the US southern Great Plains, both with and without irrigation. Research involving dryland (rainfed) sorghum at the USDA-Agricultural Research Service, Conservation and Production Research Laboratory, Bushland, Texas, USA, which provided 502 treatment-years of data from 37 studies, indicated grain yields more than tripled during the 1939 to 1997 period. A major yield increase occurred in the early 1970s when crop residue retention on the soil surface through use of no-tillage became common in the studies. From 1939 through 1970, mean annual grain yields exceeded 2000 kg ha^{-1} only six times, but exceeded 2000 kg ha^{-1} in 20 out of 27 years after 1970. Our objective was to determine the factors responsible for the increased yields. Factors evaluated were annual precipitation, growing season rainfall, soil water content at planting, soil water use, total water use, and year of record. Analyses performed for the 1956 through 1997 period included one uniformly managed study for which the overall yield increase was 139%. Results for that study showed use of improved hybrids accounted for about 46% of the increase and the remaining 93% was attributable to other factors, including increased soil water content at planting after 1970. This corresponded with the time when conservation tillage (no-tillage) studies involving use of improved herbicides became common in at the Laboratory. Retaining crop residues on the surface through use of no-tillage increased soil water contents at planting in many studies and was primarily responsible for the yield increases.

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A-0153

Crop residue and fertilizer management for increased rice based farm productivity. M. A. Saleque, P. K. Saha, and G. M. Panaullah, Soil Science Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh.

A field experiment was conducted in a farmer's field in Natore, Bangladesh (Sara silty clay loam soil), for two years on a permanent layout to evaluate the effect of application of the specific soil test based (STB) fertilizer doses and cowdung, and crop residue management on crop production in a mustard-mungbean-rice yearly cropping sequence. Mustard (variety Tori 7) was grown with four fertilizer treatments: T1 = no fertilizer, T2= local farmers' practice (FP) (80-26-33-20-4 NPKSZn kg/ha), T3 = STB fertilizer doses (120-26-33-20-0 NPKSZn kg/ha), and T4 = T3 + application of 5 t/ha cowdung (oven dry weight basis). The second crop, mungbean (variety Kanti), was grown on half of each plot while the remaining half was kept fallow. Mungbean was grown without any fertilizer. After harvest, the mungbean stover was incorporated into the soil in the respective halves of the plots. The third crop, wet season rice (variety BR11) , was grown with four fertilizer treatments under two crop residue management conditions((soil incorporation of mungbean stover (+MB) and no mungbean stover incorporation (-MB). The fertilizer doses for rice were as follows: T1 = no fertilizer, T2= FP (70-13-17-10-0 NPKSZn kg/ha), T3 = STB (90-26-17-10-0 NPKSZn kg/ha), and T4 = T3 + residual matter from 5 t/ha cowdung applied to the first crop, i.e., mustard. The 2(year mean grain yield of mustard in the T1 plots (no fertilizer) was only 0.31 tha-1. The application of STB doses alone increased the yield to 1.48 tha-1. The application of cowdung did not give any significant yield benefit over the STB doses. The mean stover yield of mungbean succeeding mustard ranged from 1.12 tha-1 to 1.21 tha-1, the yield differences being statistically insignificant. The 2(year mean grain yield of rice in the no fertilizer plots was 2.92 tha-1. The incorporation of mungbean stover alone raised the yield to 3.20 tha-1. The +MB treatment, likewise, increased the yield from 4.79 to 5.19 tha(1 in the FP plots and from 5.55 to 5.71 tha(1 in the STB plots. The two years' results showed that the application of STB doses and +MB were agronomically superior and economically profitable management practices for a yearly mustard - mungbean – rice cropping sequences.

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A-0154

Farmer empowerment in the dissemination of soil conservation technology. W. H. Utomo and A. Sinaga**,** Brawijaya University, Malang, Indonesia

Soil erosion has been considered as the main agent in decreasing soil productivity of upland agriculture. Many efforts that have been done to combat this problem only yielded a little success. A lot of soil conservation technologies have been proven to be very effective in controlling soil erosion. However, only a few of farmers willing to adopt these technologies. This is thought due to unsuitable methods in the development and dissemination of the technology. In the past, most of the soil conservation technologies were developed based on the idea and willingness of the researchers, with a very little involvement of the farmers. As a result, the technologies did not meet the farmer's need and condition. The work reported here used the "Participatory " approach in the development and dissemination of soil conservation technology. The work was done in Blitar, East Java, and has been executed during four years. With the Rapid Rural Appraisal (RRA) approach, the involvement of the farmers was started from the identification of the problems, discussion of the possible solution, the trial some selected technologies, then ended with the adoption of some preferred technologies. Most farmers had aware of soil erosion problem in their land, and understood some technologies to solve the problem. However, they thought that the technologies are too complicates and too costly, so they unwilling to practice them. Farmer's Participatory approach has a good prospect for the development and dissemination of soil conservation technology. In the first year 15 farmers joint the project, and . Increased to 21 farmers in the second year. For the third year, the numbers of participating farmers increased to 24 , 6 of them had already adopted the preferred technology in their whole field. The numbers of adopter farmers in the fourth year increased to 15 farmers.

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A-0155

Evaluation of soil and water conservation methods for land use systems in Northern Ghana. B.O. Antwi, E.O. Ampontuah, S. Anane-Sakyi and J.T. Adomako, Soil Research Institute, Ghana

There is usually non-adoption of recommended soil conservation practices in land use systems of Northern Ghana. This has been attributed to lack of understanding of farmers' circumstances and the historical backgrounds to the practices in use. This paper describes a systematic approach of introducing soil and water conservation packages compatible to the complex situations of rural poor inhabitants of three degraded catchments in Northern Ghana. A preliminary socio-economic survey using participatory rural appraisal (PRA) methods was used to determine farmer circumstances and aspirations. Two things seem new in adopting recommended soil conservation methods by resource poor farmers: the method and packaging. The method used involved step by step on-farm evaluation of soil conservation practices instead of a final package, which favours the few resource rich group. Various bund-forming practices such as mounding, ridging, square bunds and their modifications were carried out. The packaging of soil and water conservation trials included fertility and crop improvement programs based on farmer preferences and soil type. The soils in the experimental area covers Leptosols, Plinthosols, Lixisols and Fluvisols. The pH of most soil samples ranged from 5.5 to 6.5 with no salinity threat. Phosphorus levels were generally less than 2.5mg/kg soil and decreased to trace levels in subsoils. Total nitrogen was less than 0.1 percent. Organic matter levels around compound houses were around 3 to 4% while it was less than 2% for other fields. The results showed 30 to 50% increase in yield over the farmers' adopted practices. Farmers adopted the

improved methods, which were further improved by subsequent trials. Workshops were held to discuss the results. The farmers' awareness to the improvement in their land use system was awakened by discussions at the workshops. It is suggested that soil and water conservation evaluations should select a wide range of farmer domains for test and improvement programmes to improve land use systems in poor rural communities.

A-0163

The effectiveness and economic viability of soil conservation: Case studies in Yunnan Province, China. M.A. Fullen, D.J. Mitchell, T.J. Hocking, A.P. Barton, E. Milne, The University of Wolverhampton, United Kingdom, Wu Bo Zhi, Liu Liguang, Huang Bizhi and Zhao Yan, Yunnan Agricultural University, P.R. China.

Soil erosion poses a serious environmental threat to sustainable agriculture in Yunnan Province. A joint British/Chinese team has been investigating soil erosion and conservation within Yunnan Province since 1990. Attention has particularly focused on the effects of cultivation and conservation treatments on erosion rates and processes on the arable Ultisols of the Central Plateau of Yunnan. To contribute to the development of appropriate soil conservation strategies, a runoff plot study at Yunnan Agricultural University (Kunming) is evaluating the effectiveness of various soil conservation measures. Cropping treatments, typically employed in local agronomic practices, were applied to maize (*Zea mays*) grown in 30 erosion plots at three different slope angles, cultivated both parallel and perpendicular to the contour, thus simulating a range of agricultural conditions on arable slopes. Plot data from the 1993-96 cropping seasons (May to October) suggest several suitable soil conservation measures. The average rank order of treatment effectiveness in diminishing erosion rates was: 1) straw mulch, 2) intercropping, 3) no tillage, 4) polythene mulch and 5) conventional tillage. The mean erosion rate on the straw mulch plots was 0.22 of the mean conventional tillage rate. Erosion rates were generally lower on plots where contour cultivation was used. The mean contour cultivation erosion rate was 0.69 of the mean downslope-orientated rate. Therefore, straw mulch and contour cultivation seem particularly suitable soil conservation measures. The current erosion plot research programme (1997-99) is a replicated study of the most effective treatments (straw mulch and contour cultivation), using conventional cultivation and bare soils as controls. Data from the 1997 and 1998 seasons confirm that straw mulch and contour cultivation significantly decrease soil erosion rates. The research team is currently investigating the effectiveness of conservation treatments validated in plot experiments in actual field conditions, by the development and scientific evaluation of modified and novel cropping practices in a representative highland catchment in north-east Yunnan. The selected catchment, Wang Jia, covers 500 hectares near Kedu, in Xundian County. The initial project (funded by the U.K. Department for International Development/British Council) consists of an evaluation of the effects of modified cropping practices on maize productivity and soil properties. Currently, selected soil conservation treatments are being implemented in the catchment and the environmental and socio-economic benefits of effective soil conservation are being assessed. This European Union funded project involves a collaborative research team from Belgium, China, Ireland, Thailand and the U.K. Evaluated effects include physical, chemical and ecological impacts, the conservation of natural resources, management of wastes, returns for stakeholders, poverty alleviation, income augmentation and rural development. This holistic approach has not been attempted previously in the region. The catchment is being used as an experimental area and training model for sustainable agricultural development in the South China highlands. A parallel study, restricted to scientific evaluation of agronomic and physico-chemical impacts, is being carried out in an erosion plot study at Pangmapha, in the highlands of north Thailand, testing the broader applicability of the cropping practices being developed for South-East Asia. Five co-ordinated work packages are being implemented: (1) Background agricultural and environmental assessment of Wang Jia catchment. (2) Implementation and evaluation of modified and novel cropping systems for wheat, corn and soybean in the catchment. (3) Evaluation of the socio-economic impact of the changed cropping practices. (4) Comparative scientific evaluation of the cropping techniques in the highlands of northern Thailand. (5) Dissemination of project outcomes and establishment of training programmes for best practice in highland rural development. This project aims to inform the international research community, regional training agencies, local agricultural and conservation services and village communities.

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A-0164

REHABILITATION OF THE SOIL QUALITY OF A DEGRADED PEAT SITE. Schindler, U. and L. Müller, Center for Agricultural Landscape and Land Use Research Institute of Soil Landscape Research, Müncheberg

Intensive agricultural use of shallow peat soils connected with deeper ground water tables causes degradation processes that result in peat loss, reduced rooting depth and dropping crop yields.. The hydrophysical properties of degraded peat are worse. The plant available water as well as the total porosity will be reduced. Increasing dry bulk density by 0.1 g/cm3 reduces the plant available water content by approximately 2.2 % Vol.-% and the total porosity by roughly 3.4 vol.-%. Deep Plough Sand Covering is a measure to improve the hydraulic conditions of degraded shallow peat sites and to conserve the peaty soil material if an intensive agricultural use is required. A Deep-Plough-Sand Covering was carried out at a 20 ha peat site within the Upper Rhinluch in Oct. 1988. Results of the site dynamics and site development are presented for the period from 1988 to 1998. The new soil has favourable hydraulic properties and suitability for crop production The water balance was more equalized and high water contents in the soil may be kept all the year. The water movement - vertically up- and downwards - was improved. The capillary water rise and the infiltration rate were increased, whereas waterlogging was eliminated. The sandy cover, now plough horizon, had a thickness of about 30 cm. The organic matter content varied between 3.3 and 7.2 %. Consolidation processes are quite closed after 10 years. The surface level changed only 1 cm/a after 10 years with decreasing tendency. Ongoing work is to investigate the development of further site properties. Caused by improved infiltration the transport behaviour of solutes into the shallow ground water will be changed. Therefore the improved hydrological regulation properties can result in a higher risks of water pollution in the ditches.

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A-0166

Dynamics of soil organic carbon and the potential of carbon sequestration in the soils of southern China. Zhang Taolin and Li Zhongpei, Institute of Soil Science, Chinese Academy of Sciences, Nanjing China

The dominant landuse patterns in tropical and subtropical regions of China consist of paddy fields, uplands, secondary forests, and artificial forests etc.. The changes in soil fertility under these landuse patterns correlated closely to the development of regional economy and the land management level. The dynamics of soil organic carbon pools, which relate closely to the soil fertility, are of great importance for assessing the capability of soil as the source and/or sink of atmospheric CO_2 in the regions. In this paper, the cycle and balance of organic carbon in major landuse systems and their effects on the dynamics of soil organic carbon were studied by field plot experiments. Furthermore, the potential of carbon sequestration in the soils of southern China was preliminarily estimated by integrating the field experiment results with the regional investigation data. Results obtained from the field plot experiments conducted at the Ecological Research Station of Red Soils (ERSRS) showed that the amounts of organic carbon returned to the soils of paddy fields, artificial forest lands, and trees/farm crops intercropping lands at present management level were 2-10%, 9-40%, 21-85% higher than that lost from the soils respectively, although these data would vary with the original soil fertility level, tree types, and intercropping patterns. With these positive balances, the organic carbon content in soils of these landuse patterns at equilibrium status could, therefore, increase by 22-87% as compared with the original level. For example, after 5-10 year's reclamation and cultivation, the organic carbon content of a highly-eroded red soil would increase from 5.8 g/kg to 9.6 g/kg. Therefore, it was suggested that the soils in paddy fields, artificial forest lands, uplands with adoption of agroforestry technologies, and uncropped lands after reclamation in southern China were the sink of atmospheric CO_2. Furthermore, an estimation showed that the potential amount of carbon sequestration in the soils from the atmosphere, by enhancing farmland productivity, exploiting wasteland resources and establishing fast-growing forests in southern China, would be increased by 2.38×10^{15}g, 25.0×10^{12}g, 3.85×10^{14}g CO_2 in the following 10 years, respectively. Therefore, the rational utilization of agricultural resources, especially the maintenance and enhancement of soil organic carbon and soil fertility in southern China would change the functioning of soils as the source and/or sink of atmospheric CO_2 and enlarge the capability of the sink.

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A-0170

Methodology for Monitoring Sediment Loading and Modeling of Sediment Production in the Itaipu Watershed. Dr. Darrell Norton, USDA-ARS National Soil Erosion Research Laboratory, West Lafayette, IN USA, Dr. Celso de Castro Jr., Institute of Agronomy Parana. Londrina-Parana, Helio Martins Fontes Jr., Luis Dalmi Marenda, Itaipu Binational Authority, Foz do Iguacu-Parana, Luis Paulo Johanson, Itaipu Binational Authority, Foz do Iguacu-Parana, João Henrique Caviglione, Institute of Agronomy Parana, Londrina-Parana

The Itaipu hydroelectric facility on the border of Brazil and Paraguay is presently the largest in the world. Sediment loading was a minor problem and the project was expected to have a life span of some 300 years based on estimates of flow and sediment concentrations prior to construction. Since construction, significant land use change from forest to intense row crop production has changed considerably the amount of sediment entering the lake. This change has caused considerable reduction in the quality of the aquatic habitat and is reducing the storage capacity of the lake and thus shortening the life of the project. In order to determine the extent of sediment loading and target areas within the drainage basin that produce the greatest sediment, a study was begun to monitor the sediment entry, and to model areas in the watershed to determine where the most sensitive areas are to concentrate conservation efforts. Monitoring of the water and sediment fluxes of the major tributaries will be accomplished with a network of gauging stations and turbidity meters. Calibration curves for relating stage height to discharge will be developed for each station and the height digitally recorded. The turbidity measurements will also be calibrated to sediment concentration and digitally recorded. These measurements will allow for computation of

water and sediment flux on an hourly scale into the lake. The modeling will be performed with the Revised Universal Soil Loss Equation (RUSLE) in a Geographic Information System (GIS) framework. Rainfall erosivity (R) data will be collected from a network of climatic stations, erodibility maps (K) from the SOTER database, topographic (LS) data from digital elevation models and cropping and management (C and P) data from remote sensing and field plot data. These parameters will allow predictions of soil loss potential within the framework of the GIS. The monitoring data will be compared to data from the modeling on successively smaller watersheds in order to calibrate the RUSLE/GIS model. The calibrated model will then be used to develop erosion potential maps for the entire Itaipu watershed above the lake. The impact of this project is to make predictions on the effect land use change has had on the projected life of the project and to target those areas of the watershed for conservation efforts to protect the longevity of the lake.

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A-0171

The Impartance of Coordinating Water Resources Utilization to Oasis Ecosystem in Xinjian. Wang Lan

Irrigation is a prerequisite for the agricultural development of oasis along the rivers and round the lakes in Xinjian. But development of irrigation led to a series of problems on the ecological environment of oasis, whtere the degradation of natural vegetation, even its disapearance resulted in serious menace for oasis ecosystem. The degradation of natural vegetation arised mainty in the river lower reaches and near the maginal zone of the oasis, whter either owing to that the river flow was broken and the water table descended extremly, then the root system of the plants did not got the moisture, or owing to that the water table ascended, secondary salingation of soil became serious, they led to degeneration of the natural vegetation. The diminution of river bank foret, even disapearance, was spectacular. The situation mentioned above was very common in the north foot of Tianshan Mountain and the South Xinjian. As to the River Manasi, the water source of the Lakes Manasi, its water flow was broken owing to developing the cultivation in the upper-middle reaches and channeling the water into the farmland, for irrigention of caurse the lake Manasi dried up. The River Talimu is the greatest one of the interior rivers in China, its flow has broken completely at Tieganlike since 1974, and for this reason, ecological environment in the lower reach worsened even a vast amount of diversifolious poplar (Populus diversifolia) died there. The diminution of diversifolious poplar foret, even disappearance in this green corridor is a serious warning to us. Our research showed that, in order to turn back this tendency of ecological environment deterioration, in essence, the coordination of using water resources will play a determined role. First, the macroscopic control of agriculture using water in upper-middle reaches, including planning the dimension of wasteland reclamation and theim irrigation area. Second, the regulation of agricultural land structure, including expanding the fields with high, stable yields, increasing yield per unit area and diminushing the agriculture using land and agriculture using water. Third, the revolution of irrigation technique, including substitution of the irrigation economizing on water for traditioal irrigation and diminution of irrigating water. This spatial coordination of water resource use among the uppermiddle and lower reaches and sturtural regulation on distribution of agriculture using water, will be favorable to amelioration of oasis ecosystem.

Wang Lan

A-0172

New Initiatives To Control Soil Erosion In England. Roger J. Unwin, Farming and Rural Conservation Agency, London, England

In the last 15 years there have been indications that soil erosion has increased in both lowland and upland areas of the United Kingdom although the scale is thought to be less than in many other European countries. Attention has focussed on off-site effects and damage to landscape and ecosystems in upland areas. This paper outlines the problems and the steps taken by the Ministry of Agriculture, Fisheries and Food (MAFF) to reduce them. In lowland areas erosion has increased where certain soil and slope conditions coincide with changes in management practices. These include increased areas of autumn sown cereals; the use of tramlines for in-crop operations; the removal of traditional boundary features such as hedges and ditches; the increase of outdoor pig keeping and poaching of land by grazing livestock, particularly along river banks. The confounding effect of decreasing soil organic matter contents is unclear. In upland areas the relative importance of various causes is the subject of on-going research. Among the issues are overstocking by sheep and deer and human disturbance of ground cover during recreational activities. Farmers rarely see erosion as reducing the long-term potential of their land. Any high soil losses are usually dismissed as the result of exceptional rainfall events. They are more concerned at immediate crop losses and the risk of financial penalties for clearing sediment from roads or drainage channels. There is increased pressure to prevent damage to fisheries by sediment in spawning gravels. In 1997 MAFF published a booklet to increase awareness of the problems of erosion. A manual aimed at farmers and their advisers has been prepared. It identifies problems by a four-class risk system and offers guidance on practical solutions to limit erosion. A further booklet highlights the need to manage livestock to reduce erosion. MAFF also plans to set up local demonstrations of techniques to reduce erosion in four areas with very high-risk soils. These publications and activities support a Soil Code, published in 1993 and revised in 1998, which provides advice on avoiding long-term damage to soils through erosion, contamination and other factors. Payments to farmers under the European Union's Agri-Environment Regulation provide indirect opportunities to fund management changes which can limit erosion (indirect because the payments are targeted at landscape and wildlife). These include reversion of arable land to grass or woodland, encouragement to reduce stocking rates in the uplands and river margin management.

Roger J. Unwin

A-0174

GPFARM: An Integrated Decision Support System for Great Plains Agriculture. James C. Ascough II, Marvin J. Shaffer, Gregory S. McMaster, and L.R. Ahuja, USDA-ARS-NPA, Great Plains Systems Research Unit, Fort Collins, Colorado USA

The USDA-ARS Great Plains Systems Research Unit, in a collaborative effort with Colorado State University, has developed the Great Plains Framework for Agricultural Resource Management (GPFARM) decision support system (DSS). GPFARM analyzes both medium- and long-term farm and ranch level management plans, based on the predicted productivity of selected management options and associated environmental and economic risks. GPFARM provides an operational framework for a whole farm and ranch DSS across the Great Plains including site-specific management, economic and environmental impact analysis, site database generation, and risk analysis from which alternative agricultural strategies can be developed and tested. GPFARM implements an integrated systems approach to address the problems of agriculture in the Great Plains. GPFARM combines site-specific databases and environmental models with economic analysis to evaluate long-term individual farm and ranch sustainability as a result of management changes and impacts of: 1) chemical use (pesticides and nutrients); 2) soil quality (soil productivity indicators); and 3) cropping, tillage, and livestock systems. The overall goal of GPFARM is to determine the long-term effects of current cropping and ranching practices on environmental and economic sustainability. These analyses are related to targeted users (agricultural consultants, computer-oriented producers, Extension personnel, and the USDA NRCS) in understandable and familiar terms. GPFARM was designed for hardware platforms available to the majority of potential users, i.e., IBM-compatible Pentium PC's. GPFARM runs in the Microsoft Windows 95™, 98™, and NT™ operating environments and is being developed with Microsoft Visual C++ 6.0™. The DSS consists of a graphical user interface (GUI), site-specific Microsoft Access™ databases (currently populated for Eastern Colorado climate conditions and farming/ranching systems), and an object-oriented C++ framework encapsulating the Fortran 90-based science or simulation modules. When developing suitable management plans for a farm or ranch, GPFARM accumulates and compares multiple management scenarios, allowing the user to select the best management scenario for their individual operation. GPFARM is being tested on two ARS cooperator sites in Eastern Colorado for both irrigated and non-irrigated conditions. General test cropping systems include dryland wheat-fallow, wheat-corn-fallow, and wheat-corn-millet-fallow rotations, and continuous irrigated corn. In addition, GPFARM is being tested on an integrated systems experiment (a combined dryland wheat-corn-millet-fallow farming and livestock production ranching operation).

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A-0177

Biological restoration of soil productivity in the humid tropics: the use of planted woody fallow on a degraded Alfisol**.** G. Tian, F.K. Salako, C.O. Adejuyigbe, J.A. Olimah and B.T. Kang**,** Soil Fertility Unit, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, c/o L.W. Lambourn & Co., Croydon, England

Continuous cropping without proper management and conservation strategies has led to loss of soil productivity for a large area in the humid tropics. A long-term trial was initiated in 1989 in Ibadan, southwest Nigeria to evaluate the feasibility of using planted woody fallow (species: *Senna siamea*, *Leucaena leucocephala*, and *Acacia leptocarpa*) to restore productivity of a degraded Alfisol. Results obtained after six years are reported here. The mean earthworm numbers (no. m^{-2}) during the rainy season were 80 - 131 for planted woody fallow, 147 for natural regrowth fallow (dominantly by *Chromolaena odorata*) and 14 for continuous cropping (14). Fallowing, especially planted woody fallow, considerably increased population and diversity of soil microarthropods. Increase in surface (0-15 cm) soil organic carbon content was 24% for planted woody fallow and 35% for natural regrowth fallow relative to continuous cropping. The extractable P was 108% higher under planted woody fallow, and 6% lower under natural regrowth fallow, compared to continuous cropping. The potentially minerable N was increased with fallowing, and was 32% higher under the planted woody fallow than under natural regrowth fallow. Particulate soil organic matter (0-5 cm depth) was 14.2 g kg^{-1} under planted fallow and 3.9 g kg^{-1} under continuous cropping. The surface (0-15 cm) soil bulk density decreased from 1.56 to around 1.1 Mg m^{-3}. Mean surface (0-2 cm) soil penetrometer resistance was between 75 and 157 kPa for fallowed plots and 192 to 295 kPa for continuous cropping plot. Fallowing also improved aggregate stability and water infiltration rate. Maize grain yield was higher after planted woody fallow (288%) and natural regrowth fallow (193%) than after continuous cropping. The results indicated that restoration of productivity of the degraded soil in the humid tropics is possible with

fallowing. The planted woody fallow appears to be superior to natural regrowth fallow in soil regeneration in the humid tropics because of its capacity in CO_2 sequestration (38 to 70 t C ha^{-1} in trunk after 6 years growth) in addition to improving in soil productivity.

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A-0179

Soil productivity in Central Highlands of Kenya. Mira Ovuka, Göteborg University, Department of Earth Sciences, Physical Geography, Göteborg, Sweden

This study examines soil productivity in the Central Highlands of Kenya analysing soil nutrient status and yield data from farms with different resource endowments. In addition, it explores soil nutrient status along slope profile, SWC, soil erosion and farmers' perception of productivity in the area. Soil samples were collected on 136 farms and along ten slope profiles. These samples were analysed with respect to grain size distribution, CEC, rates of Na, Ca, Mg and K, available P, total N, organic C and pH values. From the sampled farms, seasonal yields were recorded, erosion was noted using PLUS and USDA classification. Farmers' resource level was measured by indicators such as number and type of animals, land size, off-farm income, access to credits and inputs in agriculture. To obtain historical data on SWC and farmers' perceptions of productivity, aerial photographs were interpreted and discussions were held with 40 farmers. Results from soil sample analyses showed significant differences between high resource and low resource farms in organic C, N, base status and percentage of sand and clay with higher levels for high resource farmers. There were also significant differences in P, base status and percentage of sand and clay between high resource and medium resource farms. Analyses of soil samples from slope profiles indicated that nutrient status decreased as the slope increased and that above well maintained terraces there was an enrichment of nutrients as well as in valley bottoms. Results from soil erosion analyses showed declining rates of organic C, P, K and Ca, with increasing erosion. SWC practices have changed from grass strips and shifting cultivation to bench terraces and permanent cultivation, but less land is conserved today than in 1960. According to farmers the production of crops were higher in the past when fertilisers were not used. Today there is hardly no production of crops without fertiliser and manure. This could indicate better nutrient status of the soil in the past. Well endowed farmers purchase agricultural inputs necessary for crop production while low resource farmers lack most of these inputs. New technology and investments in land, especially for low resource farmers, are necessary to sustain soil productivity and hence secure rural livelihoods.

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A-0180

Facilitating Better Linkages Between Hilltribe Communities and Government Agencies with Digitised Land Use Maps in Mae Hong Son. Oliver Puginier, Land Use Planning , Humboldt University, Berlin. Chiang Mai, Thailand

The aim of this paper is to present a tool for land use planning in the project areas of the Thai-German Highland Development Programme (TG-HDP) in northern Thailand in the form of digitised land use maps at village and sub-district (Tambon) level in Mae Hong Son province. There are conflicting interests between the nearly 800,000 hilltribe people in northern Thailand and the government, which has declared that most of them live in forest reserves under the watershed classification category 1A, according to which they are neither allowed to settle in these areas nor practice any agriculture or use forest resources for subsistence. Yet hilltribe communities have practised their various forms of shifting cultivation for centuries in a sustainable way and it is important to have their types of land management accepted by the central government. In the final phase of the project, which closed in September 1998, a three-year PhD study funded by the Tropical Ecology Support Programme (TOEB) of GTZ (funding period: 10/1996 till 9/1999) examines the different stages of participatory planning in selected villages and assists the project in the aggregation of village land use maps into inter-village networks and into the newly forming Tambon Administrative Organisations (TAO). The use of digitised land use maps becomes increasingly important for the coordination of the village based decision process with government organisations such as the Royal Forest Department (RFD) as well as for the effective functioning of the TAOs in the management of natural resources. This information can subsequently be used in a future land capability classification to be done by the Department of Land Development (DLD), as currently most of the highland areas are classifies as slope complex by DLD and as forest reserves by RFD. Working up from the village as the lowest level of planning to the district level, recommendations are developed for necessary linkages in the consolidation of this process with the national policy framework, yet in this paper focusing on the rotational shifting cultivation system practised by the Karen hilltribe, which accounts for 50% of the highland population. The Karen farming systems, whether they are purely of shifting cultivation types or in intermediate stages towards permanent farming, demarcate about twice as much land area for conservation forest as for agricultural use. Of this agricultural area, only about 10% is actually burned and cultivated every year, while the rest is in various stages of forest regeneration through fallow. This shows that there is a strong awareness among farmers to preserve the environment they live in. In most cases village maps are only available in the villages themselves, but a constructive discussion requires information sharing for all parties concerned. By cross-checking maps with villagers and government agencies, a communication platform is created for the formulation of annual land use plans, thus linking traditional systems with planning priorities of the government.

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A-0182

From Plot to Continent: Reconciling Fine and Coarse Scale Erosion Models. Mike Kirby, School of Geography, University of Leeds, UK

Most of our process knowledge is based on plot-scale studies an it is now possible to make reliable forecasts at this scale for a year or two, provided that there is sufficient data to parameterize the best models. Many policy-related issues must be addressed at catchment, regional and national scales, and for periods of decades, where fine-scale models cannot be properly applied due to lack of parameter data, computing power and finance. In scaling up, it is essential to simplify the complex set of process interactions. At the same time, complex system theory warns us that new interactions are likely to emerge as we study larger areas and longer time spans, so that coarse and fine scale models may well be based on different dominant processes. It is argued that surface characteristics, including roughness at all scales, and heterogeneity of properties (such as rainfall intensity and infiltration) over space and time play a larger part at coarse scales. Perhaps the most important integrating concept is that of the runoff threshold, which has the required simplicity and has meaning at all scales. Two specific strategies are proposed for scaling up, on the basis of ongoing research. First the explicit nesting of sub-catchments within catchments; and nesting of representative flow strips within each sub-catchments (MEDRUSH model). Second the application of a SVAT type model, in combination with meteorological, soil, topographic and land cover data, to provide a process based Regional Degradation Indicator to estimate water erosion risk. Reconciliation between these scales can be achieved through explicit integration over frequently distributions and through the use of robustly derived expressions for the distribution of erosion of cultivated and semi-natural landscapes. Nesting is also seen as an appropriate strategy for implementation of policy. Coarse scale models identify sensitive areas for more detailed study, and this process may be repeated with models and field studies at each appropriate scale down to the level of the hillside of field at which conservation measures are finally applied.

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A-0183

Soil and water conservation as a factor of water pollution control in the Vranjska Kotlina Valley. Stanimir Kostadinov, Faculty of Forestry, Belgrade University, Belgrade, Yugoslavia

Vranjska Kotlina valley in the South-east Serbia is a well -known erosion and torrent region in Serbia. The main river in the valley is the Juzna Morava which has a 73 typically torrential tributaries. Two wery important communication lines cross the Juzna Morava valley in this area and connect Western Europe with Greece and the Mediterranean, namely the Belgrade -Skopje-Athens(Greece) road and railway line. In addition to the traditionally recognized damages inflicted by soil erosion the harmful influences the soil erosion on the nature resources (first of all soil and water) were ever more present. The latter are reflected by:environmental degradation of the landscape due to the soil loss; the mechanical pollution of the streams and reservoirs by the sediments; the chemical pollution of water in the streams and reservoirs by organic and mineral fertilizes and pesticides. In order to prevent the damages caused by soil erosion at the beginning of the twentieth century. Soil an water conservation works started in this part of South-east Serbia. After the Second World War much more extensive soil and water conservation works were performed. The research of state of erosion and sediment transport in the torrential watersheds of the Vranjska Kotlina valley showed that although all of the planned works were not carried out, the intensity of erosion processes, sediment yield and transport has still been significantly decreased. Also, the measurement of sediment transport in the Ljestarska Dolina watershed showed that in every ton of the suspended sediment taken away on average there are: 50.30 kg. of humus, 3.80 kg of nitrogen, 0.70 kg of phosphorus, 5.00 kg of potassium, 10.00 kg of calcium and 8.10 kg of magnesium. At the average annual transport of the suspended sediment of 487.18 t each year on average 19,418.40 kg of humus, 1,774.12 kg of nitrogen, 339.12 kg of phosphorus, 2,458.39 of potassium, 4,892.83 kg of calcium and 4,240.53 kg of magnesium also reach the river Juzna Morava and cause the mechanical and chemical pollution of water. It is clear that before the soil and water conservation works these quantities of sediment and nutrients were significantly higher in this and others watersheds in the valley. It can be concluded that a considerable segment in the water pollution control is presented by the consequent and persistent soil and water conservation activities in the watershed.

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A-0184

Soil Mapping As A Base For Optimum And Sustainable Landuse In Some Areas Of Egypt. F. HANNA SOLIMAN, DOKKI,GIZA,EGYPT.

Egypt is a large,arid and for the most part low-lying country on the north-east African penplain,exceptions to this general rule can be found along the northern coast,where

climate is semi-arid. The total land area is 1001449 Km2. Physiographic and pedological constraints to agriculture in Egypt are immense. These include salinization,alkalinization,and waterlogging of soils in Nile valley and Delta. Upland soils fare little better;in these areas the low water-holding capacities and inherent low fertility make soil management difficult. Dune encroachment on the agriculture land and shifting sand present problems all over the country. This current work presents four models of soil mapping in four representative areas for horizontal agricultural expansion in Egypt. The first area represents the coastal zone of Nile Delta,the second one located in the northern part of Nile Delta and represents the lowlands,the third one is a desertic area west of the Nile Delta in the western desert and represents the newly reclaimed desertic lands irrigated with Nile water, and the fourth one is a desertic dry valley area in western desert west of Nile valley and irrigated with artisian water. The studies focus on soil mapping using aerial photo-interpretation and other remote sensing techniques as well as GIS. The field work and lab analyses with special reference to soil constraints and soil and water resources are the main targets to reach the land evaluation and land suitability goals. The physiographics and soil maps scales 1:20000, 1:50000 and 1:100000 as well as the land suitability for main crops,fruit crops and vegetables were the final goal of these studies.

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A-0186

Sustainable Land Use in Poor Countries and Poor Communities: A Mirage or Real Water? Mohammed Atif Kishk, Prof. Dr., Soil Science Department, Minia University, Minia, Egypt

Running after a mirage is dangerous. Talking about sustainable land use in many poor countries is dangerous too. In many instances, the real causes of desertification are deliberately underestimated or neglected. Very few, particularly among policymakers, want to admit the fact that poverty and resources conservation are in conflict. Instead of admitting the facts, there is a tendency to blame the victims. Instead of addressing the problems of marginalization and impoverishment of most resources users sin rural areas, the issue is often reduced to abstract talks about margin lands, scarcity of resources, droughts, population growth etc. Among the serious consequences of this approach is that resources degradation is mainly treated as a technical problem that can be solved with technical solutions like reducing growth and more efficient use of land and water resources. In many cases, this does not work and it has been the real reason behind many failures in combating desertification. This paper tries to show that the main constraints to sustainable land use are not technical but essentially political, socio-economic, cultural, institutional and legal. Therefore, instead of wasting time and efforts in running after mirage, it is more yielding to challenge the real causes and dig in the desert for real water. The analysis done in this paper is based on examples from Egypt and some other poor countries in Africa. They show how the concept of desertification is misinterpreted and the efforts made to combat it are misguided.

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A-0189

Assessment of soil erosion at the watershed scale from ^{137}Cs measurements. Claude Bernard, Institut de recherche et de développement en agroenvironnement, Sainte-Foy (Québec), Canada, and Marc R. Laverdière, Université Laval, Département des sols et de génie agroalimentaire, Sainte-Foy (Québec), Canada

Erosion is a major process in soil and water degradation, resulting in reduction of upstream soil productivity and pollution of downstream water bodies. Assessing the severity of erosion under a variety of soil-slope-crop combinations from plot measurements, either under natural or simulated rainfalls, is resource and time intensive. Identifying, at the watershed scale, the sources actually contributing to the measured suspended solids loadings is a complicated task. Cesium-137 (^{137}CS) , a fallout product from the atmospheric atomic tests of the early 1960's is an excellent soil movement marker, and thus an interesting tool to achieve the aforementioned tasks. The Boyer River (Québec, Canada) drains a 200 km^2 watershed, cultivated at 60%. The last 2 km of the river bed were once used for reproduction by Rainbow Smelts *(Osmerus mordax)*. This fish population, which plays an important ecological role in the St.Lawrence estuary, has dramatically declined over the last decades. Siltation and excessive algal growth in the spawning area were identified as the major causes of the fish population decline, suggesting that soil erosion is a major process. ^{137}CS is used to help understand the erosive behavior of the watershed. From measurements of this isotope, soil movement budgets (in-field redistribution, net output) are assessed for fields presenting typical agri-environmental conditions. The relative contribution of field and bank erosion is assessed by comparing their ^{137}CS content to that of bottom sediments collected in different parts of the watershed. Results obtained so far suggest in field erosion rates up to 12 t ha^{-1} yr^{-1} and net outputs between 0-5 t ha^{-1} yr^{-1}. The ^{137}Cs data also suggest that 75% of the sediments would originate from cultivated fields, and 25% from streambank erosion. Erosion assessment for the whole watershed from the USLE produced an estimate of 3 t ha^{-1} yr^{-1}. Extrapolating the losses measured at the field scale from ^{137}Cs data to the entire watershed, resulted in an estimated net loss of 2.5 t ha^{-1} yr^{-1}.

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A-0191

Soil Pollution Patterns in Terrestrial Ecosystems of the Kola Peninsula, Russia. S. Koptsik, G. Koptsik, Faculty of Physics, Soil Science Faculty, Moscow State University, Moscow, Russia

Conservation, management and recovery of endangered and degraded terrestrial ecosystems require exhaustive knowledge of soil chemical state. Soil chemistry is analysed in terrestrial ecosystems subjected to airborne pollution in the fragile boreal environment in the industrial part of the Kola Peninsula, north-western Russia. Sulfur and heavy metal deposition vary from background to really homicidal values, causing complete degradation of vegetation. Prevailing in the region poor thin sandy podzols form a convenient and promising natural-anthropogenic model object for understanding the combination of natural and pollution-induced processes. The tools of investigation are the simple process-oriented models, multivariate as well as traditional regression and correlation technique. The overview of pollution and basic soil properties patterns is presented in the form of multivariate ordination diagrams, giving a concise graphical rendition of present soil chemistry state in the region. The organic horizon of podzols appeared to be the important accumulator of heavy metals and the barrier against transport of pollution to underlying mineral horizons. The concentrations of Ni and Cu in soils near the smelter are approximately one to two orders of magnitude higher than the background levels in the region. Based on pH values air pollution has not resulted in a detectable topsoil acidification near the smelter. However, exchangeable K tend to be lower towards the smelter most likely due to replacement by air pollutants and leaching, thus confirming the ongoing acidification. Near the smelter heavy metals contribute significantly to cation exchange occupying up to ¼ fraction of exchangeable sites. Principal component ordination reveals the general structure of exchangeable cations as naturally divided into three groups – nutrients, heavy metals and acidity. Objectively structured ordination diagrams appeared to be a useful method of assessment of interrelations between different environmental properties in their unreduced, inherent uncertainty, caused by natural and pollution-induced variability. Multivariate procedure might be viewed as a system filter, giving a better characteristic of the system on the whole than the simple agglomerate of the studied properties and interrelations. Evaluation of regional problems gives a light footpath for a better understanding of the theoretical basis and practical needs of soil conservation and management within the paradigm of viably and sustainably developed systems in our global environment.

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A-0192

Assessment of Soil Quality for Biodiversity Conservation in Boreal Forest Ecosystems. G. Koptsik, S. Koptsik, S. Livantsova, Moscow State University, Moscow, Russia

Soil conservation has fundamental significance for biodiversity conservation and sustainable land use. The conditions of the forest is influenced by various natural variations in the environment and by man-made factors. However the issue of soil diversity as a base of biodiversity in forest ecosystems is often overlooked. The result is a serious impediment to effective, sustainable ecosystem management. Variations in types of soils within the area, to secure habitat diversity, were analysed in National Natural Park "Russian North", European Russia. Park territory is covered by woods entirely: taiga is intermittent with the birch woods traditional for the Central Russia plains. More than 500 species of higher plants (without mosses) have been recorded in the Park. North species make the main group of the local flora. Siberian taiga plants are neighbouring with the areas of oak trees, maples, limes, elms. Soil cover is complex and nonuniform. Most of the area is covered with acid podzolic and demo-podzolic soils developed on the flat tops and gentle slopes of the moraine hills. The chief factors preventing the development of podzolization process on the other part of the area are the abundance of carbonates in the parent rocks and the limited vertical migration of soil solutions due to the presence of the waterproof horizon Dg. Soils with higher degree of gleyzation are distributed in saddles. Depressions between hills are occupied by peat gley and peat soils. The features of structure and function of soils play important role in formation of plant communities, their species and structure diversity, in typical boreal forest ecosystems on the park territory. Forest soils differ greatly in thickness and storage of forest floor, total elements, acidity, exchangeable cations, organic matter content. Improving of soil properties in a range: podzol, podzolic soil, demo-podzolic soil, brown earth, pararendzina leads to growing diversity and changes in floristical composition of phytocoenoses, followed by changing of pine and spruce forest by mixed and birch forests. The soil properties are in turn affected by the vegetation through root uptake/exudation and litter decomposition/accumulation. Assessment and conservation of soil quality will enhance the current capabilities to determine the status and the change of forest biodiversity resources and their sustainable management.

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A-0193

Insurance As a Tool to Promote the Adoption of Best Nitrogen Management Practices to Protect Water Quality. Wen-Yuan Huang and Harold Taylor, ERS/NRED/PMTB, U.S. Department of Agriculture, Washington DC USA

Agricultural use of chemical and organic nitrogen (N) fertilizers is a major contributor of non-point-source pollutants to a variety of water quality problems in the nation. There is intense public interest in adopting policies that will motivate farmers to improve nitrogen fertilizer use efficiency to protect water quality. This study explores the potential of using insurance as a tool to promote the adoption of best nitrogen management practices (BNMPs). The paper demonstrates, analytically and empirically, potential private and public benefits of using an insurance program to improve farmer's certainty-equivalent (CE) income so as to motivate farmers to adopt BNMPs. This paper also investigates the feasibility to design a sustainable insurance program that can be actuarially sound to the insurer and beneficial to the insured for adopting BNMPs, and addresses the limitations of implementing such an insurance program. Using the data obtained from the 1996 USDA Agricultural Resource Management survey, two insurance programs are designed for Iowa corn growers to reduce N use: (1) to apply N only in the growing-season and (2) to split N application at the time of planting and in growing season. Our results show: (1) When farmers currently applying all N fertilizer before planting face a probability (p) that they may not be able to enter the field to apply N fertilizer in the growing season because of possible adverse weather conditions, would not adopt these two BNMPs, because the CE net returns from adopting these two BNMPs would be less than the CE net return of their current practices. In this situation, the insurance program can be used to increase the CE net return to improve farmer's incentive to adopt these two BNMPs. (2) The ranges of the sustainable insurance premium for the farmer to insure a full- yield coverage are: $19.30 to $28.42/acre for p = 0.15, and $12.87 to $27.78/acre for p= 0.10 for adopting the growing-season only applications; and $13.61 to $19.71/acre for p= 0.15, and $9.07 to$19.71/acre for p=0.10 for adopting a spring-and-growing season split application. (3) The reduction in residual nitrogen can be as much as 142.60 pounds per acre for p= 0.15 and as much as 142.20 pounds per acre for p= 0.10 for the adoption of growing-season only application; and can be as much as 116.79 pounds per acre for p = 0.15, and as much as 114.50 pounds per acre for p = 0.10.

Wen-Yuan Huang

A-0194

Measurement System of Mountain Watershed Management. Lixian Wang, Professor, College of Soil and Water Conservation, Beijing Forestry University, Beijing, China.

According to practical experiences of watershed management in China, in order to attain the object of sustainable development, a number of measures for comprehensive management of watershed must be adopted. Land use planning of soil and water conservation in the watershed. On the basis of detailed survey of land resources, land types are classified. Local social and economic conditions as well as the state policies are used to rationally determine the direction of land utilization of each plot in the watershed, the proportion and specific position of land used for the productive undertakings of agriculture, forestry, animal husbandry and fishery in the watershed, and the place and time where and when to carry out different measures of soil and water conservation. The techniques of remote sensing and GIS should be applied and the principle of ecological economics should be implemented. Appraisal of the dangerous nature of soil erosion. In order to prevent and control soil erosion, it is necessary that the dangerous nature of soil erosion of each plot in the watershed should be surveyed. In zones of hilly slope, the intensity of surface erosion and the distribution and dangerous nature of gravity erosion should be mainly surveyed. In gully channels, the stage of gully development and the impacts of the mountain torrents and mud rock flow should be surveyed. And in zones of alluvial cone, a hazard map of mountain torrents or debris flows to determine classes of danger of different positions should be drawn. Establishment of protective system closely integrating biological with engineering measures. Biological measures mainly refer to forest-grass measures, while engineering measures are mainly divided as engineering of slope surface (can be further divided into engineering of soil and water conservation in farmland, in grassland and in forest land), engineering of gully channels, and engineering of soil and water conservation in the zone of alluvial cone. Measures of supervision and management. The development of serious soil erosion is not only caused by natural factors, man's irrational productive management activities, such as destructive cutting of forest, collecting timber from slope to slope, reclaiming waste land on steep slopes and ignoring soil and water conservation during mining and road repairs, also have great influence. In face of illegal acts of worsening soil erosion and aggravating ecological environment, the legal system of supervision and management must be strengthened.

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A-0196

Funding the future: Have we got the facts right? T F Shaxson, Land husbandry specialist, Greensbridge, Winterborne Kingston, Dorset UK.

Government-sponsored initiatives aimed at restoring or maintaining land productivity and improving rural welfare are usually of the 'pilot-project' type, of limited initial duration, and funded by grants rather than loans. They generally aim to test technical methodologies and social acceptability of 'interventions', but seldom attempt to assess the implications and future viability of the supposed improvements using formal economic criteria. However, funding beyond the end of the pilot stage -- usually to assist expansion of promising activities over larger areas and more people -- usually passes from the project-initiating technical institutions to lending institutions such as national or international banks. To date these have generally applied commonly-used economic theories to work out whether possible returns on such an investment would justify making such a loan. But where the trends are for rural populations to continue to rise, for land productivity to fall, and/or for market opportunities to remain scarce, possible future rates of return from investments in such areas may, using common economic methodology, prove to be unattractively low or even non-existent. If present trends continue, the number of such desperate situations (even apart from effects of wars or infrequent catastrophic climatic events) will likely increase. Are such situations moving beyond the scope and help of textbook economics? Will lenders increasingly be reluctant to make loans where likely realistic returns are poor? If so, are there any alternatives for funding post-pilot stabilisation and improvement in welfare of rural people and their lands? Governments and lending institutions are going to have to face up to hard discussions about how to compatibilise moral imperatives for providing aid in low-return scenarios with possible mechansims for its funding (and refunding) until stability is achieved and the external assistance is no longer needed. Re-interpretation of some possibly erroneous assumptions in original programme design in three grave situations -- in Nepal, India and Malawi -- indicates possibilities for improving ratios of benefits to costs.

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A-0197

Land Husbandry And Better Livelihoods: The A.B.L.H. Experience In Kenya. R J Cheatle, Executive Secretary, Association for Better Land Husbandry, Nairobi, Kenya, E.Africa and T F Shaxson, Chairman, Association for Better Land Husbandry, Winterborne Kingston, Dorset UK.

Over the last six years, more than 2800 resource-poor farm families in western and central Kenya have achieved significant livelihood improvements, with assistance from the small NGO 'Association for Better Land Husbandry'. This has followed from a twinned focus on better land husbandry and marketing. The process started from a realistic basis of 'near-nil investment' for improvements in vegetable production and bee-keeping, using little more than the very limited resources of land, labour and cash available to these families. Interest in improved bee-keeping has resulted in increased production of honey and in local initiatives to protect its vegetational sources within the Kakamega Forest. Physical improvement to small intensively-managed areas of land near people's houses have been widely achieved by the enthusiastic adoption of composted double-dug beds as a means of raising yields and increasing crop diversity. Welcomed large benefits cited by samples of small-farm families across the high-, medium- and low-potential areas of Kenya include: (a) significant increases in self-sufficiency in maize; (b) markedly reduced experience of hunger between successive harvests; (c) greater resilience of the land/crop systems in the face of climatic drought; (d) notable increase in sales of vegetables by those who formerly had to buy them; (e) great improvements in diet, in terms of both quantity and quality, with resulting better health of children; (f) generation of cash income which is capable of covering a range of household needs. Other observations include (g) the spread of the composted beds beyond the houses and into maize fields; (h) much spontaneous adoption and continuation of the methods via farmer-to-farmer training, research and networking within and between Self-Help Groups. In contrast with many other rural development efforts, ABLH has been promoting 'Conservation is for Business', an approach that aims to improve livelihoods simultaneously with profitable practices that rehabilitate and maintain environmental qualities. Added to conservation-effective production practices are emphases on (a) training of members of Self-Help Groups in good business practice; (b) well-prioritised actions towards higher-value crops; (c) adding value by processing and sale of SHGs' outputs - produced and graded to a recognised 'Conservation Supreme' standard - by their own recent organisations. The beneficial effects can be seen as a major contribution to shifting the development process into a business orientation in Kenya and as a role model for conservation-based improvements to livelihoods in many other lesser-developed countries.

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A-0198

Toxicity Test To Evaluate The Quality Of Polluted Soils. Egorova K.V., Institute of Organic and Physical Chemistry, RAS, Kazan, Russia, Zaripova S.K., Biology faculty, Kazan State University, Kazan, Russia, Kaiuokova G.P. Institute of Organic and Physical Chemistry, RAS, Kazan, Russia, Romanov G.V., Institute of Organic and Physical Chemistry, RAS, Kazan, Russia, Naumova R.P., Biology faculty, Kazan State University, Kazan, Russia

One of the main criteria in the soil quality assessment is an estimation of it's toxic status. Crude oil that spills on oil-producing wells, pipe-lines, etc. can have significant impacts to different ecosystems. Ecotoxicological tests performed directly on soil give information about on the total toxicity and may facilitate the evaluation of potential bioavailability of

pollutants. The objective of this work is to assess the toxicity of different oil-polluted soils by using a kit of biological tests, includes an inhibition of reproduction of algae (Scenedesmus quadricauda), a lethal dose for the ciliates (Paramecium caudatum) and an inhibition of seeds germination, seedling growth and roots elongation of higher plants (maize - Zea mays L., radish - Raphanus sativum L., cabbage - Brassica oleracea L.). The light oil caused higher toxicity during the first days of exposure, than the toxicity decreased in the time course of the experiment. Compared to the light oil contamination the toxicity of the heavy oil is developed with the time of exposure. The toxicity tests were correlated with plant growth in the soils in a field experiment. When germination and seedling growth were inhibited more than 20% in the test, the root system and the aerial parts of plants were reduced in size. The toxicity of oil pollution is depending on the type of soils and the composition of the oils. Both oils were more toxic in the soddy-calcareous soil than in the peaty soil. Toxicity of the light oil is explained by the present of low-molecular aromatic substances, compounds with oxygen-containing functional groups, hydrocarbons C17-C28 and solid paraphyns. In the case of heavy oil toxicity was related to the high concentration of polycyclic aromatic and resin-asphaltene compounds. The toxicity tests to evaluate of different methods of remediation (combustion, irrigation, extraction by organic solvents, treatment with an active oil-degrading microbial consortium) of oil contaminated soils showed that in most cases its toxicity increased after the treatment. For example, the treatment with an oil-degrading microbial consortium resulted in a more toxic effect (by 20-30%) compared to the variant without the treatment. The process of oil mining is often carried out using special pickles with total salt contents up to 300 g/l. It led to an additional spillage and leakage as oil so well as salts into the environment. The 50% effect-concentration (LC50) of the salt-contaminated oil-mining wastewater (SOW) for the algae, ciliates and higher plants was 15 g/l; 3,75 g/l and 11,75 g/l, respectively. Dose-dependent increase of ciliates mortality, reductions in algae reproduction, seeds germination rate and seedling growth were observed. The sodium chloride solution in the same concentrations caused 2-5 times less toxicity in algae and ciliates tests compared to the SOW. Consequently, the toxic effect of the SOW are mainly explained by the presence of other compounds and than by the salt stress. A drastic synergistic effect was observed when a soil was contaminated with oil and SOW at concentrations which are non-toxic itself.

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A-0199

The use, maintenance and development of soil and water conservation measures by the small farming households in the different agro-climatic zones of Ethiopia. Yohannes Gebre Michael, Researcher in land and water conservation, Addis Ababa, Ethiopia

The study area covers six Peasant Associations (each PA covers an average area of 1500 ha). located at different agro-climatic zones and receiving high or low levels of government extension input in Soil and water conservation. Using random and stratified sampling 371 household were selected from a total of 3176 households. Moreover, a detail field measurement and investigation was made on 1303 plots owned by the sample households. One of the objectives of the study was to inventories the existing SWC practices (indigenous and introduced) and analyses their use, maintenance and development at PA, catchment, household and plot level. The findings had indicated that land users were well aware of land degradation problem. Their perception of land management was reflected in their proverb " Sterilisation is applied to human being not to the land" which implies that land can be made always productive under different land uses and land degradation can be reversible. Accordingly to alleviate such problems the land users had used a wider range of physical and agronomic SWC technologies and land management. Generally these technologies are characterised by high integration to the farming practice, multi-functionallity, they are very dynamic, scale neutral, stepwise in construction and maintenance, they offer extended benefits and have low risk. Generally the optimisation of the ecological, economic and social benefits through SWC was a fundamental strategy under the small farming household. Different stakeholders had made an evaluation of the introduced physical SWC measures. Farmers` evaluation and field verification indicate that the introduced SWC technologies had been by and large adaptive than being doomed to failure as many external evaluations had reported. A wider range of modification at plot level was observed which imply a potential for improvement than limitation. Moreover, the physical structures are still very dominant irrespective of agro-climatic and wealth rank differences. The study result also indicated that: Under subsistence farming land security issue does not seem to play an important role in the use of SWC measures on the arable land; The PAs with low extension input in SWC had the highest length of physical SWC per hectare than PAs with high extension input. This was mainly attributed due to the low external shock, which enables them to solve their own problems; Moreover, the average length of Physical SWC per hectare was higher among the poor farmers than the rich. This trend has at least two implications first for the poor survival without SWC measures is difficult. Secondly the classic attitude which says" physical SWC has a long term benefit while subsistence farmers are short sighted and SWC is not their priority" might be a wrong concept. The result also highlighted the potential and limitations of the introduced and indigenous SWC technologies. Finally one of the fundamental recommendation was the need for an intermarriage of the technologies and an empowerment of land users as one step ahead to ensure sustainable land use.

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A-0201

Land resource constraints for sustainable agriculture in Thailand. P. Moncharoen, T. Vearasilp, Department of Land Development, Bangkok, Thailand and H. Eswaran, USDA Natural Resources Conservation Service, Washington DC, USA

The recent economic crises in Thailand have placed additional strains in the management of land for sustainable production. The resource poor farmers are decreasing the off-farm inputs from levels which were already low and coupled to a lower price for their produce, the ability of the economically disadvantaged farmers to invest in conservation measures and adopt some tenets of sustainability is significantly reduced. The prognosis for the near future is enhanced land degradation, which entangles the farmers in the poverty spiral. To develop appropriate policies to address this issue, the Department of Land Development is considering several options, a starting point of which is a reassessment of the land resource constraints. The soil map of Thailand at a scale of 1:1 million was used for the national evaluation and more detailed maps for other site-specific constraints. The national soil map was combined with climatic and land-use data to evaluate important land-related constraints for agriculture. Experience and expert knowledge provided the basis for assigning the constraints to the polygons on the map. The constraints were ranked based on the ability of the farmer to manage the land. Each polygon was assigned the most limiting factor, appreciating that some soils have multiple constraints. Finally, based on the analysis, an assessment was made on vulnerability to desertification. The poster presents the maps of the assessment and results of the analysis. The information is used for evaluating impacts of current soil and water conservation efforts and for targeting areas for new mitigating technologies. To facilitate this process, the country is divided into resource management domains for delivery of conservation technology.

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A-0202

Evaluation of WEPP under different land uses. L.M. Risse, A.K. Tiwari, Driftmier Engineering Center, University of Georgia, Athens, GA USA and Mark Nearing, USDA-ARS, West Lafayette, IN USA

WEPP, the water erosion prediction project, computer model envisages the recent advancements in the process of hydrology, plant sciences, soil physics and erosion mechanics. The model has the capabilities of predicting spatial and temporal distribution of net soil loss or gain for the entire hill slope for any time. It has a wide range of applicability as it contains its own process based hydrology, water balance, plant growth, residue decomposition and soil consolidation model as well as a climate generator and many other components that broaden its range of usefulness. The model, with these advantages, has a wider scope in soil & water conservation and environmental planning and assessment than traditional empirical models. Earlier studies depict that WEPP recorded a model efficiency of 0.71 in predicting average annual soil loss and that the model performs equally well when compared with the traditional methods such as USLE, the Universal soil loss equation and RUSLE, Revised universal soil loss equation. The phenomenon of overestimating the low values and under predicting the high values is inherent to all erosion models and WEPP is no exception to it. Research has indicated that errors in soil loss predictions from the soil erosion models are primarily influenced by the land management and topographical factors. The analysis taken up at 20 different sites in USA with 1600 plot years data reveals that model predicts better for the fallow plots and the plots with single crops accounting for model efficiencies of 0.79 and 0.71 respectively. The model efficiency sequentially drops in case of crop rotations, crop + grasses and permanent cover. This error might be attributed to the model over predicting the low values of soil losses in these cases. The model predictions vary slightly for the longer slope lengths, however, model predicts accurately for a wide range of slope and soil conditions. This paper presents an evaluation of the model accuracy and located potential sources of error.

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A-0204

Hydrological implications of planting bluegum in natural shola and grassland watersheds of Southern India. J.S.Samra, A.K.Sikka and V.N.Sharda, Central Soil & Water Conservation Research & Training Institute, Dehra Dun, India

The paper discusses the hydrological behaviour, tree growth and economic evaluation of planting *Eucalyptus globulus* (bluegum) in a natural mixed Shola and grassland forest using paired watershed technique. Shola forest portion (18.7 ha) of a watershed was replaced with bluegum in one of the two comparable watersheds of about 32 ha each during 1972 after a calibration period of 4 years (1968-71). Ten years rotation cycle was followed for harvesting and coppice regeneration. The probability calculations of rainfall, total runoff and base flow during the first (1972-81) and second (1982-91) rotations analysed higher rainfall during the first rotation as compared to the second rotation in all respects. Average annual rainfall was 1569 mm and 1309 mm during first and 2nd rotation, respectively. However, the *Eucalyptus* planted watershed produced lesser

base flow and total runoff than the natural watershed and the reduction was more pronounced during the second rotation. The double mass curves also analysed similar trend. The regression equations developed during the calibration period were used to analyse the effect of bluegum plantations on water yield reductions during the two rotations. As against 16 and 15% reduction in total runoff and base flow during the first rotation, the coppiced bluegum caused higher reduction of 25.4 and 27% over the natural grassland during the second rotation. Immediately after clearfelling of bluegum in 1982, there was hydrological recovery since the computed total runoff (201.8 mm) and observed (201.1 mm) were almost same. Rapid and vigorous growth of coppice shoots in the subsequent year (1983), reduced the total runoff and base flow by 19 and 31%, respectively compared to natural grassland watershed. A similar trend was observed during 1992 after the second harvest of coppiced bluegum. From the pooled monthwise analysis, it was inferred that 68, 76 and 56% of the mean annual reduction in total runoff, surface runoff and base flow happened due to coppiced bluegum growth during the months from July through October. The bluegum covered only 59% (18.7 ha) of the total watershed area of 32 ha. If the entire watershed area had been fully stocked, the reduction due to bluegum plantations would have been much higher. The analysis of peak flows for the selected storm events revealed significant moderation of peakedness. The average ratio of peak discharge from planted and natural grassland watershed decreased from 1.03 during the calibration period to 0.54 during the first rotation and to 0.52 during the second rotation. The dry period (January-April) total flow also reduced by 20% due to bluegum plantations during the first rotation and by 28.6% during the second rotation. The base flow went down by 18% during the first rotation which was further reduced to 24% during the first coppice growth period. The low flow analysis assuming 10 days flow duration curves for the calibration also confirmed reduction in water yield due to bluegum plantations both during first rotation and second rotation periods. The Low Flow Index (LFI) indicating 10 days average flow which exceeded 95% of the time of the duration of series registered a decrease of 3.75 times during the second rotation as compared to 2 times during the first rotation, thereby indicating higher reduction in water yield due to coppiced bluegum. This dry period flow, though small, is very crucial for sustaining water supply in hydro-electric reservoirs. The increased utilization of water produced 42% more biomass and 40% higher economic returns during the second rotation as compared to the first rotation. The coppiced bluegum depleted soil moisture from deeper soil layer whereas during the first rotation, the extraction was mostly confined to the surface layers. Direct contact of the root system with the ground water table was not observed during the two rotations.

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A-0207

Indicators for the sustainability of land use systems on degraded areas of the Terra firma in the Amazon Basin : soil characteristics and parameters for transport processes. Wenceslau Geraldes Teixeira, Götz Schroth, Jean D. Marques, Johannes Lehmann, Manoel da Silva Cravo, Bernd Huwe· Wolfgang Zech, Embrapa - Amazonia Ocidental, Manaus - Manaus - AM - Brazil. Institute of Applied Botany, University of Hamburg - Germany. Institute of Soil Science, University of Bayreuth - Germany.

This study is part of a long-term program for the recultivation of degraded monoculture sites in the Central Amazon Basin. The soils occurring on upland site in this region generally have a low fertility. Large areas with those conditions are deforested and abandoned after short period of cultivation. There is a need to develop alternative land use systems which allow the utilization of degraded areas in a economically viable, and socially and ecologically sustainable way. If this can be achieved, there is a chance to reduce the rate of deforestation and to reintroduce those areas in the production process. The objective of this work is to investigate the soil characteristics and water fluxes under different types of land use and to use this information for the identification and the design of sustainable, site adapted and productive land use systems. The present experiment was conducted on a Xanthic Hapludox near Manaus. The investigated systems were monocultures of cupuacu (tropical fruit -*Theobroma grandiflorum*) and pupunha (peachpalm - *Bactris gasipaes*) and an agroforestry system composed of cupuacu, pupunha, urucum (seeds for red dye - *Bixa Orellana*), castanha do Brasil (nuts and wood - *Bertholletia excelsa*) with a cover crop of kudzu (*Pueraria phaseoloides*). For comparison adjacent sites with fallow and primary forest were included. The physical (particle size, bulk density, pore size distribution, aggregate stability), chemical (organic matter, available nutrients, soil solution composition) and hydrological (hydraulic conductivity, soil retention curves, water storage, soil matric potential) parameters were evaluated. The soil parameters showed a high spatial heterogeneity caused by different sources (natural development, root distribution, macrofauna activity as affected by different management). Especially the chemical characteristics varied between treatments and species due to different doses and sources of fertilizers. A comparison of soil water behavior in different layers measured close to individual plants using tensiometers and TRD probes indicated a "single tree effect" on the available water in the soil and a high matric potential in dry season. Practical and ecological interpretation of these data are emphasized.

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A-0209

Water conservation and utilization. K. G. TEJWANI, LAND USE CONSULTANTS INTERNATIONAL, NEW DELHI, INDIA

The paper focuses on rainwater-catchment management issues at Micro and Field - scale levels, in sub-humid and semi-arid regions with dense human and livestock population levels. While doing so, it describes some actual case studies. In all the case studies the central theme is that the edaphic conditions and the land use in any size of a catchment and in any agro-ecological conditions determine the water yield and therefore have to be taken into account in determining the actual land use within and outside the catchment. While the climate, the rainfall, the geology, geomorphology and inherent soil conditions cannot be changed, the land use, the hydrological behavior, and the production and productivity within a catchment can be modified. While describing the three types of water harvesting, the paper focuses on the technology of ponds and tanks, which are very extensive in India. The impact of land use, the degree and length of the slope, and the conservation measures on the amount and rate of runoff are described for designing of ponds / tanks, details of technology available in India (e.g. determining peak rate of runoff, runoff volume, storage, conveyance and recycling of runoff, water application and budgeting, and crop production etc.) are described. Four case studies of successful application of this technology are described. In one case a severely degraded and denuded catchment was intensely treated to reduce sediment yield, harvest and store runoff, and develop the command area for irrigation. This case study resulted in the protection of the catchment and also increased crop production and diversification in the command area. This led to an overall socio-economic development in the project. In two other case studies the catchment treatment improved the underground water storage as indicated by the increase in the number of wells, and the well irrigated area and crop diversification. In the fourth case study, the afforestation of a watershed led to a decrease in the water yield for hydropower purposes. This is an important finding for sub-humid tropical areas where the value of the water could be monetized in terms of hydropower or industrial wood/fuelwood production etc. The issue of managing the rainwater within the individual fields by "conservation bench terraces" is addressed.

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A-0211

Important and controversial watershed management issues in developing countries. Ted C. Sheng, Colorado State University, USA

Over the last decade, international meetings in soil conservation have raised many interesting but controversial issues in watershed management. One who has attended these meetings or reviewed their proceedings often finds that these issues are important but they needed to be discussed more in order to obtain complete pictures and better answers. The first of such issues has been in developing countries who should receive most benefit from watershed management work, upstream people or downstream people? Or, should the main objective of watershed management be production-oriented, or protection-oriented? The next controversial issue has been whether or not incentives should be given to farmers who practice watershed conservation work. Should farmers carry out conservation work in compliance with an overall plan but without government financial support? The third issue often discussed is whether structural measures or vegetative measures should be emphasized in watershed conservation. Structures can be costly, yet vegetative measures may not be effective in erosion control on steep slopes. The forth issue is, in watershed conservation, should the major work concentrate on prevention or rehabilitation? What are the differences in technical designs and requirements? The next issue deals with watershed planning. One school of thought is that planning should be done on farm basis rather on watershed basis. Another school of thought, however, puts emphasis on whole watershed or integrated watershed planning. The last issue which is related to integrated watershed management is how far integration should go? If a watershed plan integrates every activity in a watershed, it becomes a regional development plan and it needs no less than a local government to manage it. This paper focuses on discussing the above mentioned six important, but often controversial, issues. Pros and cons of both sides of arguments are presented, and an objective analysis is given. The author tries to present an overall picture and wishes to stimulate further discussions for the benefit of watershed work in developing countries.

Ted C. Sheng

A-0213

Environmental status of land and socio-economic policy in Russia during the 20th Century. Alexander Gennadiyev, Faculty of Geography, Moscow State University, Moscow, Russia

During past 100 years Russia was a country where were very close interrelations between changes of environmental status of land and socio-economic development, and between the soil conservation issues and ideological doctrines. In the beginning of the century the Russian conservation movement was well developed and introduced ideas of nature protection to the public. In 1916, the first Russian nature reserve was established. During the first several years after the October Revolution of 1917 some conservation legislation was initiated by Soviet government. Government tried to realize the Bolshevik concept of the rational organization of human society and the environment. According to the concept, natural reserves were considered as monuments of wilderness. Beginning in the 1920s, a major priority of Soviet economical development was conversion of an agrarian country into an industrial one. Industrial activities spread further North and into Siberia. Official ideology told that people must conquer nature in order to develop the economy of the country. Many real land degradation problems were withheld from the media and the public. It was period of collectivization of agricultural lands and environmental policy. During World War II, especially in 1942-43, more than one thousand large industrial plants were moved to the Ural, Siberian and Central Asian regions from the European part of the USSR. Under these conditions land conservation policy was not considered a significant priority. As a result of this, a lot of land around new industrial and mining areas was contaminanted. For several post-war years the so-called "Great Plan of Nature Transformation" was developed. Large-scale hydrotechnical construction on the Volga, Don, Dniper and other rivers was started and have caused flooding and waterlogging of most of cultivated lands around these areas. In the 70s-80s the "Federal Program for Intensification of Agriculture" was developed. Improper use of herbicides and pesticides caused non-point pollution of soils in some Central Russia and North Caucasus areas. Since 1968 several major environmental protection laws were adopted by the Soviet Parliament, including "The Principles of Land Legislation of the USSR". All criminal codes of the country contained articles stipulating the punishments for causing land damage. However in reality the urgent economic needs were often taken into account rather than possible consequences of soil degradation. Industry was not interested to invest in land protection measures. A series of new laws concerning land conservation were issued in Russian Federation during last decade. These are: "On Environmental Control", "On Land Taxes", "Land Code", "On Environmental Risk", etc. Most of the laws were oriented to the market economy and contain the principles of economic stimulation of land tenants for environmental management of land resources. At the present time a draft of new law "On Soil Conservation" is being discussed in the Russian Parliament. The future of the soil conservation in Russia depends entirely on the direction of Russian political and economic development.

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A-0215

Challenges and Future Strategies for Conservation and Sustainable Management of Land Resource in Bangladesh. M. S. Hussain. Dept. Soil Science. Univ. Dhaka, Bangladesh.

Environmentally Bangladesh is a humid tropical country, but surprisingly its soil resource is overwhelmingly nontropical, as almost 80% of its soils belong to the Entisols and Inceptisols orders of the US soil taxonomy. In Bangladesh 125 million people are squeezed in only 15 million hectares of land which is unable to provide an acceptable standard of living and to bring in stability in the society. To meet the demands of this huge population the soils are being constantly subjected to undue anthropic pressure and interference. More than 60% of the total land has been brought under cultivation by ignoring the principles of ecological balance. Only 10% of the total water that passes through Bangladesh is received as rainwater within its territory and the rest 90% enters through the rivers from outside. Flooding has been a common feature of this country when more than half of its territory remains under water for months. This seasonal excess wetness causes undetermined degradation to soils both physically and chemically. Of the 2 billion tons of sediments that enter Bangladesh along with the flood water, a portion is deposited within its territory, and the rest is carried to the sea. Rains in this country rains are characteristically erosive because of its torrential nature. Siltation and erosion, thus occur simultaneously and their impact has hardly been the subject of any serious study. In Bangladesh land is the only major natural resource for the supply of food, fodder, fiber and fuel. It is appalling that the nation has no sizeable grassland for its 36 million cattle and goat population. The consequence is the dire shortage of protein and milk products thus seriously affecting the health of the entire population. The present use of land for double or triple cropping by rice monoculture is seriously hampering the soil health and soil quality. The overexploitation of soil has caused a decrease of its productivity. Intensive land use and a high yielding single crop production annually will restore soil health and this can be a sustainable soil conservation practice. The problem of soil conservation in Bangladesh is simply not a technical one. It has its complex socioeconomic aspests as well . Farm holdings are small and land is partitioned into countless small plots separted from each other by small earthen *ridges* that is a legacy of tenancy and that cannot be disturbed because of popular will and which has caused mechanized farming almost impossible. There is no soil conservation act or land use policy in rural Bangladesh at present. As a result more and more good agricultural land is being diverted to nonagricultural purposes. Finally, the main problem for soil conservation in Bangladesh is the scarcity of land .To sustain the present population with this limited land resource and at the same time to conserve it are extremely difficult tasks. In this situation even slight land degradation is bound to be perilous.

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A-0216

Measurement of Erodibility for Soils in Subtropical China by Rainfall Simulator. Shi Xuezheng and Yu Dongsheng, Institute of Soil Science, Chinese Academy of Sciences, Nanjing, P. R. China

Erodibility factor K of seven different soil types in Subtropical China was measured by rainfall simulator. These soils include eroded Acrisol, cultivated Acrisol, barren land Acrisol, barren land Cambisol on red sandstone, cultivated Cambisol, calcaric Regosol and Cambisol on granite. Results show that factor K varied sharply from type to type, the cultivated Cambisol derived from red sandstone being the highest (about 0.390) and the barren land Cambisol derived from the same parent material being the lowest (0.054). The measurement of the erodibility factor K for these soils was also measured by using field plots without any vegetation cover under natural rainfall and the factor K measured by the two methods were compared in the paper.

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A-0217

The Remote Sensing prediction and Application for Soil Erosion of Southeast Coast Water-eroded Area in Fujian. Chen Yongbao, Nanan City Experimental Station of Soil & Water Conservation in Fujian Province, China

The Jinjiang valley is located in the Southeast coast of Fujian, and it is the third river valley of Fujian Province. The total area of valley is 11,000 km^2, the population density is 550 people/km^2, the till is only 0.026 hm^2/person.Because of the nature and society, the soil was seriously corroded in the history, and the Jinjiang valley is serious water-eroded area of Southeast coast of Fujian. In order to control soil erosion, the government, the collection and peasants have made the movement of controlling soil erosion in wide scope, the environmental quality of valley has improved obviously.As the application of RS and GIS, the local government needs urgently a set of rapid, practical predicting method about testing the soil erosion, so that they can manage the resources of soil and water effectively.Therefore, this research uses the practical data of soil and water conservation for the past 15 years: (1).Retain the original structure of USLE (A=fRKSLCP), but every factor is put the practical data of this area, then a soil erosion remote sensing prediction model which meets the water erosion area of this valley is set up. (2).A system of remote sensing soil loss(in quantity)in a county is firstly set up in the red soil area of the South of China, and it can measure and forecast rapidly, timely and in quantity. It can also be used in the whole valley-11000km^2 field. (3).It sets up not only the Space Database System based on the unit(30*30m)and the replacable GIS system, but also the forecast model of presenting types, it can give out preventing proposals according to the local need of soil erosion's prevention and economy. According to the research, compared with hydrologic method, runoff-plot method, on-the-spot investigated method and file method, the agreement is more than 80%, and the saving of manpower, material resources and financial resources is more than 80%.

Chen Yongbao

A-0221

Regionalization methods for watershed management – hydrology and soil erosion from point to regional scale. Christian Renschler & Bernd Diekkrüger, University of Bonn Geographical Institutes, Bonn, Germany, Jon Harbor, Purdue University, Department of Earth and Atmospheric Sciences, West Lafayette, IN USA.

There has been a long history of research aimed to develop models for water and matter transport from the pedon scale to the watershed on a regional scale. Modern watershed models focus on the prediction of water fluxes for certain Space and time scales. However, when the problem of interest is not at the scale of the model, there are difficulties in scaling both data and model results. Often hydrologic processes are described depending on the model's scale, and decisions about the level of spatial aggregation in input data, analysis and model output are irfluenced by the scale the model is designed to operate in. The research presented here takes an altematine approach to model development that avoids many of these scaling problems. Regionalization of effective and representative model parameters instead of upscaling by model or data aggregation allows to use the same model concept on the small scale as well as the large scale. Therefore representative model parameter avoid data limitations related to aggregation procedures. Hydrologic conditions and erosion processes will be simulated at a small scale using physically based models, and then representative results will be used in modeling at the watershed to regional scale. Research at the University of Bonn has focused on the development of a new

regionalization approach which allows use of detailed physically-based hydrologic models using far less data and computation time than traditionally required. The regionalization concept for hydrologic purposes is based on the simulation of a limited number of representative ecotopes instead ofsimulating each point of a watershed. Results to date have shown that accurate simulation results for a watershed on regional scale (1000 km^2) can be produced with saving up to 90% of calculation time. The present concept allows highly detailed, continuous, physically based hydrologic simulation in various time steps without loosing spatially distributed information about the hydrologically relevant characteristics of soil, land use, relief and climate. Instead of aggregating the combination of characteristics in a necessarily non linear way, an aggregation is performed based on the similarity of hydrological behavior between a certain number of ecotopes. This guarantees the preservation of the geometric identity of the ecotopes without losing the spatial distribution. Simulation results from the representative ecotopes were applied to several watersheds and were analyzed in this distributed manner. This presentation will outline the difficulties, possibilities and requirements to transfer and modify these results for a regional soil erosion modeling approach. If this regionalization method is performed successfully with a physically based erosion model, such as the model of the Water Erosion Prediction Project (WEPP) which is applicable in various geographic areas, then this will allow the application of this model approach for regional watershed management projects in other parts of the world. 'I'he new erosion regionalization approach will guarantee spatially distributed results, as the hydrological approach already does, without loosing the quality of the local model results needed by decision makers for real world problems.

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A-0224

Land tenure aspects and the implications for sustainable agricultural alnduse in Sierra Leone. Harrison K. Tarawali, Land & Water Development Division, Ministry of Agriculture, Forestry and the Environment, Freetown, Sierra Leone

The subject of land tenure systems in Sierra Leone is a 'touchy ' one, usually not freely discussed, even by Central Government. This is because of the expected social implications on the majority of the people, the rural communities who own the bulk of the lands. This situation of communal land ownership is often viewed by many as a constraint to agricultural development in the country. Basically there are two forms of land ownership in the country. In the Western Area (I. I % of the country) there is freehold of land. The rest of the country is communal ownership of the lands. This is the traditional system in which the land belongs to the family group, including those yet unborn. Access to these lands is based on customary tenure, not by individual ownership. The head of the family, usually the eldest male, is the custodian of the lands. There is a lot of debate on whether or not investment and agricultural development are actually hindered by the lack of a freehold land system in the country. Uniquely the bulk of the lands to be exploited belong to the poor small holder farmers. Incidentally this system of ownership is synonymous with the traditional low input/output bush fallow cropping systems. The farm management practices continuously deplete the soil, so the farmer moves in search of fresh farm bush. In the process of his moving about from plot to plot each year, the farmer is aware of the processes of land degradation. He does not necessarily would like to do so each year, and to clear A thick forest or bush to cultivate. He does so because he sees this as his best guarantee for optimum crop yields. Also in the face of population pressure investigations have revealed that the small holder farmer manages to cope, adapt and charge his practices, using various local and indigenous technical knowledge. These include crude rotation of major and domestic crops - to delay the fallow period of the lands, multiple seasonal cropping of terraces to allow longer fallows in the uplands, conserving particularly the large trees on the farm, etc. These management techniques provide chemical requirements, rapid forest regrowth and litter formation, thus meeting minimal nutrient requirements. It is important to understand that land is a means of livelihood in rural communities. Losing land is seen as a way of disintegrating the extended family and creating landlessness. Therefore policies designed towards the transfer of excess lands must adequately address the socioeconomic practices of the people. Such land policies for reform must include rural man as a principal factor.

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A-0228

An Ecological Approach In Soil Quality Assessment For Sustainability Evaluation. M.S. Nagaraja, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, V.R.R. Parama, C.A. Srinivasamurthy, Dept. of Soil Science,University of Agricultural Sciences, Bangalore, N.R. Viswanatha, Dept. of Agril. Microbiology, University of Agricultural Sciences, Bangalore and R. Siddaramappa, Dept. of Soil Science,University of Agricultural Sciences, Bangalore, India

Sustainable agricultural production ultimately depends on the availability and efficient use of essential resources. The concept of sustainability has been developed and interpreted on different strategies in evaluating sustainability. The natural systems and their functions would suggest a set of soil attributes for sustainability evaluation. An investigation was carried out at University of Agricultural Sciences, Bangalore, Southern India (Red Soil; Alfisols) to identify soil attributes for sustainability assessment. Soil organic-C constitutes the central part in soil productivity. Natural systems (ungrazed grassland and mixed forest) and high biomass turnover man made systems (grapes, pomegranate and FYM applied agricultural systems) were relatively sustainable. The larger soil microbial biomass pools in ungrazed grassland, mixed forest as well as grapes and organic manure treated agricultural systems would classify these as sustainable. Based on the proportion of soil microbial-C to soil organic-C, the grassland systems, teak forest and irrigated agricultural systems were more sustainable. The systems with smaller inorganic nutrient pool to the total nutrient pool are more matured ecosystems with closed nutrient cycles exhibiting least losses. Based on this, the natural systems and grape orchard appeared to be more matured than other man made agricultural and horticultural systems. The latter systems appeared to be more prone for nutrient losses by keeping relatively larger proportions of nutrients, especially nitrogen, in inorganic pool. The observations made among natural and man made ecosystems suggest that evaluation of ecological based sustainability parameters are important. The systems which receive least inputs (nutrients) from external sources in terms of quantity and which recycled more *in situ* with least nutrient losses can exhibit higher biological activity and would be more sustainable.

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A-0229

Changes in Aggregation and Aggregate C and N in CRP lands in the Central Great Plains. J.D. Reeder, G.E. Schuman, R.A. Bowman and R.W. Lober, USDA-ARS, Fort Collins CO USA

To restore and maintain the productivity of Conservation Reserve Program (CRP) lands, a better understanding is needed of the factors controlling SOM formation and degradation. This requires a better understanding of the distribution of organic matter among soil aggregate size fractions, and how this arrangement affects SOM decomposition and accrual. We conducted an 9-year field study at two CRP sites in Wyoming to quantify changes in aggregation and aggregate C and N of marginal croplands seeded to grass, and of native rangeland plowed and cropped to wheat-fallow. A native range sandy loam soil was weakly aggregated, with >60% of the soil, and the soil C and N, in microaggregates (50 - 250) and <50 -diameter size particles. Rapid deterioration of macroaggregates (>250) with cultivation further increased the amount of C and N associated with <50 size particles, but the overall C and N contents of the surface soil decreased. Seeding marginal sandy loam cropland to grasses increased surface soil macroaggregation to higher levels than found in the native rangeland, and surface soil C and N contents were comparable to native rangeland soil five years after grass reestablishment. The rapid accumulation of surface soil C and N was in part the result of inputs from the 64% higher plant biomass production in the reseeded grass plots compared to native range. In comparison, a native range clay loam soil was strongly aggregated, with >65% of the soil and the soil C and N in macroaggregates (>250 diameter). Cultivation mixed the shallow A horizon with B horizon material, resulting in an increase in surface soil clay content, an increase in the proportion of soil in large water-stable macroaggregates and a strong tendency for the formation of large water-stable clods. Cultivation decreased organic C and N concentrations of all aggregate size fractions in the surface soil, but approximately 60% of this decline was due to vertical redistribution of SOM by plowing. Seven years of established grass on marginal clay loam cropland has been insufficient to significantly increase the C and N contents of the surface soil, or to alter the size distribution of water-stable aggregates. Aggregation and the SOM content of marginal, highly erodible cropland soils can be improved by the reestablishment of grasses through the CRP. However, the rate and level of change will depend on soil texture.

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A-0231

Developments in measurement and models for suspension-dominated wind erosion. D.G. Chandler and K. E. Saxton, USDA-ARS, Washington State University, Pullman WA USA

In recent years, many urban areas in the Western U.S. have experienced concentrations of airborne dust particulates which exceeded the federal health standards. The policy considerations raised by the impact of aeolian dust from upwind agricultural sources on downwind air quality have emphasized the need for improved prediction methods. Most current wind erosion models predict average annual or seasonal erosion amounts, and only very approximate estimates of suspended dust emissions are available. Furthermore, most wind erosion research has been conducted on sandy soils and the derived models consider the vertical (suspension) component of wind erosion as negligibly small in comparison to the horizontal (saltation) component. A project on the Columbia Plateau of Eastern Washington State was initiated to develop an empirical method to estimate dust emissions on a wind event basis. Three years of field measurements, wind tunnel tests and laboratory analyses have been combined to provide a wind erosion equation and a related vertical flux dust emission model. Continuing data analysis indicates that suspension may dominate as the primary mode of transport in the study region due to the significant amounts of suspension-size particles prevalent in the regional soils. The application of contemporary wind erosion measurement techniques to loess soils are discussed in terms of project results.

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A-0233

Spectral reflectivity as a diagnostic criteria of the degree of erosion of the Grey Forest soils. Karavanova E.I'. , Sorokina N.P.'" and Kudelina E.A.' 'Soil Chemistry Department of the Soil Science Faculty, Moscow M.V. Lomonosov State University, Moscow, Russia. Docuchaev Soil Science Institute,Moscow, Russia.

Soil erosion presents the greatest problem for land use in the forest steppe zone of Russia. The traditional methods for the assessment of erosion degree are based on the morphological features and measurements of the humus content in soil horizons. But in case that soil type is characterized by the differentiated spectral profile the spectral reflectance (SR) coefficients can be used as additional indexes for the recognizing of soils erosion. The goal of the given study was to estimate the validity of the SR parameters for the investigation the erosion processes of the grey forest soils of Tulskaya region (Central Russia upland). The SR was determined for the genetic horizons of 4 soil pits and in more than 80 samples from the upper horizons of soils characterized by the different degrees of erosion. As the result of erosion originally lower soil horizons are exposed at the day surface and it's followed by the distinct change of the surface spectral parameters. The analysis of the variation ranges for the spectral indexes shows that both slightly and moderately eroded soils differ from noneroded soils by the β_{750}, tan andvalues with a probability 0.95. However the confidence intervals of reflection coefficients for slightly and moderately eroded soils are overlapped, that is caused, preferably, by the different degree of involvement of the lower soil horizons in the plow layer. The effect of the degree of involvement of lower horizons in the plow layer on the soils spectral parameters was proved by the model experiments. It was shown that the 60% mass share of the BA2 horizon to the composition of plow layer is a threshold limit under which all the spectral indexes (first of all the are noticeably changed, and the soil should be classified as eroded.

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A-0235

Sustainable Organic Matter Recycling Practices In Arecanut Based Farming Systems In Western Ghats Of South India - A Field Appraisal. N. Narasimha, H.S. Subramanya And D. Nanjappa, Associate Professor, Department of Agricultural Extension, University of Agricultural Sciences, G.K.V.K Campus, Bangalore, India.

Agriculture, Man and Ecology are intricately connected. Farming practices evolved over centuries definitely reflect the collective wisdom of farmers in a given ecological situation. The agricultural production system in its totality is determined by a complex interaction of biophysical and socio-economic factors, which vary over space and time contributing diversity in agriculture and plant species at large. This diversity should be maintained and conserved to make the farming sustainable. In this paper an attempt is made to document the farming practices of the unique agro-ecological situation of Western Ghats in peninsular India. Uttara Kannada district in Karanatka comprises of mountainous region with evergreen tropical forests. Here farming is carried out both in up lands and valleys. Commercially high value Arecanut (*Areca Catechu*) is traditionally grown as major crop along with banana, pepper, cardamom and a host of medicinal plants as intercrops in this agroforest ecological system where biomass is available in plenty and organic farming is in vogue since time immemorial. Farmers in this area believe strongly in organic manure and practice sustainable recycling of organic matter since ages. It is evident from farmers' fields and gardens that there is a dominant organic link among forestry, agriculture, livestock and water resources. The authors had taken up an assessment here, during May 1998 to document the farmers' knowledge related to sustainable farming practices. The relevant data were collected using Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) techniques. The study included randomly selected villages in Western Ghats belt of Karnataka State in Southern India. The Arecanut growers in this hilly track are dependent on green manure, livestock manure, insitu utilization of agriculture and non-agricultural wastes as well, for agricultural production system. A typical farming activity linked with insitu natural resource management, consists of cropping system as the central focus with its multiple linkages to the various facets of biomass based natural resource on the one hand and providing a renewable base for organic farming with the juxtapposition of human efforts to recycle the biomass from the farming and animal husbandry activity on the other hand. These flow pattern and recycling mechanisms are documented based on field appraisal and enumeration technique.

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A-0236

Research And Extension Gaps In Soil Conservation: A Critical Analysis Of Indian Coffee Growers. P. Chandrashekara, Reg. Coffee Res. Station, Chundale - Wynad, K.S. Krishna, Dept. of Agril. Extension, Univ. of Agril. Sciences, Bangalore, S. Glory Swarupa, Reg. Coffee Res. Station, Chundale - Wynad, and M.S. Nagaraja, Centre for Ecol. Sciences, I.I.Sc., Bangalore-India

Transfer of suitable technology to the end user is very important in sustainable farming. Coffee is the most consumed drink after water and is only next to petroleum trade in the world. This stimulating beverage crop is lifeline of 0.14 m growers, 0.3 m workers and a sizable trading community in India. It is cultivated over an area of 0.305 m ha producing annually around 0.2 m tons, having a gross turnover of around US $500 m. Coffee is more suitable at an altitude of 3300-4900 ft, characterized with gentle to moderate slope, receiving 1000-2500 mm of rainfall. High rainfall and slopy land futures of the coffee crop makes it more prone for soil loss. The issue of soil conservation consciousness operates at three levels. At farmer level, from the point of increasing yield and profit, at organization level to develop appropriate research and extension strategies and at society level with regard to passing the safe earth to the next generation. Therefore, it is necessary for the coffee growers to adopt the recommended soil conservation practices viz., contour planting, terracing, mulching, cradle pits and shade trees. This study was conducted in India to understand the knowledge and adoption level of coffee growers regarding soil and water conservation measures, identifying the gaps in knowledge, adoption, extension, research and problems of coffee growers in adopting recommended practices. The study revealed that few growers had knowledge regarding terracing (36 %), contour planting (30%), mulching (25.5 %), spacing of shade trees (22.5%) and method of shade regulation (26.5%). Like wise only few had adopted soil conservation practices namely, terracing (22.5%), contour planting (14%), mulching (15.5%) and spacing for shade trees (22.5%). Knowledge gap was found to be high in soil conservation (71.33%) and shade regulation (32%). Adoption gap was very high regarding soil conservation measures (80.33%). The paper also identified extension and research gaps regarding adoption of soil conservation technologies. As perceived by growers, high initial cost of existing soil conservation methods, low timber value of shade trees, non-availability of labour and poor management of cradle pits were important problems. The present study also helped to prioritize research activities and to formulate extension strategies for effective implementation of soil conservation measures among Indian coffee growers.

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A-0237

Soil Conservation and Management of Arid soil in Kuwait. M. Abdal and M. Suleiman, Arid Land Agricultural Department, Kuwait Institute for Scientific Research

Soil of Kuwait is mostly sandy in texture with shallow horizons and contains high calcareous materials within the lower layers. Overgrazing, gravel mining, and vehicle movement through the fragile soil enhanced winds erosion and increase sandstorm occurrences. High evaporation (3000mm/year) and low rainfall (100mm/year) during the year limited native plant growth and increase soil mobility through wind movement with enormous environmental hazard to the urban areas. Soil erosion is a common habitat of arid zone, but the phenomena has tremendously increase with man interfering with the natural setting of the environment, introducing new destructive mining equipment, four wheel drive, overgrazing, and oil pollution. Sandstorm and soil movement in Kuwait affected various aspect of life and industrial development within the country. Most of the roads, oil refineries, desalinated seawater factories, power station, and all the urban areas are totally influenced by soil erosion and windstorm movement. The paper discusses the soil properties in Kuwait and wind movement with some solution for soil management in arid area to decrease soil erosion and improve the urban environmental condition.

M. Abdal

A-0240

An expert-type methodology to assess land degradation and melioration requirements. A. Canarache, Research Institute of Soil Science and Agrochemistry, Bucharest, Romania

A simple computer programme (in Excell) is presented, enabling assessment of soil limitations and land degradation processes. It refers to drought, waterlogging due to shallow groundwater or to low soil permeability, water and wind erosion, salinity and alkalinity, topsoil and subsoil compaction, acidity, major nutrient deficiencies, workability and trafficability, and pollution. The required input consists in data in current soil survey reports and maps, as existing in this country. Input data may be automatically taken out from the PROFISOL database, where some 6,000 soil profiles are stored, or they may be directly tasted. The output of the programme shows the actual status of land degradation and risks for future degradation processes, as well as general requirements for melioration (irrigation, drainage, salt leaching, erosion control) or current farming techniques (land shaping, contour farming, deep ripping, liming, fertilization), feasibility of such practices, and, in some instances, recommendations concerning details of these techniques (irrigation schedule, sprinkling intensity, drain spacing, lime and fertilizers rates).

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A-0245

Watershed management in semi-arid region – Experiences in India. Prasad Rasal

History has proved that civilisations have risen on lands with favourable land and water resources and destroyed by soil erosion and siltation e.g. Indus valley. Interestingly India and many developing countries with agriculture dominant, are prospering with new developments in agriculture. With depleting natural resources, changing lifestyle and values, sustainable development is a dream today. Government working with huge infrastructure has its own problems and limitations. Rural Development being the principle objective, the stress should be on natural resources and its management. There are some places in all parts of the world, acting as lighthouse in thunderstorm. Concerning India, some villages developed themselves through NGOs, who created initiative in local people. With rise in productivity of some food grains like rice, wheat, sugarcane (requiring huge quantity of water), concept of environmentally sustainable development requires to be injected into the minds of the people. Devoted voluntary workers in NGO sector can show a way for this huge task, as can be seen in villages like Ralegan Shindi. INDIA believes in what Mahatma Gandhiji said "There is enough for everyone's need but nothing for anyone's greed." Different techniques adopted in all places under integrated approach for sustainable development are - low external input, optimum utilisation of available local resources, indigenous technology and sustainability, considering village as a unit of development, soil and water conservation on watershed basis, new improved methods of organic manure, equitable distribution of available local resources like water, participation of villagers from planning to distribution of benefits. Planned land use pattern, self-imposed disciplines, equitable distribution of benefits are the key words in each case. In all the villages, water availability less than 750 cum per capita. But they have shown a way to sustainable development. Now in all the places more than 25% area is under forest, 20% under irrigation. Above discussed models show that each village can be self-sufficient only with its own natural resources. At village level, soil conservation, water conservation, biomass and agricultural development will play a substantial role with active participation of villagers. Work done by these villages has been responsible in changing the government policies. When selfless leadership and urge of the people join hands, unbelievable things become a reality.

Prasad Rasal

A-0247

Vetiver Grass Hedgerows for soil and water conservation in farm lands in Uganda. A success story. J.G. Dembe, Executive Director, Foundation for Urban and Rural Advance, Kasese -Uganda

Soil Erosion is severe in high Rainfall Areas of Uganda where the major crops are Bananas, pineapples and vegetables. The system used was the old up down planting system adopted due to the absence of vegetation protection to the existing machnical measures which resulted in severe soil erosion where by all soils with nitrates increasingly washed away causing land degradation. The introduction of vetiver grass for the protection of soil and water, planted in the hedgerow, become very successful to farmers. A study revealed that all farmers who put it into practice succeeded in their soil protection hence increased farm profitability. Mechanical measures are generally not accepted by the farmers due to high costs and maintenance, while the vetiver grass Hedgerow popularly accepted due to low costs techniques, easy to apply, low maintenance, and also apart from soil and water conservation vetiver has also presented other potential economic values such as fodder, mulcl, animal beddings and for making hand craft. Farming systems that incorporated vitiver grass and other types of grass have many advantages of producing high Quality of Bananas, pineapples, and vegetable in the Hills of Bushenyi -Uganda.

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A-0249

Soil Effects Due To Sewage Sludge Application As The Amendment. Selivanovskaya S.Yu., Gainullina S.N., Alimova F.K., Latypova V.Z., Applied Ecology Department, Ecology faculty, Kazan state university, Kazan, Russia

The agricultural practices adopted to boost productivity have often led to adverse effects on soil quality and fertility. In the recent decades the use of sewage sludge as the organic fertilizer has been a common practice. This way is not only alternative to landfilling or incineration, but also provides a useful organic amendment that can improve soil properties such as structure and nutrient status. At the same time an important contribution to reducing the urgent problem of sewage sludge disposal is achieved. Since sewage sludge contains plant nutrients and organic matter, it may be beneficial to soils and their productivity. However, depending on its source, sewage sludge often contains considerable amounts of heavy metals and organic toxicants. One of the main fields of interest is the impact of the complex of toxicants of sewage sludge on soil microflora, as it constitutes the living pool of soil organic matter, which is responsible for an essential part of major nutrient cycles (C,N,P). It should be expected that the microbial activity in soil would increase with the application of organic matter in sewage sludge. One the other hand the negative effects on the microflora by simultaneous enrichment of organic matter and inorganic and organic pollutants were found. In this work the modification of the soil microbial activity by the addition of sewage sludge was studied in field experiments. Three types of sewage sludge (composted, anaerobically digested and dried sewage sludge) were compared. Chemical characteristics and some parameters related to biological components (microbial biomass, organic C mineralization, N2 fixation and four enzyme activity –of dehidrogenase, cellulase, protease and urease) were determined in the amended soil. The contamination with heavy metals of the soil did not exceed the control level of the control variant. All types of sewage sludge led to an increase in the microbial biomass but the effect caused by the addition of the composted sewage sludge was more pronounced than that of other types of sludge. Besides that the addition of the composted sewage sludge to the soil had a significant positive effect on the soil respiration and increased the protease activity. The of N2 fixation was observed in the case of composted and anaerobically digested sewage sludge. Urease, dehydrogenase and cellulase activities increased with the addition of the all types of sewage sludge. On the base of results obtained an adequate sludge management was proposed.

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A-0251

Gila Monster Watershed Association Addresses Issues on Gila River in Arizona and New Mexico. Donna Matthews, Coronado RC&D Area, Inc., Willcox, AZ USA

The Gila River originates in the mountains of New Mexico and enters Arizona near Duncan. It traverses central Arizona and eventually merges with the Colorado River just north of the Mexican Border. The arid nature of this region as well as intensive agricultural diversion has made it a dry wash in its lower desert stretches. A river of many issues, the upper Gila is free flowing with a major ecological and economic impact on the state. Agriculture, mining and recreation provide the economic base. Ninety percent of the basin is public land subject to increasing multiple uses. Threatened and endangered species reside within the watershed; there is increased sedimentation in the river and loss of riparian habitat due to flooding, and high salt content water entering the San Carlos Apache Nation. These concerns brought citizens and entities along the river in Arizona and New Mexico together to look for solutions. The first step in finding solutions was to form a watershed association to formulate and implement short and long term plans and projects that would have a positive benefit to the watershed. This association became known as the “Gila Monster”. Participants include: Federal Agencies-8, State Agencies-7, Indian Nations-1, County Government-5, City Government-2, State Associations-6, Conservation Districts-4, RC&D Areas-2, Advisory Groups-4, Environmental Groups-12, Ranches/mining-9, University-2, State Legislative Rep.-2, Other local groups-6. The Gila Monster has a 501c(3) tax-exempt status and is directed by an elected executive council. In the three years since inception, the association has accomplished the following: completed a 10 year plan, capped an artesian saline well, completed a fluvial geomorphology study on the New Mexico portion (AZ proposal in progress), fenced to protect sensitive species in the Gila Box riparian area, completed an Ecological Inventory and Analysis, planted willow poles at critical points for bank stabilization and implemented a sediment control demonstration project in the upper watershed. By bringing partners to the table, local citizens have facilitated a method to address concerns in an entire watershed.

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A-0254

The study on the characters of soil and vegetation ecosystems on the abandoned fields on the tropical region, Hainan Island in the South of China. Yang Xiao Bo, The center of the biology, Agriculture college, Hainan University, HaiKou City, Hainan Province, P. R. China

Hainan Island is the biggest tropical region in the South of China. The soil erosion and degradation is an important ecological problem because of the increase of the strength of the land use. In order to evaluate the fertility of soil and setup the model for recovering the forest vegetation on the abandoned fields, this paper deals with the secondary vegetation successional law and relationship between the different vegetation characters (community coverage, number of the plant species, number of the woody species , number of the late successional species and index of plant-diversity) and soil fertility (the content of the organic matter, nitrogen, phosphate and potassium), base on the analysis of the characteristic of different vegetation system types on the abandoned fields (about 2-20 years), the North of Hainan Island. The study results are as following: The index of plant-diversity(α-biodiversity) and soil fertility(the content of the organic matter and nitrogen) increase by the vegetation successional stages of the initial grassland to woodland (open stand of trees). The index of β-biodiversity of the different vegetation types change more (the index of β_s and β_r increase and the index of C_s and C_N decrease) in the transition stages of the grassland and scrubland, but the soil fertility(the content of the organic matter) increase more in the transition stage of the scrubland and woodland then other stages of vegetation succession. The increase of the content of organic matter relate closely to the increase of the late successional species, the content of nitrogen, relate to the community coverage, the number of woody species and late successional species, along with the vegetation successional stages of the initial grassland to woodland.

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A-0255

The Use of Polyacrylamides to Reduce Erosion and Increase Yields of Furrow Irrigated Corn, Onions, Tomatoes and Peppers in the Arkansas River Valley of Colorado. James C. Valliant, Regional Irrigation Specialist, Colorado State University Cooperative Extension

The use of PAM, a linear-linked polyacrylamide, alone or in combination with HYDROGEL, a cross-linked polyacrylamide, substantially reduced soil loss due to erosion and increased yields of corn and freshly harvested onions, tomatoes and peppers in the Arkansas River Valley of Colorado in 1996 and 1997. Using a combination of PAM and surge irrigation, erosion was reduced an average of 64% while using 25% less irrigation water and producing equal yields of 179 bushels per acre of grain corn when compared to untreated conventional irrigated corn in 1996-97. Soil loss was reduced 47% when using PAM on 6 of 11 irrigations and still produced similar total market weight of 370 cwt/ac compared to 357 cwt/ac on the untreated check in the 1996 trials. In 1997, soil loss was reduced 22% when PAM was applied on only 3 of 10 irrigations and total yield was significantly increased from 377 cwt/ac on the untreated control as compared to 425 cwt/ac on the PAM treated plots. The use of HYDROGEL did not have any effect on stands or yields in these trials. Fresh picked tomato yields were substantially increased in 1996 from 14.8 tons/ac on the untreated control to 20.8 tons/ac when using a combination of PAM and HYDROGEL, as a seed treat. Soil loss was reduced 39% on the PAM/HYDROGEL area as compared to the untreated control. In 1997, HYDROGEL, either as a seed treat or incorporated in the soil, increased the number of emerging plants from 50 to 300% when compared to the untreated control while yields, after thinning, were increased as much as 2.4 tons per acre. In 1996, soil loss from a Jalapeño pepper field was reduced 47% when using PAM as compared to the untreated control. Also, fresh picked pepper yields were increased from 4.0 tons per acre on the untreated control to 8.7 tons per acre on the PAM + HYDROGEL area.. On a Mira Sol pepper field in 1997, the combination of PAM + HYDROGEL produced 9.5 tons per acre as compared to 6.5 tons per acre on the untreated check. These results indicate the use of PAM can substantially reduce soil loss in a variety of different crops while the addition of HYDROGEL in combination with PAM on small seeded vegetable crops can help improve emergence while increasing yields in many instances.

James C. Valliant

A-0257

Soil-based GIS Applications for Environment Protection in England and Wales - Current Practice and Future Development. T.R.E. (Dick) Thompson (SSLRC), Soil Survey and Land Research Centre, Cranfield University, Silsoe Bedfordshire United Kingdom

The Soil Survey and Land Research Centre is the custodian of national soil resources information for England and Wales. The environment Agency is the Government agency responsible for protection of the environment. Interest in soil information is growing within the Environment Agency and a range of projects has been completed in which soil information has been used to assist Agency staff identify solutions to environmental problems. These ranges from research into climate change impacts to catchment-based projects aimed at controlling agricultural impacts on water quality. This paper will report on experience to date and describe the results of a scoping study to identify future options for the development of soil-based GIS systems to assist the Agency in its work. The paper will include consideration of the future requirement for new, more detailed spatial data on soil resources.

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A-0261

Spatial Ranking The Vulnerability Of Shallow Aquifers To Agricultural Contamination For Water Conservation And Management. Neda Leonaviciute, State Land Survey Institute, Kaunas, Lithuania

In Lithuania all drinking water is derived from groundwater sources due to poor quality of surface water bodies. However, the process of groundwater pollution has also reached a threatening level: one third of the country's shallow groundwater resources are polluted by nitrates at concentrations exceeding drinking water standards of 45 mg/l. The rural population, which totals up to 22% of national population, is exposed to the greatest risk of polluted groundwater. Hence, a systematic approach to identifying the inherent risks of potentially polluting activities is urgently needed for improving water management and groundwater quality in Lithuania. As a comprehensive tool for groundwater protection against nonpoint agricultural pollution, groundwater vulnerability maps have been developed, the concept of which is based on the spatial assessment of the intrinsic characteristics of a site. The vulnerability assessment methodology developed by the Soil Survey and Land Research Centre at Cranfield University (UK) has been successfully adapted to Lithuanian conditions. The factors that together define the vulnerability of groundwater resources are: 1) soil layer thickness; 2) depth, duration and type of waterlogging; 3) soil texture; 4)presence of slowly permeable horizon; 5) organic matter content; 6) nature of geological deposits; 7) depth to groundwater. Leaching potential relates to a wide range of pollutants that are soluble in water and have the capacity to adsorb onto clay and organic matter. 3-fold soil leaching potential classification is superimposed on a 4-fold permeability classification of the uppermost geological deposits. Groundwater vulnerability zones identify all the different soil leaching potential classes occurring within each individual area of geological deposits. A 1:50,000 scale digital maps of the groundwater vulnerability have been produced. Validation possible from available shallow groundwater analyses suggests that the methodology satisfactorily predicts the relative groundwater vulnerability: differences in the frequency distribution of nitrate levels are consistent with the soil leaching potential classification. The primary purpose of groundwater vulnerability maps at this scale is to serve as a spatial basis for devising and installing a Lithuanian Groundwater Protection Policy at a national and district level. The greatest advantages of this methodology is that it has a clearly defined classification system, which can be readily used and understood by non-specialists; and that it is based on a relatively low cost technology, thus perfectly corresponds to economical conditions of the countries in transition at CEE region.

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A-0264

Slope Length Effects on Soil Loss for steep Slopes. B.Y. Liu, Professor, Beijing Normal University, Beijing, China, M. A. Nearing, Research Engineer, National Soil Erosion Research Laboratory, USDA-ARS, West Lafayette, IN and P. J. Shi, Professor, Beijing Normal University, Beijing, China.

An empirical soil erosion model is still playing an important role on soil conservation planning and environment evaluations. Slope length factor is one of the main and the most variable factor in an empirical model. It was expressed as a power function as $L=(l/22.1)^m$ in the widely used model, Universal Soil Loss Equation (USLE) in which the slope exponent, m, was 0.2, 0.3, 0.4, and 0.5 for different slope gradient. In Revised Universal Soil Loss Equation (RUSLE), the exponent, m, was defined as a function of slope steepness. When the slope is 50%, the exponent m is 0.7 for the moderate rill/interrill erosion ratio in RUSLE. That will predict 22% more soil loss than using slope exponent 0.5 suggested by USLE on 60-m long slope and predicted 35% more soil loss in 100-m slope. Many farmlands are on very steep slopes on loess plateau in China. The purpose of this study is to verify which exponent (USLE or RUSLE) is better adapted to the steep land on loess plateau. Soil loss data from natural runoff plots at three locations on the loess plateau in China were used to assess the effect of slope length on soil loss for very steep slope. The slope length for Zizhou location was 20,40,60 meters with slope steepness of 40.4%, the plot length for Suide station was 10, 40, 60 meters with 40, 42.8, 40% slopes respectively; the length of slope for Ansai was 10, 20, 30, 40 with 57.7% slope steepness. The width for all of the three locations was 5 meters and the land management for Zizhou and Suide were cropland with low density of crop cover but fallow for Ansai location. The soils were loam or silt loams. The results indicated that for these plots, the exponent, m, for the relationship between soil loss and the slope length, was 0.49,0.48, 0.40 respectively according to the equation $L = (l/22.1)^m$, where l is the slope length and L is the slope length factor normalized to 22.13 m. This relationship was assessed in terms of the limited existing experimental data for rainfall erosion on steep slopes and would indicate that the USLE exponent, m=05 is adapted better for steep slope on loess plateau than the RUSLE exponent.

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A-0267

Research and extension gaps in soil conservation: A critical analysis of Indian Coffee Growers. P. Chandrashekara, Reg. Coffee Res. Station, Chundale, Wynad, INDIA, K.S. Krishna, Dept. of Agril. Extension, Univ. of Agril. Sciences, Bangalore INDIA, S. Glory Swarupa, Reg. Coffee Res. Station, Chundale, Wynad, INDIA and M.S. Nagaraja, Centre for Ecol. Sciences, I.I.Sc., Bangalore INDIA

Transfer of suitable technology to the end user is very important in sustainable farming. Coffee is the most consumed drink after water and is only next to petroleum trade in the world. This stimulating beverage crop is lifeline of 0.14 m growers, 0.3 m workers and a sizable trading community in India. It is cultivated over an area of 0.305 m ha producing annually around 0.2 m tons, having a gross turnover of around US $500 m. Coffee is more suitable at an altitude of 3300-4900 ft, characterized with gentle to moderate slope, receiving 1000-2500 mm of rainfall. High rainfall and slopy land futures of the coffee crop makes it more prone for soil loss. The issue of soil conservation consciousness operates at three levels. At farmer level, from the point of increasing yield and profit, at organization level to develop appropriate research and extension strategies and at society level with regard to passing the safe earth to the next generation. Therefore, it is necessary for the coffee growers to adopt the recommended soil conservation practices viz., contour planting, terracing, mulching, cradle pits and shade trees. This study was conducted in India to understand the knowledge and adoption level of coffee growers regarding soil and water conservation measures, identifying the gaps in knowledge, adoption, extension, research and problems of coffee growers in adopting recommended practices. The study revealed that few growers had knowledge regarding terracing (36 %), contour planting (30%), mulching (25.5 %), spacing of shade trees (22.5%) and method of shade regulation (26.5%). Like wise only few had adopted soil conservation practices namely, terracing (22.5%), contour planting (14%), mulching (15.5%) and spacing for shade trees (22.5%). Knowledge gap was found to be high in soil conservation (71.33%) and shade regulation (32%). Adoption gap was very high regarding soil conservation measures (80.33%). The paper also identified extension and research gaps regarding adoption of soil conservation technologies. As perceived by

growers, high initial cost of existing soil conservation methods, low timber value of shade trees, non-availability of labour and poor management of cradle pits were important problems. The present study also helped to prioritize research activities and to formulate extension strategies for effective implementation of soil conservation measures among Indian coffee growers.

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A-0270

Cover management in relation to erosional losses under simulated rainfall. Pratap Narain, R.K. Singh and N.S. Sindhwal Central Soil & Water Conservation Research & Training Institute, Dehradun India AND L. D. Norton, USDA-ARS, National Soil Erosion Research Laboratory, West Lafayette, Indiana USA

A study was conducted (1993-98) on 8% slope in eight runoff plots of 1.0 m x 7.5 m on loam soil containing 22% clay and 35% silt. In the I set of cropped plots, corn (50,000 plants ha^{-1}) was grown in 60 cm contour rows with and without 4 t ha^{-1} mulch of crop residues. The canopy and land cover were varied by increasing 100 and 150,000 plants ha^{-1} and reducing row and plant spacings. After 1 month of sowing, 50% plants were thinned and used as mulch retaining 50,000 and 75,000 plants ha^{-1}. Cowpea (30 cm x 30 cm) and *Chrysopogon fulvus* grass (60 cm x 30 cm) were also tested alongwith a cultivated fallow. Sowing was advanced to last week of March in order to escape rains. In II set of fallow erosion plots, mulch was applied @ 1, 2, 4 and 6 t/ha in two replications, which created 23, 42, 69 and 100 percent ground cover respectively. Portable Purdue series III rainfall simulator with programmable microprocessor for controlling intensities and six V-jet nozzles in a row was utilized to rain at 91 mm hr^{-1} intensity for 15 minutes. Rain was applied each year at three monthly stages one before and two after thinning of corn on I set and only twice on II set of plots. Entire runoff was measured at 1, 3, 5, 7, 9, 13 and 15 minutes and analysed for sediment. Ground cover, canopy cover and canopy height were measured fortnightly. Soil moisture was estimated down to 30cm before and after application of rainfall. Since intensity and duration of rain was kept constant, cover treatments in I set were compared for runoff and soil losses considering year as the replication. Erosional losses were related with different cover parameters and rainfall for three stages of runs using statgraphic software. The ground cover with organic residues was more efficient in controlling erosional losses in corn than above ground canopy cover. During high intensity simulated storm 4 t ha^{-1} residue mulch was less effective in controlling runoff (23% reduction) but efficiently prevented soil loss upto 90% as compared to unmulched plot. Increasing plant population to 150,000 ha^{-1} and thinning 50% to provide 2.8 t ha^{-1} residue mulch after one month of sowing also reduced soil and water loss significantly. Improving canopy cover by 100,000 plants ha^{-1} was not effective in controlling erosional losses but use of 50% thinned mulch material (1.5 t ha^{-1}) in left over 50,000 plants ha^{-1} reduced soil loss significantly. Chrysopogon grass provided best protection and cultivated fallow revealed highest erosional losses during all the events. On fallow erosion plots 23, 42, 69 and 100 percent ground cover through mulches recorded average 87, 79, 61 and 52% runoff and 1.2, 0.9, 0.47 and 0.18 t ha^{-1} soil losses respectively. Erosional losses with 4 t ha^{-1} mulch were more or less similar with crop and without crop showing little contribution by canopy in presence of ground cover for controlling erosion during intense storms. Erosional losses with 2 t ha^{-1} mulch giving 42% ground cover without crop were comparable to cowpea having 84% above ground cover. Through runoff hydrographs, the cover practices could be arranged in decreasing order of runoff production : CF < Corn-50,000 < Corn 150,000 + 50% mulch < cowpea < corn 50,000 + 4 t mulch < grass. The order of sediment concentration was < corn 50,000 + 4 t < grass < corn 150,000 + 50% mulch < cowpea < corn 50,000 < CF. This shows higher silt trapping efficiency of surface residues in preventing soil losses. The concentration of sediment was high in the beginning of the run dropping sharply and assuming constancy lateron. Predominance of splash at the start and sealing of pores with flowing sheet of runoff in later stages are possible causes of decreasing sediment loss during the storm. Regression model relating runoff and soil loss with canopy parameters and rainfall fitted for 128 observations on I set of plots are as follows : $RU = 3.4772 + 1.6407\ ST - 0.00120\ CC^2 - 0.00073\ GC^2 + 0.5497\ R_n$ (Adj $R^2 = 0.5115$) $\sqrt{SL} = 3.978 + 0.2102\ ST - 0.0196\ CC - 0.0171\ GC - 0.0873\ R_n$ (Adj. $R^2 = 0.4949$) Where, RU = Runoff; SL = Soil loss, ST = Stages, CC = Crop cover, GC = Ground cover, R_n = Rainfall

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A-0273

Soil Erosion: A Combined Analysis of Tillage and Water Erosion over a Complex Landscape. M.J. Lindstrom, T.E. Schumacher, USDA-ARS, N.C. Soil Conservation Research Laboratory, Morris, MN USA, D.A. Lobb, Department of Plant Science, South Dakota State University, Brookings, SD USA and J.A. Schumacher, Eastern Canada Soil and Water Conservation Centre, University of Moncton, Grand Falls, New Brunswick, Canada

Soil erosion prediction analyses have changed considerably in the past decade. The development of RUSLE and WEPP for water erosion prediction along with RWEQ and WEPS for wind erosion represent major advance in soil erosion prediction systems. Soil translocation through tillage operations is also an important erosion producing agent which has not been adequately considered. It has been documented that soil translocation by tillage produces annual soil erosion rates from specific landscape positions that can greatly exceed soil loss tolerance levels. It is the objective of this study to characterize soil erosion over a field transect considering both water and tillage erosion from an annual tillage sequence of moldboard plowing and two discing operations at specific landscape positions over a 40-year period. The field transect, 800-m in length, was constructed to include topographic features common to western Minnesota and eastern South Dakota. Analysis for water erosion will be simulated using WEPP, whereas, tillage erosion will be determined from empirically determined soil translocation rates as a function of slope gradients in the direction of tillage for individual hillslope segments with dimensions of 1 m by 1 m. Results from this analysis will identify specific field locations where water or tillage are the predominate erosive agents but also demonstrate the interaction between the two processes. Tillage erosion rates up to 55-t ha^{-1} yr^{-1} were identified at abrupt convex slope positions representing a 16-cm loss in soil over the 40-year period. Water erosion was most predominate in steep backslope positions with maximum slope gradients. Deposition of eroded soil occurred in concave slope positions for both erosion processes. The overall effects of soil erosion from both water and tillage was an increase in field soil variability and degradation of surface soil quality with tillage erosion contributing equally to the degradation.

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A-0274

Environmental benefits of conservation tillage. D.C. Reicosky, Soil Scientist, USDA-Agricultural Research Service, North Central Soil Conservation Research Lab, Morris, MN USA

The magnitude of greenhouse gas emissions from soil degradation depends on land use, cropping systems and tillage intensity. Concern for soil quality and related environmental issues requires new knowledge to minimize agriculture's impact on the environment. Agricultural ecosystems can play a significant role in the production and consumption of greenhouse gases, specifically carbon dioxide. Information is needed on the mechanisms and magnitude of greenhouse gas emission from agricultural soils with specific emphasis on tillage mechanisms. This work evaluates the impact of various conservation tillage tools and strip tillage on tillage-induced CO_2 loss. Results showed the maximum CO_2 loss following the moldboard plow with less CO_2 loss from various conservation tillage tools and the least from no-till. Strip tillage decreased the amount of CO_2 loss and appears to be related to the volume of soil disturbed by the tillage operation. Additional information on CO_2 loss from the soil without using the portable chamber was collected to characterize the plume of CO_2 from a plowed strip 5.5 m wide by measuring the concentration up and downwind. Concentration differences decreased with time after tillage and were as large as 140 mol mol^{-1} immediately after tillage. The smaller CO_2 loss from conservation tillage tools is significant and suggests progress in developing conservation tillage tools that can lead to soil carbon enhancement. Reducing the volume of soil disturbed through strip tillage should enhance soil and air quality by increasing the labile carbon content and decreasing the tillage-induced CO_2 losses. These results suggest that soil and environmental benefits of less intensive tillage should be considered in soil management decisions.

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A-0275

Indigenous soil and water conservation practices in Karnataka State, India. G.M.Varadaraju, Assistant Professor, Dept. of Agril. Extension, University of Agril. Sciences (UAS), G.K.V.K.V.K., Bangalore INDIA, B. V. Chinnappa Reddy, Associate Professor, Dept. of Agril.Economics. UAS GKVK Bangalore-, INDIA, N. Nagaraja, Danida Advisor, Karnataka Watershed Development Project, Vivek Nagar (East), Bijapur, INDIA, M. J. Chandre Gowda, Scientist (Agril. Extension) TTC, Indian Institute of Horticultural Research, Hesaraghatta, Bangalore, INDIA and M. V. N. Rao Director, Gram Vikas (NGO), Honnashettahally, Via Devarayasamudram, Kolar District, INDIA

Soil and water are vital natural resources that have to be conserved both qualitatively and quantitatively. Although, organised soil and water conservation (SWC) practices were initiated in the recent past, farmers have been practicing indigenous SWC

practices since ages for sustainable livelihoods. Recognition and appreciation of these practices strengthen farmers' motivation to undertake SWC programs. This paper attempts to list some of these practices, besides their rationale. Agriculture in Karnataka is predominantly under rainfed conditions. Low and uneven distribution of rainfall and poor water holding capacity of soils has made farming a gamble on the plains. On the other hand hilly and coastal areas, which receive intense rainfall, pose a different set of problems to their cultivators. Farmers overcome these challenges in their own way through innovative indigenous strategies. These are categorised into cultural practices, management of bunds, cultivation of tree crops, maintenance of drainage lines and construction of water bodies. Cultural practices involve inter-cropping and mixed cropping with suitable crops that enhance productivity and soil fertility. There are other cultural practices like sheep penning, green leaf manuring and tank silt application. Unique bunds are constructed and maintained as per the requirements each field. Farmers are Engineers for several such practices. Terracing and trenching are done to the perfection wherever required. Marginal lands have been planted with valuable and multipurpose tree species like tamarind, jackfruit, guava, mango and cashew, besides the in situ moisture conservation techniques. In non-arable lands planting of tree species like pipal, neem, pongamia, cassia, banyan are common. Contour planting and windbreaks are practiced in hilly ranges. To manage drainage lines placement of boulders and its fencing, diversion drains, and agave planting is followed. Planting indigenous tree species like darakadamba *(Sarcocephalus missions)* and mahakadamba *(Anthocephalus cadamba)* because of mat like root system protects streams and riverbeds, which are prone to severe soil erosion. Farmers have also built barrages and check dams across streams to store water and to use it for community needs. Ponds, seepage tanks percolation tanks and irrigation tanks have been constructed and maintained to meet the specific requirements. Community celebrations on the occasions of the first overflowing of tanks reflect the value attached to water and its linkage with the sign of prosperity. At the same time conflicts between neighboring farmers are also common when upstream farmers fail to check the run-off water flowing over the down-stream farmers' fields.

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A-0276

Influence of Cabbage Growth on Ridge Erosion. Takahiro SHIONO, Azuma TAKAGI, Chikara OGURA, Ken-ichiro KAMIMURA, National Research Institute of Agricultural Engineering, Tsukuba, Ibaraki JAPAN

Evaluation of temporal variations of ridge and furrow erosion affected by crop growth is vital to predict cropland erosion from a physically-based erosion model. However, little research has been conducted to treat the relationship between the rate of the erosion and crop growth quantitatively. The objective of this study is to evaluate the influence of cabbage growth on interrill (ridge) erosion rate experimentally. Small container plots simulating crop row sideslopes with and without cabbage were prepared. At five crop stages, simulated rainfall was applied to the plots and soil loss from the slopes was measured. In addition, experiments for the effect of row sideslope steepness on the soil erosion were made in the same way. The soil loss was mainly caused by splash erosion due to direct impact of raindrops on the soil surface. The soil loss increased proportionally to the approximate square of the rainfall intensity and to the slope steepness. Thus, interrill erosion rate for the plots without the crop was given as a function of rainfall intensity and a slope factor empirically. In the plots with the crop, the soil erosion decreased corresponding to the crop development. Our observations suggested the great contribution of crop cover to the decrease of the soil erosion. Furthermore, the data on the plots with the crop was compared with the data on the plots without the crop. The result of the comparison indicated that the effect of the crop cover on interrill erosion rate could be described as a function of crop cover ratio. Moreover, the result suggested that temporal variations of ridge erosion affected by cabbage growth could be practically estimated using the crop cover ratio.

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A-0278

Irrigation Tank Water Conservation And Management: The Role Of Voluntary- Social-Group Action In Karnataka, India. B.V. Chinnappa Reddy, Associate Professor, Dept. Agril. Economics, University of Agril. Sciences (UAS), GKVK, G.M. Varadrajau, Assistant Professor, Dept. of Agril. Extension UAS, GKVK, and Lalith Achoth, Associate Professor, Dept. of Dairy Economics and Business managementUAS, Hebbal, Bangalore-India

The tank system in India was the basis for the development of villages and hence, they play a pivotal role in development. They are common property resources, which have declined over the years due to neglect and break down of institutions. The paper documents a detailed account of factors and process in the evolution of an indigenous voluntary-social-group-action for conserving rainwater under a tank system and its socio-economic impact on the livelihoods of people. Malamachanahally village tank is one and half centuries old, irrigating water to a large cultivated area of small farmers. The amicable water-sharing method hitherto in vogue was disrupted due to low water storage because of silt accumulation in the tank. This predicament was further compounded by the declined water level in surrounding wells. Conflicts over sharing of scarce water culminated in clashes. The village elders solved this problem by evolving an indigenous coping mechanism based on the voluntary-cooperative-group action that envisages a ban on water use and allows storage of water for groundwater recharge. The voluntary group action currently under practice for the last 15 years, has culminated in the following positive impact: Improvement in the groundwater table in a five-kilometer radius; Shift in cropping pattern from paddy to light irrigated crops like mulberry, vegetables and other commercial crops, which are more profitable than paddy; Sustenance of livelihoods of a great majority of small farmers lending a perceptible degree of stability and resilience to their livelihoods; Equity in groundwater distribution as number of small farmers benefited in the region exceeded that under tank irrigated area; Realization of substantial economic gains from fisheries due to standing water; Steady increase in number of milch animals due to higher availability of fodder and through mulberry cultivation. The existence of complementary rural-urban linkages along with improved groundwater regimes in the area further accelerated the process of development of commercial agriculture, which enhanced the socio-economic status. The sustenance of the group action is largely attributed to the increased awareness and conviction among farmers about the need for conserving a scare resource like water. Perceived tangible economic benefits, improved livelihoods and a high degree of equity in the distribution of gains due to the conservation and management of water, further boosted the sustenance of the group action.

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A-0280

Finite element modeling of erosion from agricultural lands. V.N. Sharda, Central Soil & Water Conservation Research & Training Institute, Dehradun, U.P., India and M. A. Nearing, National Soil Erosion Research Laboratory, Purdue University, West Lafayette, IN USA

A finite element model simulating runoff and soil erosion from agricultural lands was developed by Sharda and Singh (1994). The sequential solutions of the governing differential equations of Richards with a sink term, Saint-Venant in conjunction with kinematic wave approximation, and sediment continuity were used to simulate infiltration and soil water dynamics under cropped conditions; overland and channel flow; and soil erosion, respectively. The reference crop ET was computed using modified Penman's method from which actual plant transpiration under prevailing moisture conditions was calculated by employing the methods suggested by Feddes et al. (1978), Van Genuchten (1987) and Borgs and Grimes (1986). The sediment continuity equation was solved by employing a fully implicit scheme for time integration, Yalin's equation for sediment transport capacity, and inter-rill and rill relations of Foster (1982). The model reasonably simulated the runoff and erosion from agricultural lands treated with major mechanical soil and water conservation measures. However, the model assumed a representative size (medium diameter) of particles for soil erosion and inter-rill, rill and transport capacity relationships needed further refinement to improve its prediction power as the model had a tendency to over predict the soil loss especially for high intensity storms. The model has been refined and updated following state-of-art in the inter-rill, rill and transport capacity relationships. The comparison of inter-rill erosion relations suggested by Foster (1982), Kinnel (1993) and Liebnow et al; (1990) has revealed that under field conditions, the relations based upon the product of runoff rate and rainfall intensity predict better than those involving intensity alone. It is ascribed to the fact that inter-rill soil erodibility is not a function of soil properties alone but also of infiltration and runoff differences between soils which vary with flow depth. For simulating rill erosion, the empirical relations evolved by Nearing (1997) and those used in the WEPP model were found to be in a reasonably good agreement through the latter has a tendency to slightly overpredict the peak sediment rate. The model of Nearing based upon stream power concept has the potential of better simulating rill erosion phenomenon due to its inherent advantage of knowing only the unit flow discharge rather than both hydraulic radius and velocity of flow. The comparison of predicted and observed sediment graphs has shown that sediment transport capacity simulated by simplified Yalin's equation (Finkner et al, 1989) was in close agreement with the solution of complete Yalin's equation and the former can be conveniently used. The model has been updated to simulate erosion for individual particle size fractions considering five particle size classes as suggested by Foster et al; (1985). The comparison under field conditions assuming uniform particle size equivalent to median diameter and the non-uniform size fractions has indicated that rise and recession in the sediment rate is much faster for the uniform size and the peak rate was also higher than the non-uniform size. Hence, size fractions must be considered while simulating erosion under natural conditions. The concept of shift of transport capacity from excess to deficit type particle classes was also tested and analyzed. The analysis has revealed that the shift of transport capacity not only distorts the peak rate but also results into its sharp decline. Hence, it is not desirable to follow the concept of shift of transport capacity during erosion simulation. The model has been upgraded to simulate deposition and transport in impoundments using modified overflow rate concept for variable flow conditions. The testing of the model in a conservation bench terrace system for simulating erosion in impoundments has yielded satisfactory results. For simulating erosion in natural catchments, watershed version of the model has been developed. the procedure involves discretization of the watershed into sub-catchments, flow strips and elements. The flow has been assumed one-dimensional along the strips and channels, and perpendicular to the contour lines. The variable size elements constitute hydrological units of identical slope, soil and landuse. The watershed model employing

finite element technique has been tested under field conditions.

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A-0283

Application of Cesium-137 for measuring soil erosion/deposition patterns near a sustainable agricultural practice. Jerry C. Ritchie, USDA ARS Hydrology Laboratory, Beltsville, MD USA

Maintaining the sustainability of agricultural and natural resources for future generations is a major concern. Soil erosion and loss is a major problem affecting the sustainability of agricultural areas around the world. Many methods have been used to reduce or slow soil loss from agricultural fields, especially erosion from areas of concentrated flow channels. Recently there has been increased interest in the use of narrow, stiff grass hedges as a sustainable conservation practice to slow runoff and reduce soil loss caused by concentrated flow erosion. However, few quantitative data are available concerning the effectiveness of such hedges in controlling soil loss. This study was designed to measure quantitatively the effectiveness of narrow, stiff grass hedges as a conservation tool for reducing soil loss from agricultural fields. Engineering surveys made in 1991, 1995, and 1998 measured 4 to 8 cm of sediment deposited upslope from these grass hedges. Soil samples were collected in 1998 for Cesium-137 analyses and were used to determine deposition rates and patterns upslope from the grass hedges. Deposition patterns estimated from the redistribution of Cesium-137 were related to the original topography with low areas having the greatest deposition. However, deposition rates and patterns determined using Cesium-137 do not reflect the most recent deposition patterns near the grass hedge measured by engineering surveys but do help us understand the long-term deposition-erosion patterns in the field.

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A-0284

ACRES: Automated CRP Enrollment System using GIS. Vernon L. Thomas, CIESIN Fort Collins, Fort Collins, CO USA

The USDA Farm Service Agency (FSA) and the Natural Resources Conservation Service (NRCS) are implementing the Conservation Reserve Program (CRP) sign-up for 1999. The primary goals of the CRP are erosion control, enhancement of habitat, and improvement of water quality. The process of analyzing and selecting farm parcels for inclusion in the CRP is complicated, labor-intensive and time consuming. To determine if a parcel meets CRP enrollment requirements, the conservationist must hand calculate Environmental Benefits Index (EBI) scores for each parcel using an eleven page form required by the FSA, using data and information gathered from aerial photography, paper maps, spreadsheets, and other sources. Time required to complete this form for an individual parcel ranges from 1 – 3 hours. Over 250,000 forms were completed during the 1997 CRP sign-up. The Automated CRP Enrollment System (ACRES) is a Spatial Decision Support System created using the Smart Places ArcView resource modeling system extension. ACRES allows novice and advanced users to interactively design and evaluate farm parcel CRP enrollment alternatives by automatically calculating EBI scores, drastically reducing the time required for form completion and evaluation. The use of the Smart Places extension provides a highly organized system of linked data structures that allow the user to quickly and easily evaluate parcels for CRP enrollment and integrate new or updated data and/or parameters for EBI calculation and reporting. This paper will present the results of the use of a prototype ACRES for evaluation of farm parcels for the CRP in Morgan County, Colorado.

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A-0286

Sediment transport capacity and erosion process interaction**.** Angelika S. ZARTL[1] and Chi-hua HUANG[2], [1]Department of Hydraulics and Rural Water Management, University of Agricultural Sciences Vienna, Austria, [2]USDA-ARS National Soil Erosion Research Lab, West Lafayette, IN, USA

Sediment transport capacity, Tc, is defined as the maximum amount of sediment that a flow can transport. The difference between Tc and sediment load, Qs, is used to calculate detachment or deposition rate in the current USDA process-based erosion prediction model, i.e., WEPP. Under this model concept, detachment occurs when Tc > Qs and deposition occurs when Qs > Tc. Despite its extensive usage in modeling erosion processes, the value of Tc was rarely measured, especially from an erodible surface. The objective of this work was to quantify sediment transport processes from shallow surface flows in a rill channel. A multiple box system, consisting of a cascade of three soil boxes, is designed to simulate sediment transport processes in a segment of the hillslope. For this study, the two upslope boxes were used as the sediment source and the third box was partitioned to three 0.2-m wide replicate rill channels. The flow rate, flow velocity and sediment delivery in the rill channel were investigated under different soil hydrologic conditions, slopes, rainfall intensities and sediment feeding rates. Data showed the importance of raindrop impact as well as slope steepness and hydrologic conditions on sediment delivery and the dominant erosion process. Even under a deposition dominated regime, the sediment delivery increases as the sediment feeding rate is increased. The data set suggests a non-unique sediment transport capacity that is dependent on the dynamic equilibrium of erosion, deposition and transport processes. A conceptual framework which accounts for simultaneous erosion and deposition processes has been proposed and a preliminary analyses of the analytic model with the experimental data will be demonstrated.

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A-0287

Soil erosion risks assessment at regional scale using GIS and expert system. LE BISSONNAIS Yves, MONTIER Cécile, DAROUSSIN Joël, KING Dominique, INRA Science du Sol ARDON FRANCE.

Surface runoff and soil erosion are major threats for sustainable agriculture. Mapping of regional erosion risk are increasingly needed by national environment agencies. Because erosion results from the interaction of several parameters which vary in space and time, no simple model allows to take it into account, particularly in cultivated areas where human factors are predominant. Geographical Information System (GIS) and numerical cartography may permit the development of multivariate models for the assessment of erosion risks. However, the quality of the results is limited by the quality of the data and knowledge of processes to be modelized. The various erosion factors have been hierarchised for different geographical situations and erosion mechanisms have been expressed with the help of expert rules. The soil crustability is now considered as a key factor in runoff and erosion risk on cultivated soils. A geographical database was created for the french territory, and a model allowing the erosion risks distribution mapping was developed. It uses expert rules to combine data on soil crustability and soil erodibility (determined by pedotransfer rules from the European soil database), landuse (Corine land cover database), DEM (National Geographic Institut) and meteorological data (Météo-France). They were integrated using various spatial integration units (administrative or environmental units). This study shows that the main trends of regional runoff and erosion risks may be obtained from statistical and cartographical analysis of the various factors selected in the database. The soil informations are among the most important for the model. However, their usefulness is greatly increased if erosion processes are previously classified. The main areas affected by erosion risk are the north west and east of Paris basin with intensive agriculture on crusting soils and the Rhône valley and south west of France were vineyard or summer crops cover large areas. Other areas like Brittany, Bourgogne, south of massif central or mediterranean area are moderately affected. Areas with a permanent cover of woodland or grassland show a low risk of erosion.

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A-0288

Designing research to improve runoff and erosion control practices: example, grass hedges. L. D. Meyer, S. M. Dabney, W. D. Kemper, USDA-ARS National Sedimentation Laboratory, Oxford, MS USA

New erosion control practices are needed for some land-use situations, and better designs would make many current practices more effective. Sometimes, learned research focuses on a better understanding of the principles, processes, and mathematics of the system but then stops short of the ultimate goal of improving control practices for land application. And, too often, data for quantifying and validating is inadequate. This paper discusses research directed toward effective use of relatively narrow strips of vegetation as an example of an approach that was productive in improving erosion control methodology for cropland and other erosion-prone areas. Although use of vegetative cover, either continuous or in strips, to reduce upland soil erosion is widespread and often effective, many types of plants bend and flatten, offering little resistance to the runoff in areas of concentrated flow. For such conditions, taller and stiffer plants provide better control of runoff and erosion. Several types of stiff-grass hedge (or "vegetative barrier") research are illustrated that are helping to improve hedge design and also the ability to accurately model hedge performance. Included in the research methods discussed are: laboratory studies on hydraulic properties of different grasses, mechanical evaluations of plant stem stiffness, flume tests of sediment trapping by various types and widths of grasses, natural-rainfall and rainfall-simulator erosion plot comparisons, field trials of parallel hedges on cropped fields, surveys of soil movement during tillage and erosion events, and applications of erosion prediction models. Studies and observations on a wide range of soil, climate, topography and land-use conditions plus input from users and action agency personnel provide a basis for developing more effective and economical stiff-grass hedge criteria, identifying strengths and weaknesses of the technology, and clarifying further research needs.

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A-0289

USDA NRCS Soil Quality Institute. M. Lee Norfleet, Acting Director, Soil Quality Institute, USDA NRCS, Auburn, AL USA

The Soil Quality Institute display is a presentation of the institute's purpose, goals, products, and on-going projects. Products developed by the institute include applied filed products like the Soil Health Card Development Guide for locally led conservation

and the Soil Health Kit for rapid, on-farm, semi-quantitative analysis of key soil properties. A Soil Biology Primer has been developed and published to enhance NRCS employee's awareness of the importance and role of the biological properties of soil. In addition to the primer, the Institute has developed several other information/educational products related to soil management that enhances soil quality and the environment. Current projects include a Soil Quality Index for precise quantification of key soil properties and their response to management. This project serves to support another endeavor, the Farming Systems Comparison Procedure, which allows landowners and conservationists to compare conservation practices and select the best options for the agronomic, economic, and ecological health of the their operation

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A-0292

What Can the U.S. National Resources Inventory Tell Us About Factors Affecting the Adoption of Conservation Tillage? Jay D. Atwood, USDA, NRCS and Joaquin Sanabria, Texas Agric. Exper. Station, Blackland Research Center, Temple, TX USA

The rate of conservation tillage adoption in the U.S. has slowed from 1.6 percent of cropland converting to this technology per year during the 1989-93 period to only 0.6 percent per year in the 1994-97 period. At the same time, water quality policy initiatives are depending on greater future rates of adoption for the reduction of non-point source pollution. The socio-economic factors affecting technology adoption by farmers have been widely studied, including those factors influencing the use of conservation tillage. However, these studies have not completely explained rates of adoption across diverse situations. Local agricultural researchers address site specific climate, landscape, and soil factors as they develop new technologies. Despite the site specificity of agricultural research, the influence of these physical factors on conservation tillage adoption patterns are not well understood by the policy makers who are allocating research funds or setting up programs to use conservation tillage to address sustainability and non-point source pollution problems. A statistical analysis of survey data from the National Resource Inventory is presented to show how rates of conservation tillage adoption in the U.S. vary according to climate, landscape, and soil differences. Separate results are presented for highly erodible and non-highly erodible land and by major crop for each of the ten USDA Farm Production regions. The statistical analysis also indicates for a given soil, climate, or landscape attribute, whether or not levels of that attribute differ significantly between acres with and without conservation tillage. Factors evaluated include continuous variables associated with erosion equations and categorical factors such as flooding frequency, hydrological group, land class capability rating, etc. Also included is a brief discussion of the how the data collection procedures influence the statistical results. Our examination of the physical factors affecting conservation tillage use will be helpful to national and state level policy makers in two ways: 1) the results will indicate where additional research and financial and technical assistance could best be targeted to encourage further conservation tillage adoption; and 2) the results will help water quality policy makers to understand the potential for further non-point source pollution reduction via crop residue management.

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A-0293

An applicable field method for the evaluation of some ecological significant soil-function-parameters in science and agricultural consulting practice. Andrea Beste, Foundation Ecology & Agriculture, Mainz

To assess the effects of human land management on both the condition of ecological soil-functions and resilience of soils, we need investigations of water circulation, supply of nutrients - natural and supported by human, activity of soil biota and soil structure. Concerning ecological soil vitality the condition of soil structure represents a complex and sensitive indicator. Soil structure stability is highly related to biological activity of soil organisms. Dynamic of water flow, soil structure and soil life activity are interconnected complexly. Therefore, methods which aim to assess effects of management practices on this complex ecosystem have to be able to mediate a comprehensive qualitative impression of the actual state of health as well as to deliver exact data of common soil parameters. The practice of the Spade diagnosis, developed by the German J. GÖRBING about 1930 is to dig a 'soil-brick' with a spade out of the field. This soil brick is immediately examined concerning the condition of soil structure and other parameters. In support of this method the condition of soil structure, size, shape and arrangement of soil particles and aggregates as well as density, root growth and soil moisture can be examined and estimated by little effort. This comprehensive impression has been proved as very helpful for the judgement of foregoing management practices (crop-rotations, tillage-treatments ...) and appropriate decisions about modifications for future soil management by agricultural consulters and farmers. For the scientific utilization of the complex ecological information gained by this method, some modifications and extensions have been done in order to collect data with scientific evidence about the condition of soil crumb. Experimentation and improvement of the now called Extended Spade Diagnosis (ESD) is currently implemented by A. BESTE as Ph.D.-thesis in agrosciences (SÖL/Institute of Crop-Management, Department of Organic Agriculture, University of Giessen) within the Research- and Demonstration-Project Ecological Soil Management (PÖB), which was started in 1994 near Mainz (west of Frankfurt/M., Germany) as a long time research project lasting ten years. To gain an actual comprehensive impression of the soil crumb in Extended Spade Diagnosis some new developed soil evaluation schemes and laboratory tests are applied in combination with common soil parameters. Hence, ESD offers the possibility to document scientifically as well as applicable the ecological effects of different management systems on soil vitality without high-technology expenditure. Therefore it has great advantages especially in regions were investigation-methods that require high-technology equipment are not availiable or not practicable.

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A-0294

Indirect and direct Soil Indicator Systems for the soil conservation decisions. Frielinghaus, Monika; Müller, Lothar; Ellerbrock, Ruth, Center for Agricultural Landscape and Landuse Research (ZALF), Institute of Soil Landscape Research, Müncheberg

Content of the presentation should be the analysis of the possibilities to indicate the state of soil and the pressure by agricultural land use systems. The following indicator system based on the state- pressure- response model of the OECD. Outgoing by the basic conditions for the sustainable protection of the resource soil (CONCEPT SUSTAINABILITY, 1997) were formulated Soil Quality Aims and Soil Strategy Goals for a longer term to realize this concept. The action goals for reduction of Water erosion and Wind erosion, of soil compaction and humus losses are subjected an analysis. Available methods for the indirect indication of soil state and land use pressure as well as the direct indication of the local soil conditions and parameter changes were explored. It has shown itself, that first of all the indirect indication (regional state and pressure) has given the precedence, since over this procedure for larger areas can be demonstrated potential risks. The available data are suitable for an estimation of potential risks for soil erosion, soil compaction and humus loss suitable. The direct indication and control the soil condition with regard to his current functionality or the degree of the entered damages remains the followed steps for areas with strong potential endanger or high pressure. After the concept of "critical load inputs" can derive for more efficiently and acceptable protection level for the land users. A combined evaluation, based on the regional state of soils and soil landscape and the land use evaluation shows three levels:1. soil quality sustained guaranteed, 2. soil quality not sustained guaranteed, 3. suspect of soil degradation or offsite damage exists. Conclusions for decision (response) are: best management practice for the first level, special agricultural management for the second level, land use change for the third level.

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A-0296

Man-made materials in urban soils: The influence of porous skeleton on the concentration of pollutants of soil water. Nicole Bädjer and Prof. Dr. Wolfgang Burghardt, University of Essen, Applied Soil Science, Essen

In the Ruhr area, an industrial area in Western Germany, investigations about urban soils were made. In this region (by-)products of coal-mines, founding and of other industrial activities occur in many soils and man-made materials like ashes, slags, rubble and sludges are wide-spread not only on the sites where they were produced but also in the surroundings. Some of the soils containing man-made materials were investigated with regard to their chemical composition but there aren´t many informations about their physical properties. As now soils should be used for storm water infiltration knowledge about their features for water infiltration purposes is needed. With an increased amount of infiltrated water the risk of groundwater pollution rises. Although depending on the conditions of their formation the man-made materials differ in their characteristics to a great extend they frequently have a high content of skeleton, which is more or less porous, in common. Because of the existence of porous skeleton in a fine matrix the structure of urban soils can be similar to that of aggregated soils. Gaps between the fragments of skeleton lead to a high air capacity. On the other hand in the porous skeleton there are fine pores which are partly connected. Partly these pores only can be reached from infiltrating water by molecular diffusion. From this it results a dual porosity which is characterized by a combination of pores that are used for water transport processes and pores which are only used for the storage of water and substances in the soil water. This phenomenon is well-known from aggregated soils and peat-soils. In order to investigate the influence of the porosity of man-made materials on the concentration of pollutants of infiltrating water undisturbed soil samples of slags, ashes, rubble and sludge were taken and their pore size distribution and water conductivity were determined. In irrigation experiments the breakthrough of chloride solutions through these materials was investigated. The intensity of irrigation was varied in order to imitate different rainfall intensities. The results of the investigations make it possible to give a risk assessment concerning infiltration processes in soils with man-made materials and the breakthrough of pollutants. The influence of the physical properties of man-made materials on the concentration of pollutants in soil water are presented.

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A-0297

The influence of grass strips on runoff hydrology and sediment transport**.** H. Ghadiri, C.W. Rose and W. Hogarth, Griffith University, Nathan, QLD, Australia

Grass strips have been widely used as a management technique for the control of soil erosion and the prevention of sediment transport by runoff on agricultural lands. It is a common belief that grass strips are effective in slowing down the flow and trapping or filtering out its sediment load. Such a double action by grass strips sounds logical, but there is little theoretical or experimental evidence to support this description or explain the mechanisms involved. A theoretical model of the hydrology of grass strips was given by Hogarth et al. (1997). This model was tested in a series of flume experiments carried out with runoff. A strip of grass was placed across the steady flow of sediment-laden water generated by flow over a 4 m bed of soil upslope of the grass bed. The results showed that, contrary to common belief, sediment deposition did not take place within the grass strip, at least for the range of slopes studied (0 to 6.5 percent). Retardation of the flow took place before the grass strip, causing the water level to rise at some distance ahead of the strip. This distance was dependent upon the flow rate and the slope of the flume. For a constant flow rate of 0.00227 m3/m/sec the lower the flume slope, the greater was the distance upstream of the grass bed where the velocity commenced to decrease, being indefinitely large at near zero slope. As the flume slope increased the point at which water depth increased approached closer to the strip, entering it at around 6% slope. The bulk of sediment load in the sediment-laden flow approaching the grass strip was deposited at the point where flow depth started to increase. The finer fraction of sediment load that entered the strip with the flow emerged from the other end unchanged. Some of this sediment which passed through the grass strip was then deposited as fans downstream of the strip, the rest remaining suspended until the flume exit. It was further observed that, for the range of slopes studied, the efficiency of the grass strip in slowing down the flow ahead of the strip is independent of the width of the strip in the flow direction. It appears that only the front few rows of grass provide the bulk of resistance to flow, aided by any floating plant debris which can quickly build up against the first row of grass. If the grass stems are strong enough not to bend under the flow, then a thin dense row is expected to be as effective as a wide band of grass in slowing down the flow and so causing its sediment load to deposit. Grass strips thus appear to behave more like “grass barrier” than “filter strip” as they are commonly referred to in the literature. The process interpretation of these results is discussed in this paper.

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A-0299

Application and adaptation of WEPP to the traditional farming system of the Ethiopian highlands. Gete Zeleke, Geographic Institute, CDE, University of Bern, Bern, Switzerland

Ethiopian highlands are the largest mountain complex in Africa which are heavily threatened by land degradation resulting from several thousands years of human settlement and agriculture. Understanding the process of land degradation is the first step that needs to be considered before applying any controlling mechanisms on such fragile ecology. This study focuses on the application and adaptation of WEPP (Water Erosion Prediction Project) to the traditional farming system of these mountain complexes, and to use it as a tool for describing soil erosion processes and planning soil and water conservation measures. WEPP was tested on cultivated plots in a standard soil erosion monitoring site, Anjeni Research Unit (Gojam). A breakpoint climate data generator was developed as a standalone programme to change standard rain-gauge data into the format required by WEPP. Particular attention was given to this part of methodological improvement, so that the added programme could be used in any part of the world. Likewise, other input parameters were generated based on local conditions. The time series analysis of runoff curve show that simulated values fit very well with measured values. However, WEPP slightly underpredicts runoff especially for extreme events and during the beginning of the rainy season. Except in few cases, WEPP overpredicts soil loss by an average value of 48.8%. It was noticed that some of the disparities between measured and simulated values were attributed from measurement procedures and errors in the empirical data sets, as many storms were added in single measurements and sometimes inflow of runoff into the plot. After some expected error data sets were removed, the average Nash-Sutcliffe model efficiency obtained for predicting runoff and soil loss on daily basis was 0.63 and 0.26 respectively, indicating model bias in predicting soil loss. This bias, unless it is a structural flaw in the model, could be corrected by improving the various transfer functions used to generate input parameters, error screening and through model calibration. In general, the results are promising and very important steps are done for future application of this model in the area.

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A-0301

Hydrodynamic characteristics of rills on the steep loess slope. Zhang Keli, Department of Geography, Beijing Normal University, China

Soil erosion has been a worldwide environmental problem. Soil erosion results in not only degeneration of soil productivity, but also floods and pollution of water resources. Soil erosion and its causes have been studied extensively. A major field of these is the soil-loss prediction which enables the planner to predict the average rate of soil erosion. With the development of computer technology, soil erosion prediction has shifted from empirical models to theoretical models. But many of the fundamental erosion processes are not yet well understood, especially until now relatively few attempts have been made to deal with erosion processes on the steep slopeland. In this study, inflow experiments were conducted on the loess slope to determine hydrodynamic characteristics of rills, and friction coefficients on the steep slope conditions. All experiments were conducted in a 5 m long, 0.5 m wide, and 0.7 m deep flume. Slope steepness can be manually adjusted to 6¡ã ,10¡ã, 12¡ã ,15¡ã, and 20¡ã. To let water infiltrate tested soil freely, natural sands was packed into the flume about 0.3 m in depth before soil was filled in, and than tested soil was filled and adjusted to reach a bulk density of 1.17 g/cm3 .Inflow water was added from the top end of the flume and inflow volumes, controlled with a watergauge, were designed as 40, 60, 100, 200, 300, and 500ml/s respectively. Throughout each run the following data were collected: mean velocity, depth of runoff, section shape of rill, and sediment samples. Each run consisted in 30-min duration and two replications of each of five slopes were assigned. Experiments results showed that hydraulic geometry of rill on the steep loess slope, which are the mean width of cross-sections, mean velocity, mean depth of flow, could be related to discharge and slope gradient in power relations. The related exponents to discharge are 0.26, 0.48 and 0.26 respectively. Manning roughness coefficient ranges from 0.035-0.071 with an average of 0.0536. Darcy-Weisbach fraction coefficient varies from 0.4-1.9. Data trends also indicated that roughness coefficient are closely related to Reynolds number or flow volumes, but the tendency is quite different depending on the slope steepness. The roughness coefficients are inverse proportion to Reynolds number and flow volumes on gentle slope, on the contrary, they are direct proportion to Reynolds number and flow volumes on steeper slope due to the interaction of hydraulics of flow and the shape of rill.

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A-0302

Popularization of soil conservation techniques in rural region of Madagascar. Mr Rakotondralambo Andriatahiana, Technical Director of the National Association of Environmental Action, Antananarivo 101, Madagasikara

The agriculture in Madagascar is characterised by his diversity of production brought by the big fan of climate and soil conditions. However, it is affected by many problems especially problems of land degradation and soil erosion. The farms are generally concentrated in narrow valley and irrigation is the main typical of the malagasy agriculture. Vegetal cover regresses regularly because of the excessive deforestation and the practice of bush fires. In view of the threat of food insufficiency and the increasing evolution of demography, the change of farming practice and the work of hillsides (tanety) remain the solutions to revitalise the sector of agriculture and also to safe a weak economy at the root of agriculture produce. Different techniques were carried out since 20 years ago (contour, bank, terrace,…). Unfortunately, these techniques were not adapted for social and economic conditions and for the physical capacity of the farmers that are not motivated to realise hard work for hypothetical result generally low. Measures required in Malagasy Environmental Action Plan (1991- 2001) recommend intervention at the production considering the environment especially soil. Practices quoted in this presentation summarise the action of a malagasy association, National Association of Environmental Action (ANAE). Its primary objective is to combine activities which enhance production, decrease erosion and improve soil fertility in smallholder agricultural communities work with ANAE-supported agencies to define their primary problems and needs and assess how ANAE can possibly assist. The main clients consist of densely populated agricultural communities facing considerable land constraints as they cultivate both irrigated valley and surrounding tanety. Individual small-scale project consists of a range of measures that combine short-term productivity gains with soil conservation activities with yield longer-term productivity gains and environment improvements. The gradual spread of small-scale projects in a region is expected to reduce the gravity and incidence of environmental problems including bush fires, degradation of soil structure and fertility, sedimentation of irrigation reservoirs and canals and damages of infrastructures. By 7 years of activity, ANAE financed more than 2.000 small-scale projects that permitted to analyse the complexity of the approach and the richness of rural experiences on soil conservation. That also permits to identify the place of soil conservation in his socio-economic limits and to fit out an approach for different situation in the island. Results established till now created an increased interest by the rural region. Farmers understood the aim of soil conservation and did not hesitate to invest. Data projects prove it clearly. In spite of negative view, small-scale projects tried to set up situation.

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A-0303

The Usefulness of a New Model for the Gully-Control Structures Effects Prediction. Lucia Nedelcu, Hydraulic Engineer, Senior Lecturer, University of Agricultural Sciences and Veterinary Medicine, Bucharest, Romania

Romania lies in the South-Eastern Europe and encompasses 237,500 km^2. About 43 percent of its 149,000 km^2 of agricultural fields is sloping land, with water erosion

potential. The total erosion provided by these lands is 106.6 milion tons/year. Gullies are the preferential ways for the sediments transport and delivery in rivers, causing many damages. Most of the gullies watersheds and channels have been suffering human interventions, in Romania. Under these circumstances, the effects prediction for the gully control works becomes necessary. The author achieved a study on 23 gulllies equipped with 43 dams. The field investigation objective was to measure the stable channel gradient formed above each structure. These values were 2-5 times measured in 6 years. The research finished with several results. One of them was the finding of a prediction model for the equilibrium channel profile above dams, in 1989. This is an analytical component model, based on the sediments motion mechanics theory. The model structure was discussed for the first time by D.A. Woolhiser and A.T. Lenz in 1965. The model validation was made by the correlation coefficient calculation and its significance testing. The model was checked by different data from those used to its calibration,too. Besides,to the measured data were applied other 3 prediction models known in the scientific literature. The model which the author recommends adjusts the best the equilibrium gradient magnitude, having the biggest correlation coefficient. This conclusion is a result of the mentioned comparison. The author considers the model to be useful because: it contributes to the prediction accuracy increase, by the significant input data selection and the stipulation of the kind of their gathering; it represents an appropiate tool for the uncertainity management in a prediction required in an environmental impact assessment; it offers the possibility of estimating the energetical effects of the dams; it is an important component for the economic calculations, which are used for the best management alternative choice.

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A-0304

Mineral-N Movement in an Ultisol in the Central Highlands of Kenya. D. Mugendi, M.Kanyi, J.Mugwe, P. Tuwei, I. Kariuki, G. Karanja, and M. O'Neill, KARI/KEFRI/ICRAF National Agroforestry Research Project, P.O. Box 27, Embu, Kenya

A randomized complete block experiment to investigate mineral-N movement down a soil profile in an agroforestry system was conducted in an ultisol in the central highlands of Kenya during the long rain 1998 cropping season. The study was a follow-up of previous work undertaken in the region between 1992 and 1997 that had indicated substantial build-up of mineral-N in the top soil layer in excess of crop (*Zea mays*) demand during the first four weeks of a cropping season following application of tree biomass into the soil. It was hypothesized that the accumulated mineral-N may be lost from the system through various processes (such as leaching) or may be transformed to other forms that may not be readily available to plants. The objective of the current study was therefore to quantify mineral-N movement in the soil and to propose ways of managing the mineralized N from the soil-applied organic amendments to minimize its losses and thereby maximizing its (N) economy in the cropping systems. The preliminary results obtained indicate that mineral-N progressively moved down the soil profile as the season progressed accumulating in the deeper soil horizons. Treatments that received tree biomass but had no tree hedges accumulated higher amounts of mineral-N (especially NO^-_3) averaging 400 kg NO^-_3-N ha^{-1} in the 200-300 m depth layer. On the other hand, treatments with *Leucaena leucocephala* and *Calliandra calothyrsus* tree hedges recorded an average of 50 kg NO^-_3-N ha^{-1} in the same depth, indicating that trees are capable of recycling N that would otherwise be lost to crops by capturing subsoil mineral-N that accumulates below the rooting depth of most annual crops.

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A-0305

Assessment Of The Efficacy Of Contour Bunding And Terracing Conservation System In Sustaining The Soil Resources On Peasant Farms In The Highlands Of South-Western Uganda. Festus D.K.Bagoora, National Environment Management Authority, Kampala, Uganda

The highlands of South-Western Uganda are classified as a tropical humid highland environment prone to serious soil erosion problems. It is inhabited by a dense rural population whose subsist on montane peasant farming system which concentrates on production of annual food crops. Early in this century, signs of soil erosion on the peasant farms began to be evident as the population pressure on land became significant. By 1930s the problem worsened and, in response the British Colonial Government embarked formulated and implemented soil conservation policies and practices on the peasant farms. The main conservation practice was construction and maintenance of contour bunds and terraces. By late 1940s, conservation practices in this highland were rated to be advanced and easily unsurpassed by anywhere else in Africa. Unfortunately for a number of reason, the conservation practices declined later after the country attained independence in 1962. Whilst the contour bund cultivation and the resulting bench and sloping terrace structures were considered to be effective in reducing soil erosion, their efficacy was not precisely determined, and has never been assessed so that improvements are made where necessary. Unlike the more sophisticated terracing system, the simple terraces that develop from contour bunding do not effectively reduce the slope angle of most farm plots and, therefore, runoff and soil erosion processes on the farms remain very active. As part of assessing the efficacy of these conservation structures, runoff and soil loss rates and magnitudes on the contour bunded peasant farms were studied over the two main crop growing seasons in the highlands (January - June and September - December), under the two main annual crops grown during the two seasons (sorghum and Maize intercropped with beans). A replica of fifteen 2m by 10m erosion plots were used to study the rates of runoff and soil loss. The plots were established on five hillslope sites on peasant farms in such a way to represent different slope facets (lower, middle and upper) and a range of slope angles to represent gentle, steep and very steep slopes, as well as differrent soil characteristics. Results of the study indicate that runoff and soil loss on the peasant farms still occur at high rates, in many cases beyond tolerance levels. In this paper, the efficacy of the conservation system in the highlands is assessed based on the study, as well as farmers' experiences, attitude towards conservation, and available technological levels. The conclusion is that the present conservation systems will for a long time remain the most realistic and cost-effective, but require radical improvement, including incorporation of new initiatives.

Festus D.K.Bagoora

A-0306

Soil Erosion Models and Implifications for Conservation of Sloping Tropical Lands. C.W. Rose, Faculty of Environmental Sciences, Griffith University, Queensland, Australia

A catena of modelling approaches are briefly reviewed including dynamic stochastic and deterministic approaches. It is shown that a dynamic stochastic description of soil erosion, with appropriate parameter identification, can be identified with a deterministic description of processes, but these descriptions are mutually helpful. The role of such dynamic process models is reviewed, but more attention is given to simpler limited-parameter models and their use in extensive multi-country field studies in south-east Asia and Australia. Extensive hydrologic data collected on runoff could be adequately interpreted using a single-parameter model of infiltration reflecting the dominant dependence of infiltration rate on rainfall rate. Data on soil and water loss from a bare plot incorporated as one treatment were interpreted to yield a single soil erodibility parameter at each site. The effectiveness of a variety of soil conservation options appropriate to the humid tropics was evaluated, and process studies drawn upon to seek generalisation of this evaluation. The issues of model prediction of soil and water loss are also briefly considered.

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A-0308

Estimation of Soil Erosion Using Remote Sensing and GIS, Its Valuation and Economic Implications on Agricultural Production. Manzul Kumar Hazarika and Kiyoshi Honda, Asian Center for Research on Remote Sensing, Space Technology Application and Research Program, Asian Institute of Technology, Klong Luang, Pathumthani, Thailand

Soil erosion is a serious environmental problem in Northern Thailand causing a threat to sustainable agriculture. Faulty agricultural practices, high annual rainfall and undulating topography of Northern Thailand are the key factors that contribute to high annual rate of soil erosion. Being a highly dynamic phenomenon, soil erosion calls for updating its status derived from a reliable database on its magnitude, nature and extent from time to time for taking necessary corrective measures in the erosion affected areas. Vegetative cover and land slope are two major factors of soil erosion. In this study, Normalized Difference Vegetation Index (NDVI) derived from Remote Sensing data (Landsat-TM) is used to assess the vegetative cover. A methodology is developed to integrate topographical parameters and NDVI in GIS perspective for estimating the annual soil erosion rate in Mae Ao watershed of Northern Thailand. There is a distinct change in agricultural pattern in the study area after initiating the development activities by His Majesty The King of Thailand. Changes in agricultural pattern from traditional crops to orchard plantation and adoption of soil conservation measures in Mae Ao watershed have not only decreased the soil erosion rate but also increased the annual agricultural production. A non-market economic valuation technique has been used to evaluate the external cost of soil erosion. Reduction in soil erosion rate from 1.24 mm/year in 1992 to 0.91 mm/year in 1996 in the area has attributed to decrease in external cost of soil erosion by 4,210,284 Baht (US $ 105,257). The net farm income of the farmers remains very attractive if the external cost of soil erosion is not taken in to account. Due to the external cost of soil erosion, the farm income in the study area was reduced from 62,740,720 Baht (US $ 1,568,518) to 50,940,924 Baht (US $ 1,273,523) during the year 1996.

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A-0310

Sustainable land use by small scale farmers in a mountain area of Dominican Republic - a participatory approach. Dirk E. Guenther, Academy of Science and José R. Reyes, Centro NATURALEZA, Dominican Republic

Mountain areas in the Dominican Republic are severely affected by "slash and burn agriculture", so that the management of these areas must consider the involvement of the peasants. Newer the less, in traditional approaches, small-scale farmers (peasants)

have just been spectators or workers in conservation projects, receiving a fixed package of conservation technology. This restricted participation has often led to few sustainable projects. Since 1990 in the Jaguajay watershed (D.R.), the NGO Centro Naturaleza worked on watershed management projects with "participation as a process". Organized peasants from the area are being integrated into the project management step by step. Training and systematization of experience lifted their capacity, so that today they participate actively in the planing, execution and evaluation of project activities - women and men. Accompanied by the project, peasants have reinforced their basic groups and have organized in a third level structure. They have recovered and adapted cultural elements such as mutual help, as tools for running a project. They have learned to analyze their experience, to organize working groups, to evaluate results and to modify agroecological techniques according to their needs. In 1998 a "Participatory Rural Appraisal" was done together with the peasants of the project area. The following main aspects were analyzed: peasants criteria for preferring agricultural techniques, modifications to them made by the peasants, advantages, disadvantages and multiplication of used techniques and finally their influence on incomes. Conclusion: Initially starting with traditional conservation techniques such as earth canals or stone walls, today a package of integrated measures is applied, which consists mainly of adapted agro forestry, soil conservation, horticulture and social forestry elements, which are accompanied by a small rotation credit fund, run entirely by the peasants. The package includes a considerable part of the population´s needs on consumption (more balanced nutritian) and monetary income (short and long term), and also the special and different interests in production by women and men. Multiplication of techniques and an initial positive influence on income and even on the regulation of landownership can be observed. During this process also extension workers have learned to better understand the farmers way of thinking.

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A-0311

Carbon Storage in Historic Grassland Soils of the USA under Native, CRP, and Crop Land Conditions. R. Follett, E.G. Pruessner, S.E. Samson-Liebig*, and J.M. Kimble, ARS & NRCS, USDA.

This study considers the capacity of soil to sequester atmospheric CO_2, a greenhouse gas, as soil organic carbon (SOC). Paired field sites in native, CRP, and cropped management in CO, NE, IA, TX, MT, MO and MN were sampled to the 10 cm depth, then by genetic soil horizon to 2 m. Respective average weights of various soil-C pools across these 7 states for native-, CRP-, and cropped-land uses are: SOC in the top 2 m; 126, 122, and 113 t ha^{-1}. SOC weight in the top 10 cm; 24, 21, and 17% of that in 2 m. Identifiable plant material (>2mm) in the top 60 cm; 7100,7450, and 2350 kg C ha^{-1} with about 70% in the top 10 cm. Soil microbial biomass (SMB) in the top 60 cm; 65, 623, and 396 kg C ha^{-1} with 47, 45, and 33% in the top 10 cm. The SMB/SOC ratio (top 10 cm) averaged 4.6, 4.8, and 3.4%. Sites varied because of soil, climate, and management. However, trends were mostly consistent across this large geographic region. These data show the large amounts and the effects of land use for sequestration of SOC and the importance of protecting surface soil layers.

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A-0312

Using Fuzzy Logic-Based Modeling to Improve the Performance of the Revised Universal Soil Loss Equation. L T Tran, University of Hawaii, Geography Department, Honolulu, HI, Nearing National Soil Erosion Laboratory, USDA-ARS, West Lafayette, IN, L Duckstein, Ecole Nationale du Genie Rural, des Eaux et des Forets, Paris, France, M A Ridgley and R Sutherland University of Hawaii, Geography Department, Honolulu, HI

This paper reports the application of fuzzy logic-based modeling to improve the performance of the Revised Universal Soil Loss Equation (RUSLE). For the purpose of conservation planning, the prediction accuracy of the RUSLE is very important in making sound decisions on how soil should best be protected from erosion. However, an analysis of nearly 1700 plot-years of data, taken from 198 plots at 21 sites in the U.S., showed that soil erosion is not adequately described merely by the multiplication of six factor values in all cases. For instance, data indicate that the relationship between rainfall erosivity factor (EI) and soil loss, when other RUSLE factors are held constant, is not always linear with a zero intercept. The aim of the fuzzy logic-based modeling approach was to make the RUSLE's structure more flexible in describing the relationship between soil erosion and RUSLE factors and in dealing with data and model uncertainties while not requiring any further information. The fuzzy modeling approach used in this study consists of two techniques: multiobjective fuzzy regression (MOFR) and fuzzy rule-based modeling (FRBM). First, MOFR was used to derive the relationship between soil loss and a combination of RUSLE factors. These MOFR models, which are viewed as individual fuzzy rules, were in turn linked together in a FRBM framework. Then, using the same inputs as the RUSLE, we applied the fuzzy rule set to adjust the RUSLE-derived soil-erosion prediction corresponding to each combination of RUSLE factors. The Nash-Sutcliffe model efficiency of the fuzzy model, on a yearly basis, was 0.67, 0.75, and 0.70 for calibration, validation, and whole data sets, respectively, while the RUSLE's was 0.58 for the whole data set. On an average annual basis, the efficiency was 0.90 and 0.72 for the fuzzy model and the RUSLE, respectively. In addition to central values, the fuzzy model provided lower and upper bounds on the predicted range of soil erosion. Moreover, the fuzzy model provides other valuable scientific and management information. For example, the level of uncertainty associated with a given range of RUSLE factors can be evaluated from the predicted range of soil erosion. As the approach is quite simple, no other data outside the RUSLE are needed, and the main structure of the RUSLE is maintained, the fuzzy model in this study can be used to considerably improve the performance of the RUSLE with little effort and modification to the existing RUSLE model.

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A-0313

A new generation of soil landscape modeling. S. Grunwald, D.J. Rooney, K. McSweeney, and B. Lowery, Dept. of Soil Science, University of Wisconsin-Madison, Madison, WI USA

Most soil landscape modeling techniques comprise (i) statistical methods, where soil attributes are related to landscape position, or (ii) geostatistical approaches, where the focus is on the spatial distribution of soil attributes. Most soil landscape studies yield 2-dimensional results, however, soil attributes and soil map units are distributed in 3 dimensions (x, y, z-axis). In order to address water quality issues such as nitrate and pesticide leaching, a prerequisite is to describe distribution of soil attributes in 3-dimensions. For example, dense inclined clay-rich layers are responsible for lateral flow patterns while multiple horizons with different particle size classes influence vertical flow patterns. In this study we have used a profile cone penetrometer (PCP) technology to measure the cone index of soil profiles. Continuous cone penetrometer values were collected for depths up to 1.30 m on a 10 x 10 m grid covering an area of 180 x 200 m (total samples: 273). The study site is located in Southern Wisconsin, on soils developed in loess material overlying glacial drift. The research site covers landscape positions commonly found on hillslopes - summit, shoulder, backslope, footslope, and toeslope. Cone index measurements were related to soil attributes, such as, soil texture, bulk density, and soil moisture. Because of the stoniness of the parent material some measurements showed extremely high cone index values (so-called peaks), which indicate that stones were encountered by the penetrometer. The objective of our research was to map soil morphological attributes, therefore, peak values caused by rocks or stones were removed from the data set using a smoothing technique. Vertical continuous cone index data were analyzed using geostatistics. Variograms were calculated for thin layers to interpolate the cone index data horizontally. Different kriging methods were tested to identify the most accurate approach. A high resolution digital elevation model (DEM) supported the interpolations. A pedotransferfunction was used to link cone index measurements (kPa) to soil attributes. Heterogeneous and homogeneous areas of soil attributes and topographic attributes were identified. This method is a first step in the development of a new generation of soil landscape models showing the 3-dimensional distribution of soil attributes, which could be accomplished by vertically continuous data collection in combination with horizontally kriging within thin layers. Such an approach will be used in a further study to support water quality modeling.

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A-0317

Proposal of a simple linear relation between runoff and agricultural plot state during intercrop period for the loamy plateaus context of the Caux area (France). MARTIN Philippe, Institut National Agronomique Paris-Grignon (France), Paris France

To characterise the effects of agricultural plot state on runoff generation during the intercrop period in the Caux Area (Haute-Normandie, France), a range of agricultural practices was tested under natural rainfall during two intercrop periods (1993-1994; 1994-1995). Work was conducted on two replicate 20 m² experimental plots. The five tested practices consisted of (1) a no-tillage treatment, (2) a light duty mouldboard ploughing, (3) a mustard culture, and a superficial tillage with a light rigid tine cultivator equipped with a goose foot shovel applied in dry soil conditions (4) or in wet soil conditions (5). Four post-harvest field conditions were used in 1993-1994 : wheat field without straw, wheat field with pulverised straw, spring peas field without straw (P) and fiber linen. P was the only post-harvest condition used in 1994-1995. Plot state descriptors included soil surface characteristics (tortuosity index (TI), percentage of surface covered by vegetation (VEG), macroporosity (MAC)) and soil profile characteristics (percentage of the anthrophic horizon tilled during intercrop period (TSW), percentage of compacted zone in the anthrophic horizon (COMP)). Climate descriptors, defined for each rainfall sequence, included cumulative rainfall (CR), mean rainfall intensity (I) and cumulative daily climatic balance (P-ETP) during the three days preceding the maximum rainfall intensity (CB3). A linear regression method was used to relate runoff to both soil and climate variables for each rainfall sequence. The LIFEREG method (SAS) was chosen to allow collector tank overflowing to be taken into account. The LIFEREG method, conducted on 1993-1994 results, excluded only the MAC and TSW variables (0.01 probability level). A runoff grid composed of four classes was set up. After all runoff sequences were split into these four classes, the regression equation was used to determine the runoff class of each runoff sequence. The calculated class was correct for 52 % of the runoff sequences in 1993-1994 and 56 % in 1994-1995. The

more-than-one-class error frequency reached only 3 % in 1993-1994 and 9% in 1994-1995. The equation could be used (i) to compare different plot states at the same time and (ii) to discuss the best way to decrease runoff risk on agricultural plots. Comparisons of calculated and measured runoff for each experimental treatment gave indications of how both macroporosity and soil profile descriptors should be improved.

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A-0318

Soil born dust release and deposition on polluted industrial fallow land in the Ruhr area. Silke Höke & Prof. Dr. Wolfgang Burghardt, University of Essen, Applied Soil Science Essen

In 1997 the Ministry of Environment of Northrhine Westphalia gave order to work out a literature study, that gathered the recent point of knowledge regarding the pollutant matters and their spreading in soil born dusts in industrial and urban areas. An important result of the study is, that the wind erodibility of young industrial soils and substrates is estimated highly , but more investigations have been nessesary to get proofable facts to judge the possible danger for citizens. In May 1998 the first instruments for measurements qualifying and quantifying release and deposition of dust have been installed. The station is sited on a plain fallow land (ca. 250 * 600 m) that is more than 25 years out of industrial usage, highly polluted and now almost covered by herbs and up to 8 m high birches. In the westpart, there is a circle of cultivated soil surface (vegetationless and loosened) with ca. 8000 m^2 expansion to create a "worst case" erosion plain. High Volume Samplers with PM_{10} heads combined with different dust traps with more tasks were installed. The horizontal and vertical distribution of dust particles are measured in consideration of the main wind direction and the urban background pollution. The measurements take place in different distances to the erosion plain. A microclimate station in the area takes all relevant data. That should allow more precise statements regarding the endangering of human health and environment. The following considerations helped to choose the instruments and their disposition: Yunger medical science found out, that the main danger for health is not caused by the whole amount of the suspended dust, but by the amount of PM_{10} (particle matter < 10 µm); Caused by the high pollution of the source soil, its soil born dusts contain more pollutants and is noxious especially while long-term exposition; The deposition of polluted soil born dust contaminates the surrounded soils.

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A-0319

The variation of nutrient contents and the pH-value on sandy soils after abandonment of arable fields. Dr. Angelika Wurbs and Dr. Michael Glemnitz, Centre of Agriculture Landscape and Land Use Research (ZALF), Institute of Land Use Systems and Landscape Ecology, Müncheberg

Due to the economic frame conditions for agricultural land use in the EC, arable fields were taken out of production. Abandonment of arable land occurs mainly under conditions that are unfavourable for agricultural land use. These sites are in the north-eastern part of Germany often dry sandy soils. They have a high potential for arid grassland communities. There is a need to assess the possibilities for restoration of these communities. Especially the effects of modified nutrient contents in the soil caused by the land use of the last 30 years are often regarded as a factor, which may hinder or prevent the restoration of the site specific natural plant communities. For this reason investigations were carried out on two types of abandoned fields on sandy soils: i) 2 to 5 years old (Ayoung@), ii) 20 to 60 years old (Aold@) and on dry sandy grasslands within an area of about 2500 km^2. The aim was to get informations about the variation and the differences in nutrient and pH level in the soil of this sites. Nitrogen and carbon contents of the old and young abandoned fields varried along a broad scale. On the most investigated sites the N-content was of 0.015 to 0.200 % and the C-content of 0.23 to 2.50 %. Soils of the dry sandy grasslands differed mainly in lower total nitrogen and carbonate contents to those of the abandoned fields. Differences between old and young abandoned fields could be found especially in the contents of phosphorus and potassium in the soil. Contents of both nutrients were on the most old abandoned fields similar to those of the existing remains of arid grasslands. On 2 to 5 years old abandoned arable fields were the contents of phosphorus and potassium partly strongly elevated. The Discriminant Analysis revealed, that 1/3 of the young successional fallows had similar soil nutrient contents and pH-values to the old fallows and dry sandy grassland; however 2/3 of the fields showed quite different site conditions. It shall be shown, how far the previous use of the arable land before the abandonment influences the nutrient contents and the pH-value of the young abandoned fields. In addition to these results we analyse the interactions between the nutrient contents and the pH-value and the plant assemblages. Land use over a long time period may result in modified site and environmental conditions, which hinder the restoration of the natural site specific habitats. The implementation of this knowledge into succession models is needed to improve the assessment of vegetation development and is needed in landscape planning activities and in the setup of regional landscape management programs (e.g. new set-aside programs).

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A-0320

Actions against soil erosion at the catchment scale guided by computer simulation. Prof. Dr. Juergen Schmidt, Technical University Freiberg. Freiberg, Germany

The measuring of soil erosion in the field is very difficult and expensive. That´s why we need simulation models in order to implement soil conservation measures efficiently and successfully. Such a simulation model is EROSION 2D/3D which is able to describe both soil erosion and soil deposition on slopes (2d) and small catchment (3d). The model was developed with the intention to create an easy-to-use tool for erosion prediction in soil and water conservation planning and assessment. The model is predominantly based on the physical principles: Erosion is limited either by the amount of sediment that can be detached from the soil surface or by the transport capacity of the flow. For detachment the erosive impact of overland flow and falling droplets must exceed the shear strength of the soil. In order to transport detached particles the vertical flow component within the flow must counteract the settling of the particles for deposition. The basic idea of the model is the assumption that the erosive impact of overland flow and droplets is proportional to the momentum fluxes exerted by the flow and the falling droplets respectively (*Schmidt 1991*). In analogy to that the erosional resistance of the soil is expressed in a form of a critical momentum flux. The model's algorithms are implemented as PC-based computer programs for soil erosion on single slopes (EROSION 2D) and small catchments (EROSION 3D). The latter works on the basis of a regular grid which is variable in size The temporal resolution depends on the rainfall data available and can range from 1 to 15 minutes. More than $5*10^5$ grid elements can be processed (hardware dependent). Due to the raster basis EROSION 3D can be linked to various geographical information systems such as ArcInfo or GRASS. Since 1992 both versions of the erosion model were applied to various subcatchments of the river Elbe and to other parts of germany. This contribution reports on different applications of the two model versions, in which the implementation of the following erosion contol measures is simulated: conservation tillage; landuse changes; buffer strips; Optimization of the road and drainage system.

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A-0325

Participatory evaluation of water harvesting techniques for establishing improved mango varieties in semi-arid areas of Mbeere District, Kenya. Jayne Mugwe, Agroforester, Kenya Forestry Research Institute, Embu, Kenya, Mick O'Neill, Senior Agronomist, International Centre for Research in Agroforestry, Nairobi, Kenya, Samuel Gachanja, Centre Director, Horticulturalist, Kenya Agricultural Research Institute, Embu, Kenya, Jonathan Muriuki, Research Assistant, International Centre for Research in Agroforestry, Embu, Kenya and Jack Mwangi, Extention Officer, Ministry of Agriculture, KARI, Embu, Kenya

A participatory on-farm trial was established during the short rains of 1996 in Mbeere District, Kenya to evaluate the effectiveness of microcatchments in the establishment of improved mango varieties under farmer management. The study area is characterised by low erratic rainfall (600–700 mm yr^{-1}) which is received in a bimodal pattern. Two types of microcatchments, V-shaped and diamond, were tested and compared to simple holes commonly used for tree planting by farmers in the area. Grafted mango varieties tested were Tommy Atkins, Van Dyke, Haden, Kent and Apple. Researchers designed the trial and laid out the microcatchments but farmers were given a freehand to manage the trees. Assessments carried out three months after planting showed high survival (>70%) in all cases, except for Van Dyke in the V-shaped microcatchment which had a survival rate of 65%. This was extremely encouraging, as the season was characterised by severe drought. Through their own initiative, farmers protected, watered, mulched and used bottle feeding and shading methods to increase moisture availability to the young trees. These methods, however, masked the actual effects of the microcatchments but further assessments demonstrated that modifications were randomly applied. Adoption of the moisture conservation techniques indicated farmers' awareness of the negative effects caused by moisture stress and the high value attached to fruit trees. Rankings by farmers identified the V-shaped microcatchment as the most effective in terms of soil moisture retention and labour requirements.

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A-0326

Locally-led Approaches to Watershed Management in Asia. Dennis P. Garrity, Systems Agronomist and Coordinator, Southeast Asian Regional Research Program, International Centre for Research in Agroforestry, Bogor, Indonesia.

Asian watersheds have the highest sediment loads in the world, but the evidence indicates that it is possible for smallholders to engage in farming and management of natural resources in both a productive and conservation-effective manner. Successful watershed management is built on two pillars: Sound, practical technical innovation and participatory institutional innovation. Unfortunately, past watershed management programs in the region have frequently been ineffectual. Alternative ways of building

wide-scale participation in the management of natural resources will play an increasing role in the future. Watershed management requires an integrated and multi-sectoral approach to sustainable development, but government departments are compartmentalized and geared for top-down operations. They will need to change. Selected watershed management projects in the Philippines and Thailand are examined to draw conclusions on effective pathways toward institutional innovation for locally-led natural resource management. In countries where the decentralization of power and fiscal responsibility is occurring, democracy is institutionalized down to the village level, locally-led approaches are gaining momentum. The paper reviews the evolution of grassroots organizations led by farmers to address their own problems and to attract (or demand) public sector support. The cases indicate that there is major potential for enhancing locally-led approaches to support sustainable agriculture and natural resource management in Southeast Asia. This is predicated on the recognition that rural people, educated or not, have a much greater ability to analyze, plan, and implement their own development activities than was previously assumed by outsiders. The evidence indicates that when local communities are allowed to capture the direct benefits of improved systems through tenurial security and involvement of decisionmaking , they become firm partners in reversing the environmental degradation of Asian watersheds.

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A-0327

Wind Erosion and Air Quality Research in the Northwest U.S. Columbia Plateau – Organization and Progress. Dr. Keith Saxton, Dr. David Chandler, and Dr. Bill Schillinger, USDA-ARS Agricultural Research Engineer, WSU, Pullman, WA

Many urban areas, particularly in the Western U.S., have experienced concentrations of fugitive dust particulates from up-wind sources which exceeded the federal health standards. In many cases, it was evident that a significant amount of these particulates were generated on agricultural fields during wind erosion events, entrained and transported in the regional air mass. Thus both the soil resource and the air quality in downwind urban regions are being degraded. A regional research project was developed for the Pacific Northwest Columbia Plateau of Eastern Washington, Northern Oregon and Northern Idaho. This region is a broad, relatively flat loessial plateau of over 134,000 square kilometers characterized by very erosive soils, mostly dryland farming and several urban regions experiencing air quality concerns due to particulates. The loessial soils of the study region are highly erodible and contain significant amounts of free dust particulates less than 10.0 and 2.5 microns aerodynamic diameter which readily become suspended and travel many kilometers downwind during wind erosion events causing health concerns. A multidisciplinary research project was organized and conducted to characterize soil, vegetation, and climate variables, develop empirical wind erosion and fugitive dust emission relationships, and define optional farming methods for control. Regional physical and land use characteristics were defined from satellite images, soils maps and climatic data. Data were obtained for more than 200 tests over a wide variety of agricultural fields and soils with a large (1.0 x 1.5 x 15.0 m) portable wind tunnel. Measurements of meteorology, erosion and vertical dust emissions were made during natural wind events in selected tilled farm fields over a three year period. Crop residues and field roughness were shown to effectively reduce wind erosion and dust emissions. The empirical emissions model was combined with a comprehensive transport/dispersion model and GIS-defined regional characteristics to predict downwind urban concentrations and evaluate the relative effectiveness of selected farm-level controls. Control strategies being evaluated range from alternative fallowing methods, new crop systems and rotations and winter cover crops. Numerous technical publications report the research project results and recommended best management practices.

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A-0328

Abandoned cultivation fields as gully erosion “hot spots”: The case of Peddie District, Eastern Cape South Africa. Vincent Kakembo, Department of Geographical Sciences, Vista University, Port Elizabeth Campus, South Africa

Progressive changes in land use and erosion distribution are reconstructed in a part of the dividing ridge between the Great Fish and Keiskamma rivers in Peddie District, Eastern Cape, South Africa. In particular, gully initiation and intensification in are investigated. Sequential aerial photographs between 1938 and 1988 are analysed. Widespread gullying appears predominantly from the early 1970s. A close spatial correlation between abandoned cultivated land and intricate gullies is identified. Gully development is noted to commence earlier in pockets of colluvium accumulation. These are construed as zones where the threshold values for gully initiation are lowest. Given such vulnerability of abandoned fields to severe erosion, it is suggested that they ought to feature prominently in the land restoration programme.

Vincent Kakembo

A-0329

Characterization of the stages of soil resilience to degradative stresses: soil erosion. Tenywa M.M., Lecturer, Soil Science Department, Makerere University, Kampala, Uganda, R. Lal, Professor, School of Natural Resources, The Ohio State University, Columbus, OH, USA and Majaliwa-Mwanjalolo J. Student Makerere University Institute of Environment and Natural, Resources, Kampala

In many cases, reporting relatively high crop yields coinciding with high soil erosion rates raises eyebrows. Yet, even at field scale a predominant soil type may comprise of variants that differ substantially in their characteristics and productivity reflecting the balance between soil restorative and degradative processes. Soil variants occur across a soil degradation spectrum exhibiting differential resilience to external stresses and/or factor controls of degradative processes up to an elastic limit beyond which they lose their natural self-healing /regenerative ability to bounce back their productivity. The occurrence of soil variants and their ability to recover under external stress such as erosion depends on the permutations of the magnitude, intensity and duration of the stress and the inherent soil characteristics. In this study, variants of a Miamian silty clay loam (fine mixed mesic Typic Hapludalf) and a Sandy clay loam Kandiudult (Rhodic Nitisol) cropped to maize (Zea mays) were identified and characterized at Columbus, Ohio-USA and Makerere University Agricultural Research Institute, MUARIK-Uganda, respectively. At the Columbus site, three variants were identified in each of three runoff plots measuring 21 by 18 m and after harvesting maize, sub-plots of dimensions 0.75 x 0.7 m were selected in each variant and subjected to simulated rainfall of +125 mm/hr to determine runoff and soil loss. Similarly, at the MUARIK site, three soil variants were identified in each of nine plots of size 2 x 9 m under maize-based cropping systems and characterized in terms of soil organic matter and infiltration rate. Crop yields were determined in each soil variant during the long and short (El-nino linked) rainy seasons of 1997. Also, rainfall simulations were done in each variant to determine runoff and soil loss. Based on the results, we propose three broad stages of the soil degradation process namely: high resilience, diminishing resilience and marginal resilience. The Miamian silty clay loam of high resilience was characterized by relatively high values of water stable aggregates (58%), plant available water (10%), geometric mean diameter (0.62 mm), saturated hydraulic conductivity (2.4 cm hr-1) and relatively smaller values of bulk density (1.43 Mg m-3) and overland flow (6.2 cm of 10.5 cm in 30 min). The cumulative soil loss and maize crop yields were relatively high with magnitudes of 14.4 Mg ha-1) and 15.3 Mg ha-1), respectively. In contrast, the soil of marginal resilience had relatively lower values of water stable aggregates (47.3%), plant available water (4.6%), geometric mean diameter (0.55 mm), saturated hydraulic conductivity (1.1 cm hr-1) and relatively higher values of bulk density (1.57 Mg m-3) and overland flow (8.6 cm of 10.5 cm in 30 min). The cumulative soil loss and maize crop yields were relatively smaller with magnitudes of 7.5 Mg ha-1 and 6.6 Mg ha-1, respectively. The characteristics exhibited by the soil of diminishing resilience were intermediate. At the MUARIK site, the soil of high resilience had a significantly higher values of infiltration rate of (9 cm hr-1), soil organic matter (3.6%) and maize grain yields (2.6 Mg ha-1) compared to 7.8 cm hr-1, 3.1% and 0.9 Mg ha-1recorded from the soil of marginal resilience during the long rainy season. The corresponding values for the short rainy season were 7.2cm hr-1 2.8% and 1.6 Mg ha-1compared to 5.4 cm hr-1, 2.2% and 1.5 Mg ha-1 respectively. The variants herein studied are widely recognised and named; partial contribution areas/source areas (hydrologists),eroded/uneroded phases (soil scientists), "Lunyu" (Ugandan farmers) based on their functions and attributes but are rarely characterised.

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A-0334

Study of Suspended Sediment and its Temporal and Spatial Distribution on Taleghan Basin. Vali Khojeini A., Irrigation and Reclamation Engineering Department, University of Tehran, College of Agriculture, Karaj, IRAN

The basin with 805 Km^2 area is situated within the south part of Albortz Mountains in Iran. Sedimentation is one of the most important factors in planning the Taleghan Reservoir capacity. The Taleghan Watershed has steep slopes and limited vegetation cover. Direct stream flow data is available since 1970 at Galinak hydrometric station. The main purpose of the study is to calculate the amount of sediment transport in a month, a year or a flood period of Taleghan River, also determine the spatial distribution of sediment in the basin. In this study sediment discharges were determined by three methods: (I) application of mean concentration; (II) logarithmic correlation (III) the use of flow duration and the sediment rating curve. Results show no significance difference between them. This study has indicated that the suspended sediment is about 930 tons/Km^2/ year. This value seems to be very high. Therefore, it could express the need for soil conservation practices in the basin. In the meantime a planned one-year measurement of sediment transport at seven sub-basins provided the spatial distribution of sediment in the basin.

Vali Khojeini

A-0335

Changes caused by burning process in some peat soils in Albania. Dr.Thomaq Plaku, University "Fan S.Noli" Faculty of Agriculture, Department of Soil, Korca, ALBANIA.

There are about 38000 hectares of peat soils in Albania. Burning has occurred in some of them since 1990. The process is prevalent on almost all the peat soils in Korca, a district in the south-east of the country. There are different opinions about this process in the agricultural literature: some view it as harmful and others as useful. An investigation was made into the extent of burning and its consequences. The depth of burned peat was assessed from profiles located randomly at different points over the area of 2095 hectares. Chemical analyses were conducted to assess differences between burned and unburned peat. There were burnt 1500 hectares in the study area with 8% of surfaces being burnt twice. The depth of burned peat was 52 cm and the thickness of the burned layer was 10.5 cm and the following correlation was established between the depth of the burned peat (x:cm) and the thickness of the material that results from burning (y:cm); y=0.275x –3.91, (r=0.92). Based on 1500 hectares of burning, a depth of burning 52 cm, a bulk density of the surface layer (0-35cm) of 0.41 Mg/m^3 and a bulk density of the layer below the surface 0.18 Mg/m^3 the quantity of burned peat is 2 500 000 tonnes which is equivalent to 1 500 000 tonnes of coal. There are differences in chemical and physical properties, e.g. the organic matter content is decreased from 40.92% in unburned peat to 0.52-0.60 % in burned peat, the nitrogen content is 1.76% in unburned peat and 0.05 –0.06% in the burned material. The quantity of nitrogen released into the atmosphere is 46 500 tonnes. During the burning process some toxic components are added to the atmosphere above the area of burning and surrounding environment is polluted. The study area is very near the North Greece and Macedonia and close to the Lake Ohri, an important tourist centre. Wind erosion is enchanted and by using the potential erodibility equation is determined the possible loss of the soil. The level of the ground water have come to close to surface and during heavy rains a marsh is formed damaging winter crops and impeding the cultivation of spring and summer crops. The quantity of available N, P, K, and Ca is increased in the soil after burning but there are largely leached out from the top soil; in the first year however crop production is increased. Overall the burning process appears harmful to the peat soils.

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A-0338

Changes In Soil Physical, Chemical And Biochemical Properties Under Long-Term Management Practices Used For Determining Soil Quality Indicators. M. Diack, Soil Scientist, Agricultural Research Institute, Kaolack, Senegal and D.E. Stott, Soil Microbiologist, USDA-ARS, NSERL, W. Lafayette, IN USA

With the progressive degradation of agricultural soils, there is a new emphasis on using the concept of soil quality as a sensitive and dynamic way to document the conditions of soils, how they respond to management changes, and their resilience to stress. This study relates soil physical, chemical and biological property changes under various long-term management systems. The study was conducted on a 16-year integrated pest management field where several tillage and crop rotation combinations are available. Sealing index, as a measure of aggregate stability, decreased with decreasing tillage intensity. However, infiltration rate was highest in the chisel plow system. Total C and N, microbial biomass C (MBC), particulate organic C (POC) and fluorescein released from enzyme activity, fluorescein diacetate (FDA) hydrolysis, were significantly greater in conservation systems as compared to conventional tillage practices. Tillage appeared to be the major contributor in the soil property changes with crop rotation effect being minor. Using soil erodibility as the baseline to develop a set of soil quality indicators, a standard scoring function has enabled us to rate soil quality levels. Results showed that chisel plow system had higher quality level than no-till and moldboard plow while corn/soybean/wheat presented the lowest soil quality level among crop rotations. These results suggested that soil biochemical properties are potential indicators of soil quality with regard to soil erodibility.

M. Diack

A-0339

Agricultural utilization of compost and sewage sludge under consideration of different tillage treatments and a sustained soil protection. T. Hoss, R.-A. Düring and S. Gäth, Justus Liebig Universität, 35390 Giessen

Modern agricultural production is characterized by high inputs of energy and substances. The utilization of mineral fertilizers results in huge consumption of natural ressources to produce P-, K-, and Mg-fertilizers and fossil energy sources to provide N-fertilizers. Lower input of natural ressources can be achieved by recycling organic wastes which contain plant nutrients. Suitable wastes for the amendment of soils are farmyard manures but also organic materials like compost and sewage sludge. However, it has to be considered these materials carry organic and inorganic pollutants onto the soils. The presented investigation will show potentials for the agricultural utilization of compost and sewage sludge. The examination is drawn out under special consideration of different long-term tillage systems which are applied to the soils manured by compost and sewage sludge. The systems are conventional ploughing, conservation tillage and no-tillage which are performed on three different soils. The masses of organic wastes applied to the soils conform to german legislation and amount to 10 t $dm*ha^{-1}*a^{-1}$ compost and 5 t $dm*ha^{-1}*3a^{-1}$ sewage sludge. The long-term application of the different tillage systems results in specific textures of the soils. This affects their biological, physical and chemical properties. Hence, it can be hypothesized that the behaviour of the admitted substances is different depending on the tillage treatment. Therefore differences in the enrichment and the availability of the added nutrients and pollutants are examined. For these purposes the total contents as well as the bioavailable portions in the soil are quantified over the period of examination of 3 years. Moreover, the quota transferred to plants and the amounts displaced below the root zone are determined. Additional laboratory examinations are conducted to obtain specific sorption capacities of the different soils which are influenced by different tillage systems. Therefore isotherms are generated which describe the variable capacity of the soils to adsorb added substances. This part of the investigation focuses on the inorganic pollutants like heavy metals and the metalloid arsenic. The objective of the examination is to prognosticate utilization potentials for compost and sewage sludge under the consideration of differentiated tillage systems with regard to a sustained soil protection.

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A-0341

Alternative Management Regime For Soil And Water: A Case Study Of Community Management Of Irrigation Tanks In Karnataka. C.P.Gracy, Assistant Professor of Poultry Science, Regional Research Statiion (UAS), Konehally, Tiptur, Tumkur disdtrict, Karnataka, B.L.Chidananda and S.Suryaprakash, Assistant Professor and Professor, Department of Agricultural Economics,University of Agricultural Sciences, GKVK, Bangalore, India

A major portion of Karnataka state is in the hard rock area where the aquifers are not productive. The annual natural ground water recharge in a normal year ranges from 10 to 15 per cent of the rainfall in the humid region to five per cent in the semi arid and arid regions. The distribution pattern and quantum of rainfall has varied over the years, which has a bearing on the ground water recharge. Construction and maintenance of tanks is linked to two fold objective of providing protective irrigation for crop production during dry spells and for ground water recharging of irrigation wells. The state policy of providing subsidized credit and free electrivity to lift irrigation water has resulted in inequality in water use across farms and over exploitation of ground water. This has resulted in irrigation well failures and farmers vulnerability to water problems. In order to cope up with dwindling ground water table viable alternatives are thought of. Local management by user groups have become effective and popular in different parts of Karnataka. It is with the understanding that local communities are more familiar with the resource management issues and the management needs than the formal agencies concerned with the development and management of the resources. A case study of community based irrigation management initiative in Bangalore rural district is presented in this paper. The study attempts to highlight the concept of "progressive conceptualization" of the problem which led to community planning and management of land and water. The results are encouraging in terms of a different system of water management, crop planning, management control and problem solving. The water management committee is self-sustainable with regard to funds and group coherence.

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A-0343

Better and bad soil and water use practices by the indian farmers. D.Nanjappa, N. Narasimha and M. Shivamurthy, Faculty of Agricultural Extension, UAS, GKVK Campus, Bangalore India.

More than 75 percent of people of India live in villages. Agriculture is their predominant profession and a way of life. There are numerous indigenous as well as improved practices adopted by the farmers of different states of India. Farmers are aware of the importance of maintaining the soil health in spite of raising crops continuously on the same land. Of course, they are not doing 'shifting agriculture'! Even the green revolution achieved in this country during nineteen sixties the farmers are not found with the traces of mismanagement of soil either by excessive use of inorganic fertilizers, pesticides and herbicides or by reduced uses of farm yard manure (FYM) and crop residue management. In a way we have to thank god that the resistance of the farmers in general to use the intensive agricultural practices and also their resource poor situations, which curbed them of using chemicals on their land indiscriminately. May be this is a blessing in disguise in the present context of global thinking that the world is all one! It belongs to both developed and developing countries. In addition, the chanting is sustainable agriculture for preserving natural resources of the globe. There are several research finding to show that farmers are using lesser amount of fertilizers, pesticides and herbicides on their lands compared to the situations in the many developed countries. There are examples of crop residue management in crops like sugarcane. Farmers are found using larger quantities of FYM, city wastes and tank silt for improving soil conditions. However, the water management practices by canal irrigated farms are really dangerous. The farmers have meager knowledge with respect of irrigation water

management on their lands. They have neither learnt from ' Harappa and Mahenjadaro' incident nor they are aware of it. The farmers need to be educated on water management at the earliest. This paperis based on a number of research studies in the field of adoption and wherever possible it includes the observations of the authors.

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A-0344

Measurement and Modeling of Erosion and Sediment Yield on Small Semiarid Watersheds. Mary H. Nichols and Leonard J. Lane, hydraulic engineer and hydrologists at the USDA – ARS Southwest Watershed Research Center, Tucson Arizona USA

Sediment has been accumulating in stock pond 63.223 on the Walnut Gulch Experimental Watershed in southeastern Arizona since the construction of an earthen dam in 1956. Periodic surveys to describe the pond storage volume are used to compute sediment yield rates from the 43.7 hectare (108 acre) rangeland watershed for 7 time periods between 1956 and 1996. These data are used in conjunction with observed precipitation and runoff data and hydrologic and sediment transport simulation models to interpret erosion, sediment transport, and deposition within the watershed. Following model calibration and validation at the upper end of the watershed, the models were further evaluated at the watershed outlet based on recorded inflow to the pond and accumulated sediment in the pond for the time period from 1962 through 1996. For the 35 year period of record at the watershed outlet, the mean annual sediment yields in T/ha were 3.01 MetricTons/hectare/year (1.34 Tons/acre/year) and 2.87 MetricTons/hectare/year (1.28 Tons/acre/year) for the measured and simulated data respectively. This suggests that the models used are accurately simulating sediment yield from small semiarid watersheds. These results are compared with previously reported assessments of rangeland erosion based on rainfall simulator plot studies conducted at the upper end of the watershed. This comparison points out some of the complications inherent in extending plot data to larger spatial scales. In the absence of comparison with watershed sediment yield data, reported erosion and sediment yield data from experimental plots may lead to underestimates of erosion on semiarid rangelands.

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A-0348

Surface-Soil Consolidation Factor, With And Without Traffic-And-Vegetation, For Erosion Prediction With Rusle. N.P. Cogo and E.V. Streck, Soil Department/FA-UFRGS and EMATER/RS; Porto Alegre, RS, Brazil

Specific-site parameter values are essential for erosion prediction with empirical models. In this study, the surface-soil consolidation factor (C_f) within RUSLE`S prior-land use subfactor (PLU) was investigated using simulated rainfall on a 7.5%-slope, sandy clay loam Paleudult soil, at the Agriculture Experimental Station of the Federal University of Rio Grande do Sul, in Eldorado do Sul, RS, Brazil,. from January, 1996 to May, 1998. Prior to this, the land had been retired from cultivation but kept continuously-tilled so that, by the time the study began, it was completely free of any vegetation. The soil was then once more conventionally-tilled, and the following duplicated-treatments established: i) freshly-tilled soil condition (continuous fallow, clean-tilled Wischmeier's unit plot), ii) reconsolidating soil condition-I (no tillage and no vegetation), and iii) reconsolidating soil condition-II (two no-till/corn-oats cycles, residues removed for rainfall application and returned after that). Five rainfall-tests, 5- to 6-months apart, were applied with the rotating-boom rainfall simulator, at the constant rate of 63.5mm h^{-1} for 1½-hour. The surface-soil consolidation factor (C_f) was derived by dividing the individual-tests soil loss of each reconsolidating treatment by the over-tests-averaged soil loss of the unit plot. Non-linear regression analysis was performed to fit the $C_f=e^{bt}$ model through derived C_f-data, where t is time in days since last tillage. Values for b were -0.0021, -0.0031, and -0.0039 for with traffic-and-vegetation and -0.0016, -0.0020, and -0.0024 for without traffic-and-vegetation, respectively, in both cases, using total soil loss, soil loss rate at steady-runoff, and sediment concentration at steady runoff .as the basic input-data. Using the intermediate values for b, calculated, correspondent erosion after 2½ years was, respectively for the with and without traffic-and-vegetation treatments, 0.06 and 0.12 of that for the freshly-tilled soil for which C_f=1.0. That means soil consolidated more with traffic-and-vegetation than without it. A dense crust formed on the surface of the uncultivated soil, and a nearly non-apparent thin layer of small, semi-decomposed pieces of residue firmly stuck onto the surface of the cultivated soil, influenced this rapid decay in C_f-values, however. These results, in conjunction with other erosion-related soil physical parameters, will be discussed in this paper.

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A-0349

Land Use Effects on Soil Carbon Pools in Three Land Resource Regions of Ohio. A. Lantz and R. Lal, School of Natural Resources, The Ohio State University, Columbus; OH USA

Conversion from natural to agricultural ecosystems decreases soil organic carbon (SOC) pools, and the magnitude of the decrease depends on land use, management, and ecological factors. Quantification of the loss of SOC by conversion to agricultural land uses provides a reference point with regards to the potential of resequestration of SOC through improved management. In March of 1998 a study was initiated to evaluate the differences in SOC pool in cultivated, pastured, and forested (native) sites in Ohio. Out of a total of 24 Land Resource Regions (LRRs) in the United States, this study covers three LRRs (Lake States Fruit, Truck, and Dairy Region; Northeastern Forage and Forest Region; and Central Feed Grains and Livestock Region) from north central to northeastern United States. These LRRs represent climate, water, soil types, elevation, topography, natural vegetation and land use for large areas. The SOC pool is being quantified by evaluating two predominant soil types down to the C-horizon in each LRR. Three land uses (cultivated, pastured, and forested) are represented in each soil type. In addition to SOC pool, comparison among three land uses are also being made by assessing the amount of carbon associated with stable aggregate and particle size fractions. The data show the magnitude of historic carbon loss due to conversion from natural to agricultural ecosystems, and provide a reference point for identifying land use and management systems for carbon sequestration.

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A-0350

Changes in the soil physical condition as the time and intensity of use increase in Tropical Savannan (oxisols) soils of Colombia, South America. E. Amézquita; G. Preciado; R. Thomas; R, Lal

A study related to the understanding of the changes in some soil physical characteristics of an oxisol (Typic haplustox Kaolinitic Isohypertermic) in the Colombian Savannas (Eastern plains) was carried out. In this area the farmers abandon the fields after ten years (5-8) of cultivation when the soil has been degraded and the yields drastically reduced. Soil samples under different times of use, ranging from non-intervened soil to abandoned soils were taken at different depths: 0-10; 10-20 y 20-30 cm in fields that had been cultivated to upland rice under very intensive use of machinery during land preparation. The following times of use were chosen: 0, 2, 3, 4, 10 y 20 years. In each field in three replicated areas two kinds of physical determinations were made: a) mechanical behavior of the soil under field conditions (penetrability) resistance to rupture (soil strength) and infiltration and b) volumetric changes. Results shown that soil strength increase as the time of use elapsed. Resistance to rupture was more sensitive than penetrability. It changed from 13 in non-intervened soil to 50 KPa and penetrability from 0.05 to 0.37 MPa.Infiltration and satured hydraulic conductivity decreased drastically with time of use. It changed from 7.88 cm.h'1 without intervention to 0.32 cm.h'1 after 20 years. Total porosity was reduced from 60.2% to 41.1% after 20 years, macroporosity from 21.9% to 4.8, air permeability from 46.7 cm.day-1 to 0.65cm.day-1 and bulk density increased from 1.06 to 1.54 Mg.ha.1. There was an improvement in the chemical condition of the soil, but even so yields decreased from 4500 Kg.ha.1 to 1.800Kg.ha.1. It is concluded that the negative changes in the physical conditions of the soil are the main factor responsible for abandonment of fields. From the results it was possible to determine the critical values of most sensitive physical properties which could be used as indicators of degradation.

A-0352

Use of Fly Ash as Time Marker in Soil Erosion and Sedimentation Studies. K. R. Olson, Professor of Pedology and R. L. Jones, Professor of Soil Mineralogy, Dep. of Nat. Res. and Environ. Sci., Univ. of IL, Urbana, IL USA.

Accelerated erosion, or erosion as a result of human and animal activities, including tillage, is a major environmental and economic problem throughout the world. The severity of accelerated erosion is affected by slope gradient, shape, and length and by tillage practices. Fly ash is the product of high temperature coal combustion and is easily identified by the high proportion of spherical particles in the magnetic fraction of soil. The incorporation of fly ash into soils dates to the beginning of the industrial era and invention of high temperature, coal-fired boilers. We first used its occurrence in soils of northwestern Illinois as a time marker in sedimentation studies and to separate geological sediments and accelerated erosion sediments. This study was conducted to quantify the postsettlement deposition in a 2.49 ha sediment basin with a single outlet in a 10.45 ha watershed. Buried A horizons (dated using fly ash as a time marker) identify the presettlement (~1854) surface, which was overlain by as much as 116 cm of sediment from accelerated erosion and underlain by more than 400 cm of geological sediments. The total volume of postsettlement sediment within the basin was calculated. Based on representative measurements of postsettlement sediment delivery obtained from research of drainage basins having similar size and soil characteristics it was possible to determine the amount of sediment delivered to the stream. The total postsettlement sediment in the basin and delivered to the stream was an indirect measure of the total amount of soil removed from watershed hillslopes by accelerated soil erosion. In southern Illinois, the fly ash marker was used directly on the upland as an indicator of soil loss from erosion. The extent of erosion was estimated by comparing the fly ash content at paired cultivated and uncultivated sites. The concentrations of fly ash in soils of a transect of a cultivated area were lower than those of paired soils of a transect in nearby uncultivated forest. Higher amounts of fly ash were found in A horizons at the uncultivated site and the amount of fly ash decreased with depth at the cultivated site for all landscape positions. The lower footslope at the cultivated site had fly ash to a 45-cm depth, reflecting an accumulation of sediments at this position. For

the backslope, the presence of 65% or 15 cm of the original surface soil layers and 67% of the fly ash at the cultivated site places the soil in the moderately eroded phase of the soil series. The estimated annual soil loss amounts to 7.3 Mg/ha/yr for the previous 142 years.

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A-0353

Giving Credit Where Credit is Due**:** Using the Pre-Sidedress Nitrate Test (PSNT) in Field Demonstrations to Establish Manure N Credits for Reduced N Applications and Water Quality Impacts. John Peverly, Walt Sell, and Phil Sutton, Purdue University Cooperative Extensive Service, West Lafayette, IN USA

Our watershed educational goals to reduce non-point source (NPS) pollution in northern Indiana, USA, have been focused on voluntary adoption of best management practices (BMP's) by producers where economic incentives are directly generated by the practices themselves. This approach, coupled with farmer-cooperator demonstrations and public field days in 1997 and 1998, have been successful in reducing nitrate fertilizer application rates while maintaining yields, creating less potential for water quality impacts from excess N applications in the Upper Kankakee River Watershed (250,000 acres). For instance, in the 1998 season, eight producers were recruited in April and asked to leave unfertilized (no sidedress N) multi-row strips in selected manured corn fields, but to maintain normal management and fertility practices on the rest of the field. The appropriate sidedress N rate was established for each field using the pre-sidedress N test (PSNT) for soil nitrate at the 4 to 6 leaf corn growth stage (mid-June). Side-by-side yield estimates and remaining soil nitrate were taken the day before the field day Sept. 3. In most cases, N applied above the recommended sidedress rate based on the June PSNT gave no additional yield. Even more telling in these fields, the on-site soil tests showed that extra, unused nitrate N in the 100 to 200 lbs./acre range remained in the root zone. As a result of such field demonstrations, producers in the watershed in 1997 credited an average of 25 lbs. N/acre from previous crops (soybeans) or manure applications on over 10,800 acres, for a total N savings of about 270,000 lbs. Corn yields on cooperator fields were shown to be sustained on manured land when manure N is given due fertilizer credit based on the PSNT quick test, even when N application rates were reduced up to 100 lbs./acre from normal farmer practice. Most nitrate left after harvest is lost from the soil into surface or ground water in the fall and winter months. Producers should keep the after-harvest soil nitrate pool low to save fertilizer dollars and protect water quality.

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A-0354

Land Tenure and Soil Conservation Practices - Evidence from West Africa and Southeast Asia. Andreas Neef, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics, Hohenheim University Stuttgart, Germany

There is increasing evidence that land tenure can significantly influence the adoption of soil conservation practices. However, the fact that the adoption of soil conservation measures like agroforestry systems and the planting of perennial crops can increase tenure security of smallholders is often neglected by both researchers and development practitioners. Drawing on empirical research in two West African countries (Benin, Niger) and two Southeast Asian countries (Thailand, Vietnam), the aim of this paper is twofold: on the one hand, it examines the impact of different land tenure regimes on the adoption of agroforestry systems and other soil conservation measures; on the other hand, the influence of long-term investments and integration of perennial crops on tenure security of farmers is analyzed. In Benin and Niger, land rights are shared by different institutions and stakeholders: local communities, the state, development projects and individual users. Research results suggest that tenure security of certain rural dwellers, especially of women, tenants and pastoralists, is limited by both customary land rights systems and state legislation. As tree planting is regarded as a mark of ownership rights, customary tenure in Benin and Niger does not allow non-owners to plant trees, which is an important constraint for the introduction of agroforestry systems. Long-term investments on tenants' fields in Southern Benin are inhibited by short leasing contracts. In Southwest Niger, the application of animal manure is almost exclusively done on fields of landowners or tenants with long-term use rights. Restrictive forest legislation in Niger limits farmers' rights to trees on their own land thus reducing their willingness to plant trees autonomously. The case studies from Southeast Asia show different results. Although minority groups in mountainous regions of Thailand and Vietnam are disadvantaged with regard to access to permanent land use rights, long-term investments in land are common practice. Minority farmers in watershed areas of Northern Thailand where agriculture is in conflict with the reforestation policy of the Thai government react to increasing tenure insecurity by planting fruit trees and other perennials, by converting rainfed land into paddy fields, and by applying erosion control measures like hedgerows with leguminous bushes. Similar processes can be observed in mountainous regions of Vietnam. Dao minority farmers in Bac Kan province adopt soil conservation practices mainly to make their land use rights more secure. In some cases, the adoption of agroforestry systems promoted by the government is a precondition to obtain long-term land use certificates. The varying results from the four countries suggest that tenure insecurity does not automatically lead to decreasing investments in land. Farmers in an insecure environment may use the planting of perennial crops like fruit trees and hedgerows as a strategy to secure their long-term land use rights.

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A-0355

Agri-environmental programmes and the use of soil conservation measures in Germany. Bernhard Osterburg, Institute of Farm Economics, Federal Agricultural Research Centre, Braunschweig, Germany

The Institute of Farm Economics of the Federal Agricultural Research has been charged by the Federal Ministry of Agriculture to assess the impacts of the implementation of agri-environmental programmes according to the Regulation (EEC) 2078/92 in Germany on agricultural production, incomes, profitability and the environment. The implementation of the agri-environmental programmes is carried out on regional level. The acceptance of agri-environmental programmes differs a lot between the regions, depending on: varying agri-environmental schemes; specification of programmes (grants, conditions); natural and socio-economic conditions of agricultural production. Several regional programmes include specific measures of soil conservation, e.g. reduced or zero tillage. While these techniques are widely used in crop farming systems in other parts of the world, e. g. the United States, in Germany the acceptance of soil conservation measures is in general rather low. Objectives of this paper are: to give an overview on the use and the economics of soil conservation measures in Germany; to analyse the impacts of agri-environmental programmes on the acceptance of these measures; to identify natural and socio-economic criteria which influence the spatial distribution of acceptance of these agri-environmental measures; to describe specific attributes of farm enterprises which participate in such agri-environmental schemes and to determine changes in the production systems of these farms; to calculate the impacts of different agricultural and environmental policies in a regionalised agricultural and environmental sector model for Germany. For 1996 and 1997, a complete data set on the acceptance of agri-environmental measures on regional level has been compiled. This regional data allows a detailed analysis of the spatial distribution of acceptance. Considering the different policies in the regions, variables like soil quality, land use patterns and crop yields are investigated. For the model analysis the agricultural sector model RAUMIS is used („regionalised agricultural and environmental information system for Germany"). The calculations provide an estimation of the regional economics of soil conservation measures and the impacts of agri-environmental schemes. Reasons for the relatively low acceptance of these measures will be given.

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A-0356

Small Watershed Management and Eco-agricultural Construction in Loess Hilly Region -- A case study in Zhifanggou watershed of Ansai. Liu Guobin and Li Rui, Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resource, Yangling, Shaanxi, China

This paper, taking a case study of Zhifanggou watershed as example, analyzed changes of land use and ecological environment in the last 60 years. The result showed that construction of conservation eco-agriculture is a effective approach for deteriorated ecosystem restoring in this area. The environment of Zhifanggou small watershed, from 1938 to 1997, experienced "serious damage", "continue damage, " "primary restoration" and "stable restoration" periods. In 1938, the woodland covered over 88%. However, after 20 year reclaiming, woodland was less than 1% and cultivation ratio got as high as 51%. Since early 1970*s, a planned soil and water conservation has achieved great progresses. The Zhifanggou small watershed have become a model in integrated control on Loess Plateau of China. The result showed that implement of conservation eco-agricultural needs three periods: initial restoration period; stable improvement period and well developing period. The criteria of land use, social and ecological characteristic were developed, and the watershed health index was also suggested and the time trend of the index was analysised. The case study in Zhifanggou watershed showed that the ecosystem could be restored in 20 years.

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A-0357a

Regional Evaluation of Soil Erosion and Conservation Based on GIS and RS in Loess Plateau of China. Li Rui, Yang Qinke, Liu Guobin and Hu Liangjun, Institute of Soil and Water Conservation, CAS/MWR, Yangling, Shaanxi China

The loess Plateau in China is well known for its unique landscape and severe soil erosion. On the other hand, remarkable achievements of soil and water conservation works have been gained in this region. It is very urgent and meaningful to apply advanced technique, such as remote sensing, GIS to provide decision-makers with updated data and evaluation models. In this study, a geographical database integrated main environmental factors related to soil and water loss is built. The multi-level remote sensing and ground observation are use to update data of land surface conditions regularly. From the basic monitoring of small watershed to the middle regions, then to

the whole region, a monitoring network has been formed. GIS supplies a flexible data management method, and modeling/expert systems increase practicable functions. Bases on the exited database, some simplified models were developed, including models of soil erosion caused by water and by wind.

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A-0358

Influence of planted fallow on topsoil properties in the Forest Margin Benchmark of the southern Cameroon. L.-S. Koutika, IITA, Cameroon, c/o L.W. Lambourn and Co, Croydon. UK, B. Vanlauwe, N. Sanginga, IITA, Nigeria, c/o L.W. Lambourn and Co, and S.Weise, IITA, Cameroon, c/o L.W. Lambourn and Co, Croydon. UK

In soils located in the northern, central and southern part of the Forest Margin Benchmark, with a decrease in the dry season period from the northern to the southern, the soil property changes occurred after planted fallow were studied and compared to forest. There were three types of planted fallow; (i) *Pueraria*, (ii) *Chromolaena odorata*, and (iii) fallow where the *Chromolaena* had been removed by hand. The soils were sandy loam in the northern part, sandy in the central and clayey in the southern part of the Forest Margin Benchmark. Carbon and nitrogen contents did not significantly increase after the planted fallow period as compared to forest. However the benefic effect of planted fallow was noticed in the nutrient element availability such as Ca, Mg and K, which significantly increased under the *Chromolaena* and *Pueraria* fallows. In the soils of northern and central part of the Forest Margin Benchmark, the planted fallow induced an increase in the carbon mineralization under the *Chromolaena* and *Pueraria* fallow as compared to the soil under the forest vegetation. This trend was not observed in the soils of the southern part, where the clayey texture seems to reduce the mineralization of carbon. The effect of the planted fallow was also noticed by the significantly increase in the particulate organic matter (POM), and its contribution to total soil organic matter. Moreover, this trend was more pronounced in the soils of central and southern part of Benchmark.

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A-0359

Carbon Concentrations and Transport in Sediment Leaving Small Tilled Watersheds. L.B. Owens, R.W. Malone, G.C. Starr, and R. Lal

At the North Appalachian Experimental Watershed research station near Coshocton, Ohio, various conservation tillage practices have been studied on small watersheds (0.55 - 0.79 ha) for several years. The practices include corn/soybean rotations with No-till, Chisel-plow, and Paraplow for 6 years. After that period the Paraplow management was changed to a 3-year, corn/soybean/wheat-meadow rotation with disking preceding the corn and soybean crops. An additional seven years of data have been collected with these concurrent practices. Each small watershed is instrumented with a 60-cm H-flume mounted on a concrete approach, and a Coshocton wheel is used in front of the flume to collect a proportional sample of water and sediment. When sediment concentrations in the runoff were high enough to permit sediment to be collected, sediment was collected and stored. Samples of sediment deposited in the flume approach were also collected and stored. These stored sediment samples have been analyzed for total carbon, and comparisons of soil carbon have been made among management practices. Weighted averages of soil carbon in the sediment that passed through the flumes during the treatment periods may not be greatly different among tillage treatments, although No-till was the highest (2.8%) and Chisel-plow was the lowest (1.9%). Weighted averages of soil carbon in the flume floor sediments were slightly lower with No-till being the highest (2.3%) and Chisel-plow being the lowest (1.7%). For comparison, weighted soil carbon averages in sediment that passed through flumes from small fertilized, pastured watersheds ranged from 5.2 to 7.2%. Total carbon transport was the product of total sediment transported times the carbon concentration. Even though sediment concentration was determined on all runoff, not all runoff has sufficient sediment to permit a sediment sample to be collected. Average annual sediment loss was 873, 1312, and 2281 kg/ha for no-till, chisel-plow, and disk, respectively. Using carbon concentrations from analyzed sediment, carbon estimations were made for runoff with low sediment concentrations. Sediment transport in low concentration events was 60%, 10%, and 31% of the total sediment loss for no-till, chisel-plow, and disk, respectively. The annual average transport of soil carbon in the sediment was similar for no-till (11.9 kg/ha) and chisel-plow (12.1 kg/ha). (Chisel-plow had more sediment movement with a lower carbon concentration.) Annual average carbon transport from a disk treatment was 17.1 kg/ha. Although tillage treatments may reduce carbon transport in sediment by lower concentrations, a greater factor for reducing carbon movement is by reducing sediment movement.

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A-0361

Studies on Genetic Mechanism, Management and Development of Degraded Slope on Lateritic Red Soil in South China. Huang Yingfeng and Li Huaxing.Natural Resource and Environmental Science College, South China Agricultural University, Wushan, Guangzhou, China.

The South China area is located in the tropical and subtropical zone with high temperature and abundant rainfall. Acid red soil is widely distributed there, covering about 130 million hectare, among which 40 million hectare is in Guangdong Province, but only a few have been reclaimed. Because the red soil possesses the following properties: strong acidity (PH4.5-5.5); low in organic matter and available N, P, K, especially a shortage of nitrogen and phosphorus nutrition's; poor soil structure; weak water-holding capacity and drought resistance, and the easy of water loss and soil erosion. Crops can not grow well and even fail to harvest in this red soil if the fertilization management is unreasonable. This paper has studied the possible mechanism of physical and chemical properties degradation of degraded slope on lateritic red soil in South China. Results showed that, nutrients impoverishment especially the organic matter deficiency might be the main interior factor causing physical and chemical properties degradation of lateritic soils; the vegetation deterioration was the most principal environmental factor controlling the physical and chemical properties degradation; and human activity play a very important role in the soil physical and chemical properties degradation. Also, the land Best Management Practice (BMP) has been successfully developed in South China, especially in Dongwan city, Guangdong Province these years. The BMP is effective on hilly lands, and is the principal focus of land restoration efforts in Guangdong Province.

Huang Yingfeng

A-0362

How and Why the Brazilian Zero Tillage Explosion Occurred. John N.Landers. Agronomist and Agricultural Engineer, Executive Secretary of the Associação de Plantio Direto no Cerrado, Brasília DF, Brazil and representative of the FEBRAPDP.

While it took from 1972 to 1990/91 to reach 1 million hectares of Zero Tillage (ZT) in Brazil, between 1990/91 and 1998/9, 10 million additional hectares will added, raising the total to over 25% of the area planted to annual summer crops. Development followed similar patterns in the sub-tropical region (starting 1972) and the tropics (from 1981). Erosion problems triggered the early pioneers, who accepted higher direct costs, while forging and disseminating the technology, with private sector and some government assistance. From about 1990 onwards, improved profit margins and ease of planting triggered massive adoption rates and erosion control became secondary. Official extension services, with research and private sector assistance, were important for ZT adoption by small farmers in South Brazil, covering about 50,000 hectares, while in the tropics adoption by both small farmers and extension is still at a very low level. Adoption of ZT in center pivot irrigated crops, mostly in the tropical savannah region, has been very high, probably exceeding 50%. In 20 year farm models, IRR's for ZT have shown considerable gains over CT which increase when side-effects are computed. Additional benefits perceived by mechanized farmers have been : lower machinery operating, maintenance and replacement costs, long-term economies in total inputs, a greater percentage of second-cropping and rotation with pastures, less dusty working conditions and fewer, but better-qualified, employees. All farmers gain with significantly lower erosion and drought risks (or 15-25% less water consumption in irrigation), more planting days per season, quicker turnarounds with multiple cropping, long-term reductions in input use and savings in labor and/or management time. For small farmers, can be reduced by 20 to 50 hours/ha/yr, while mechanized farmers can reduce hp/ha by 40-50%. Government incentives have been slow, starting with a reduction of one percentage point in the crop insurance rate, in 1997, while incentives foreseen in the 1995 Green Protocol have yet to be implemented, as a result of low public awareness of the huge free benefits of ZT to society. The principal agents of change for medium and large mechanized farmers were the farmers themselves and their Friends of the Soil Clubs (FSC's), private agronomists, foundations, associations and cooperatives, associated with private sector support from input and, to a lesser extent, machinery manufacturers. Farmer innovations and persistence, in partnership with public and (private) product-oriented research, were fundamental in developing the technology. Informal farmer-to-farmer contact and private and public sector sponsorship of excursions, field days, short courses, seminars, demonstration areas and technical publications were the chief mechanisms of technology transfer while press/television coverage has been important in increasing the general demand for ZT technology. In Paraná, Santa Catarina and Rio Grande do Sul states, community management of natural resources has been organized (with World Bank funding) by state extension services on a micro-catchment basis. Several organizational models are involved in ZT dissemination. The Brazilian National Federation for Zero Tillage in Crop Residues (FEBRAPDP) heads a network of state and regional associations, including the Zero Tillage Association of the "Cerrado" (tropical wet/dry savannah region) APDC, county-level FSC's, foundations and other farmer organizations, with public and private sector support. ZT has been the portal to the professionalization of Brazilian farmers of all sizes and instrumental in awakening their environmental conscience, resulting in the principal solution for sustainable highly productive farming in the tropics and sub-tropics worldwide.

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A-0363

Improvement Of Soil Management For Sustainability In The Morphological Unit Beli Potok – The Possibility For People Remaining In Hilly Regions. Miodrag Zlati, Faculty of Forestry, Belgrade University, Belgrade, Yugoslavia

Morphological unit Beli Potok is characteristic for occurrence of all the erosion phenomena in the agricultural areas of the Vo`dovac community, which constitutes the part of the hilly region of the wider Belgrade area. The existing structure of agricultural production indicates that erosion processes in this region have narrowed and also decelerated the yield increase rate which would be possible on natural and economic conditions. In this paper the establishment is discussed of the production model taking into account the conservation of land resources, the needs of the population and profitability in the case of the hilly morphological unit Beli Potok. In this sense, agricultural, fruit and forest productions are anticipated from the aspect of soil management for sustainability, and the possibilities are given for the improvements of the production model giving better long -term economic effects. The improvements of the offered production model have been performed by establishment of the bee-keeping production in two variants (I variant – production of honey as the chief product and wax, propolis, flower powder as by-products; II variant – production of royal jelly as the chief product without by-products) and by medicinal herbs collection. The assessment of the long term effects of the planned and improved models has been performed in terms of the internal rate of return (IRR), pay back period (PBP), benefit cost ratio and net present value (NPV). The assessment of risk and uncertainty has been performed by sensitivity analysis of IRR and PBP. The improved production models with respect to the planned ones have given the considerable improvement of the economic efficiency, especially with PBP, also taking into account the necessities of the population and conservation of the land resources (according to USLE equation soil loss is under the tolerant level). It is the additional reason for people to remain and survive in these areas.

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A-0364

Application of WEPS Generated Soil Loss Components to Assess Off-site Impacts. Larry Wagner, Agricultural Engineer, USDA-ARS Wind Erosion Research Unit, Throckmorton Hall, KSU, Manhattan, KS USA

Typical wind erosion studies have primarily investigated mass flux rates and soil loss from source locations. Correspondingly, wind erosion prediction models have historically focused on those same elements. Thus, most wind erosion control measures have been designed for and evaluated based upon their cost-effectiveness at mitigating on-site impacts. Yet, the true costs of wind erosion events are often those that occur offsite. With the advent of the Wind Erosion Prediction System (WEPS), a physically based, daily time step wind erosion model, many off-site impacts of wind erosion can now be successfully explored and addressed. Two examples of off-site wind erosion impacts, filling of roadside drainage ditches and reduced visibility along roadways are examined. These examples focus on how WEPS can benefit in the design and/or selection of effective practices for controlling these off-site wind erosion effects.

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A-0365

Incorporating field surface crusting phenomena and their spatial organisation in modelling runoff and erosion at watershed scale for anti-erosion schemes. V. Souchere, Inra-Sad Ile De France, Versailles Cedex (France), O. Cerdan, Y. Le Bissonnais, A. Couturier, D. King, Inra-Science du sol, Ardon (France) and F. PAPY, INRA-SAD Ile de France, Thiverval Grignon (France)

In loamy areas of Northern Europe, soil erosion is a widespread phenomenon, despite low rainfall intensity and a gentle topography. Interactions between meteorological conditions, farming operations and topsoil texture bring about rapid and significant changes in the hydraulic properties of topsoil. Deterioration of soil infiltrability and surface water storage leads to the appearance of runoff at the origin of erosive problems. The processes involved in surface crusting are extremely dynamic and crust characteristics are often difficult to measure. Modelling infiltration into these crusts has led to the development of equations of varying complexity, ranging from simple empirical equations to numerical solutions of the Richards equation. Obtaining the parameters for the more mechanistic approaches remains a challenge. The objective of our work is to develop a runoff model based on field experiments and knowledge about crusting and agricultural practices (tillage direction, roughness, location of dead furrows, etc.). The model allows the calculation of total runoff volume for a rainfall event at any point in the watershed. This model is able to serve as a simulation tool in order to test several anti-erosion schemes and choose the best for each situation

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A-0369

Study on the Utilizational Potential of Severe Eroded Red Soil in Southeast China.

Potential utilization for severe eroded land in Fujian, were reported in this paper. There were principally 3 models for eroded land exploiting and utilizing in our province. They included plantation of orchard, economic tree, timber and grass etc. Their economic and ecological benefits were also described respectively. Fujian province is located in the southeast of China, where 80 percent is mountainous areas and average land per capita is only 0.47 hectares. There are 15559.9 km^2 eroded land in Fujian, occupying 11.9% of total the area in which 52.7% of it belongs to severe eroded land and is in lower mountainous areas, and most of them are near village. They were principle weathered granite red soil where topsoil all most had been deprived because of deep and thick weathered layer so the plant was difficult to grow. Temperature on surface soil of severe eroded land reached 76.6°C in summer. Therefore, it was considered as wasteland. Some of exploiting and utilizing trials for eroded land have been conducted. Since 1982, according to these tests, large area eroded land has been controlled and evident ecological and economic benefits was made. The trials were made in Nanan County, Hetin town of Changting County respectively. Longan Fruit was given as example for orchard establishment in this paper, and Acacia mearnsli for economic forest, pine for timber with grasses.

A-0371

Proposal of a simple linear relation between runoff and agricultural plot state during intercrop period for the loamy plateaus context of the Caux area (France). MARTIN Philippe, Institut National Agronomique Paris-Grignon (France), Dpt AGER, Paris France

To characterise the effects of agricultural plot state on runoff generation during the intercrop period in the Caux Area (Haute-Normandie, France), a range of agricultural practices was tested under natural rainfall during two intercrop periods (1993-1994; 1994-1995). Work was conducted on two replicate 20 m² experimental plots. The five tested practices consisted of (1) a no-tillage treatment, (2) a light duty mouldboard ploughing, (3) a mustard culture, and a superficial tillage with a light rigid tine cultivator equipped with a goose foot shovel applied in dry soil conditions (4) or in wet soil conditions (5). Four post-harvest field conditions were used in 1993-1994 : wheat field without straw, wheat field with pulverised straw, spring peas field without straw (P) and fiber linen. P was the only post-harvest condition used in 1994-1995. Plot state descriptors included soil surface characteristics (tortuosity index (TI), percentage of surface covered by vegetation (VEG), macroporosity (MAC)) and soil profile characteristics (percentage of the anthrophic horizon tilled during intercrop period (TSW), percentage of compacted zone in the anthrophic horizon (COMP)). Climate descriptors, defined for each rainfall sequence, included cumulative rainfall (CR), mean rainfall intensity (I) and cumulative daily climatic balance (P-ETP) during the three days preceding the maximum rainfall intensity (CB3). A linear regression method was used to relate runoff to both soil and climate variables for each rainfall sequence. The LIFEREG method (SAS) was chosen to allow collector tank overflowing to be taken into account. The LIFEREG method, conducted on 1993-1994 results, excluded only the MAC and TSW variables (0.01 probability level). A runoff grid composed of four classes was set up. After all runoff sequences were split into these four classes, the regression equation was used to determine the runoff class of each runoff sequence. The calculated class was correct for 52 % of the runoff sequences in 1993-1994 and 56 % in 1994-1995. The more-than-one-class error frequency reached only 3 % in 1993-1994 and 9% in 1994-1995. The equation could be used (i) to compare different plot states at the same time and (ii) to discuss the best way to decrease runoff risk on agricultural plots. Comparisons of calculated and measured runoff for each experimental treatment gave indications of how both macroporosity and soil profile descriptors should be improved.

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A-0373

Mine Land Reclamation and Soil Carbon Sequestration in Ohio. V. Akala and R. Lal, School of Natural Resources, The Ohio State University Columbus; OH USA

Restoration of drastically disturbed mine land soils can lead to increase in biomass productivity, improved soil quality and soil organic carbon (SOC) sequestration. The land area disturbed by mining is steadily increasing and at present, 2 million hectares have been reclaimed in the US. Reclamation of mined lands is an aggrading process and offers significant potential to sequester C. A chronosequence study consisting of 0, 5, 10, 15, 20 and 25 years old mine soils in Ohio was initiated to assess the rate of C sequestration in reclaimed pasture and forest sites. Undisturbed marginal pasture land and forest were used as controls. On the basis of the SOC levels of the pasture soils, C sequestration rate of 0.05 %/yr. and 0.03 %/yr. are measured for 0-15 and 15-30 cms depth, respectively. These rates are equivalent to SOC sequestration at the rate of 0.11 Mg/ha/yr. for the 0-15 and 0.07 Mg/ha/yr. for the 15-30 cms depths with bulk densities averaging 1.5 Mg/m3 and 1.6 Mg/m3 respectively. Analyses are underway to quantify the rate of SOC sequestration in forested sites. In order to identify the mechanism of C sequestration, SOC associated with aggregate and texture classes are being assessed. The half life, turnover times and microbial biomass are being assessed.

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A-0375

Productivity of heavy clayey soil as affected by some soil amendments and drainage treatments. Abou El-Soud , M. A, Shams El-Din, H. A , Ghazy, M. A, and Abo Soliman M. S. M. , Gazia, E. A. E., Soil, water & environment Res. Instit., ARC, EGYPT

Some heavy clayey salt affected soils with low permeability in the Nile Delta of EGYPT are not generally adapted for crop production .Therefore , an efficient drainage is an important factor to improve these soils to be suitable for crop production in short time with low cost . The major concern in these soils is the maintenance of sufficiently adequate water infiltration and soil aeration. Field experiment was conducted in area of 6 ha, served by surface drainage system at Sakha Agricultural Research Station Farm in Nile Delta of EGYPT on some crops during seven consecutive growing seasons (Sorghum 1990, barley 90/91,rice 91, clover 91/92 , rice 92 , clover 92/93 and rice 93). The investigation was extended to evaluate four drainage treatments: (Ditches at 20 or 40 m spacing, ditches at 40 or 70 m spacing with sandy filled mole drains) and some soil amendments(50 tons organic manure / ha and /or 12.5 tons gypsum / ha) as an endeavor to alleviate the salinity and impermeability problems in salt affected heavy clayey soil and to improve its productivity. The sandy back filled moles at 0.5 m depth and 6 m spacing were constructed in vertical to the open ditches. The most important findings of this study could be summarized as follows: 1) All drainage treatments facilitate the infiltration of water and the sandy moles raised the efficiency of surface drainage system. The best drainage treatment was found to be 40 m spaced ditches with sandy moles followed by 20 m spaced ditches; 2) Soil amendments clearly increased water infiltration. The addition of organic manure with or without gypsum may play an important role in soil flocculation resulted in significant increase of soil infiltration especially in the last three seasons; 3) Electric conductivity and sodium adsorption ratio of soil were greatly reduced over the seven seasons of the trial as a result of drainage and soil amendments treatments. The mean values of both parameters with all treatments at the end of the trial were close together and their levels were tolerable for most of the field crops; 4)Sandy mole may improve the efficiency of the drainage system , accordingly the total yield of the seven seasons that achieved from sandy mole with 40 or 70m spacing between ditches were superior to other drainage treatments without sandy moles; 5) Soil amendments obviously increased the total yield . The organic manure with or without gypsum achieved a considerable increase in the total yield. Finally , it could be concluded that the compined effects of the drainage treatments and soil amendments inhanced the amelioration of heavy textured soil . Also, the inefficient drainage system can be improved by sandy mole drains to be more efficient.

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A-0376

Advanced international training programme in Watershed management. Björn Hansson, Course co-ordinator, SCC Natura Ltd. (Sweden)

Since the early 80's watershed management has become an increasingly important factor for dealing with degrading soil and water resources. Despite the fact that the technical practices required for the protection of the catchment areas are well known, their management has been largely unsuccessful. This is due mainly to a traditional emphasis on biophysical aspects and conventional land use planning, while the socio-economic factors have been neglected. At present ministries and department are fragmented and work in isolation resulting in several restricted approaches rather than in an integrated, holistic management strategy. The complexity of watershed management requires an interdisciplinary and multi-sectoral approach, in which experts from different fields can identify solutions in close collaboration with the people involved in and concerned with the watershed. To promote a holistic integrated approach to watershed management the Swedish International Development Agency (Sida) sponsors an annual international training programme being implemented by SCC Natura. The watershed management training programme focus on the interaction between human and natural resources seen in a watershed perspective. The concept is wider than water resource management, including all aspects of production, management utilisation and conservation of renewable resources, but water is used as the link between ecological and sociological processes. Multiple reasons for factors threatening the resources are emphasised seen as both biophysical and socio-economic. The watershed is described as a complex unit, involving many different actors and stakeholders with different and sometimes conflicting objectives: focus on interaction between bio-physical and socio-economic aspects of natural resource management, from a watershed perspective; Aim at an increased understanding of integrated watershed management; emphasise role of human resources and local participation; "problem oriented" i.e. focus on discuss problems and potential. The programme consists of one course in Sweden and one course in the participants home region (Africa, Asia and Latin America). Participants are assigned tasks to be carried out in their home country between the courses. The course is targeted towards policy-makers, high level technicians, representatives from national NGOs and lecturers at institutions of higher learning. The mixture of discipline experiences and gender in emphasised in the selection. Sixty participants from 26 countries were registered in the 1998 years programme.

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A-0377

A comparison of rain erosivity parameters for predicting interrill soil detachment. C. Salles and J. Poesen, Laboratory for Experimental Geomorphology, KULeuven, Belgium

Interrill erosion is largely controlled by rainfall characteristics. Several rainfall parameters (e.g. rainfall intensity, kinetic energy, momentum...) are being used to characterise the eroding power of the rain. There is still a lot of debate as to the performance of various erosivity parameters. The debate and confusion are due to limited sets of reliable data and to a lack of understanding of fundamental processes involved in raindrop impact and splash detachment. This study reports on the use of an Optical Spectro Pluviometer (OSP) based on optical shadow measurement, which measures independently drop size and fall velocity in real time conditions, in order to quantify the different erosivity parameters of simulated rainfall. Laboratory experiments using a very fine sand exposed to various simulated rainfall intensities have been conducted. A rain simulator consisting of four nozzles (Lechler axial-flow cone jet nozzles) produced the rain. Rain intensity was varied (in the range 25-140 mm h^{-1}) using electric valves which switched individual nozzles on or off. Rain characteristics (raindrop size distribution rainfall intensity, raindrop velocity) were measured with the OSP whereas splash detachment rates were determined using the splash cup method. The statistical performances of several soil detachment parameters were evaluated. From this analysis recommendations as to which are best performing erosivity indices will be given in order to predict soil splash detachment.

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A-0379

Approaches on Soil Erosion and its Countrolling Conter-measures in the Three Gorges Reservoir Area. BINGHUI HE, JIE YU and GUANGYI SONG, Department of Soil and Water Conservation,Southwest Agricultural University, Beibei, Chongqing, People's Republic of China

The Three Gorges Reservoir area has been known by more and more people because of the Three Gorges Project in the Yangtze River.Its area and population are fifty-nine thousand square kilometers and fourteen million respectively.But soil erosion area has surpassed thirty-five thousand square kilometers,which is caused by forest destruction and irrational land use.Forest cover percentage now is 19.5%,far lower than the demanded safety percentage of 35%-40%.Most of the natural forest has been destroyed,the reclamation percentage has been high to 40%.The erosion ratio of different land utilization is 60%,6.9% and 33.1%on agriculturally-cultivated slope lands,forest and orchard lands,bare and sparse wood lands respectively.Soil erosion modulus has been high to 9,450t/km^2.a.Amount of soil erosion is two hundred million tons,46.16% of them are eroded into the Yangtze River.So it is necessary to pay more attention to the soil erosion in this region .otherwise the Three Gorges Project will be threatened by the sediment deposition directly from the soil erosion. Hillslope land is the main source place of the sediment deposition,low vegetation cover results in a worse ecological environment. Strategies to decrease soil erosion were as follow: (1) To strengthen basic farmland construction and change slope land into terrace; (2) To improve tillage technology and carry out conservation tillage such as rotation,interplanting,covering,contour tillage,no tillage and ridge culture etc.No tillage and covering system are emphasized by Professor Guangjiong Hou to achieve the target of "Preventing flooding by ecological effects, Controlling erosion by no-tillage measures;" (3) To restore and increase vegetation coverage. Steep slope reclamation should be prohibited,protective forest should be developed,especially along the bank of the Yangtze River.A better way proposed for protective forest construction is biological dike composed by mixed forest with the combination of trees,shrubs and grass; (4) To exploit and reclaim eroded small watershed through comprehensive control measures with the combination of "hills,water,cultivative lands,forest,roads and villages",to develope integrated use of hilly land such as one hill with multiple use type of ecoagriculture.

Binghui He

A-0380

Effect of clay mineralogy on waterlogging of alluvial soils of Japan. Nishimura, T., Fac. of Agriculture, Tokyo Univ. of Agriculture and Technology, Saiwai-cho, Fuchu, Tokyo Japan, K. Nakano, T. Miyazaki and T. Higashino, Graduate School of Agricultural and Life Sciences, Tokyo University, Bunkyo-ku, Tokyo Japan

Alluvial soils in Fukaya, where a basin of Tone River and a suburb of Tokyo, Japan have been having high agricultural productivity. Recently, some soils in Fukaya area started to show waterlogging and more runoff that harm crops and fields. Nakano et al. (1998) reported basic soil physical properties, such as texture, bulk density and saturated hydraulic conductivity of undisturbed samples, and exchangeable cations were not distinctly different between well drained and waterlogged soils. Objects of presenting study were to examine the contribution of soil structural change on infiltration of irrigated water and rainfall of Fukaya soils, and the extent of the effect of clay mineralogy on infiltration. From the X-ray analysis, vermiculite was the major clay mineralogy for both

Fukaya-A, well drained, and Fukaya-B, waterlogged at the field, soils. Kaolinite and smectite were the second and the third dominant clay mineralogy. According to the Lim and Jackson's method(1986) the Fukaya-A soil contained more beidelite, which is expected to be less expansive than montmorillonite, in the smectite fraction than that of the Fukaya-B soil. Air dry soil (1 mm < d < 3 mm) was packed into acryl plastic cylinders of 8 cm in i.d. and 10cm in length. Then, 30 mm hr-1 of simulated rainfall were applied. Kinetic energy of the rainfall was 47.5 J m-2 mm-1 . Distilled water and 20 mmolc L-1 calcium chloride solution were used for simulated rainfall. In some case in the distilled water rainfall, 2.5 t ha-1 of gypsum were spread onto the soil surface prior to the rainfall. In the simulated rainfall experiment, Fukaya-B soil showed more sealing than Fukaya-A soil, and this could be a reason of water logging of the Fukaya-B soil fields during and after a rainfall. Gypsum application and calcium chloride solution promoted infiltration of rainfall into the Fukaya-A soil, however, neither of them could prevent sealing of the Fukaya-B soil. It was expected beidelite in the Fukaya-A soil clay fraction, though it was a small amount, made the soil less dispersive. Different dispersion-flocculation features of the soils may cause a difference between the well-drained and the waterlogged soils.

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A-0382

Irrigation water supply pricing and its conservation effects: a case study from Hawaii. Chennat Gopalakrishnan, Professor, University of Hawaii, Dept. of Agriculture & Resource Economics and Parashar B. Malla, University of Hawaii at Manoa

The rapidly escalating demand for water, in conjunction with rapidly diminishing sources of supply, has added considerably to the challenge of water planning in Hawaii in recent years. The situation has taken on special importance due to Hawaii's burgeoning population growth (20% in the past 10 years) and the consequent sharp increase in its municipal and domestic water use. This situation is likely to put considerable pressure on Hawaii's irrigation water supply which currently accounts for 65 percent of the state's total water consumption. The sugar plantations alone apply about 1.17 billion gallons of water per day to cane fields. The case for water conservation in Hawaii's agriculture thus becomes compelling. In this paper we attempt to determine the conservation effects of irrigation water supply pricing in Hawaii using a Water Consumption Model incorporating different supply factors and demand determinants. Total water supplied by an agency is divided into water consumed during delivery and water consumed on the farm. Consumption during delivery (W1) is a function of conveyance loss (C), type of supply agency (I), etc. Consumption on the farm (W2), a derived demand, is a function of a vector of price variables for output, water input and its substitutes (P), and a vector of environmental or technical variables (Z) representing land type, irrigation technique, weather, etc. Thus the aggregate Model for Water Consumption can be stated as W = W1 (C, I) + W2 (P, Z). Different functional forms are being examined for comparison purposes. Data for our study have been obtained from a variety of sources. These include private water suppliers, Hawaii Sugar Planters' Association, the State Board of Water Supply, Department of Land and Natural Resources, Water Resources Research Center, U.S. Geological Survey, and U.S. Department of Agriculture.

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A-0383

Appropriate technologies for controlling soil erosion in the rural communities of Ghana. John T. Adomako, Soil Research Institute, Kwadaso, Kumasi Ghana.

Destruction of houses, streets and farm roads in the rural farming communities through soil erosion is perceived by the Ghana government as a major constraint to sustainable agricultural production and socio-economic benefits. It is estimated that nearly 3-5 tons of soil is washed from unprotected houses and 60-70 tons/ha from unprotected streets per year. A team of researchers embarked on an intensive study using the participatory rural appraisal (PRA) method to extract socio-economic information to understand the farmers perceptions on land degradation within their communities and their indigenous strategies to combact the problem. During a workshop organized for the selected communities various appropriate technologies for prevention and control of soil erosion in the settlement areas were proposed and demonstrated. The application of the following principles of erosion control formed the basis of the demonstrations. It included among other things; protecting the soil against rain damage; retaining water where it falls; creating infiltration routes; fighting erosion at its source; channeling and controlling runoff water; and forcing runoff water to deposit its load. On building protection, the use of stones or gravels around perimeter of building, application of impermeable material (sand and bitumen), roof gutters to convey rainwater to drains, or reservoirs were demonstrated. For gullies, the use of bamboo pegs, sandbags and boulders were encouraged. Vegetation enhanced techniques such as growing of ornamental trees along streets and lawns around houses were also demontrated. Road tarring and provision of drains on both edges also checked the degradation of roads were also proposed and demonstrated. The use of locally available materials was stressed and the people are willingly adopting the techniques.

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A-0387

Use of Microsoft Access to Compute Near Surface Morphology Index for Soil Quality Evaluation. D.S. Harms and C. A. Seybold, USDA Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE USA

A soil quality index based mainly on soil structure and rupture resistance is presented in a separate paper by Grossman et. al. Computerization would facilitate application of the index for soil quality evaluation. The calculations are not complex, but they are numerous. By creating a series of relational databases the index can be quickly obtained. The data and the calculations can be stored and calculated in Microsoft Access.

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A-0388

A Near Surface Morphology Index for Soil Quality Evaluation. R.B.Grossman, D.S. Harms, C.A. Seybold, & M.T. Sucik, USDA Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE

Description of soil morphology in soil survey includes class ratings of soil structure, porosity, and rupture resistance. These class sets and related assessment techniques should be useful for evaluating soil quality. To achieve this possibility, we propose a well-defined protocol and associated class sets of the near-surface soil morphology adapted as an index of soil quality. The near surface soil (0-30 cm) is the depth evaluated for soil quality. Soil structure and moist rupture resistance are the main rating criteria. Numeric values are assigned to structure and rupture resistance classes to produce an initial index. The initial index is then modified downward for the presence of a raindrop-impact crust or upward for a network of surface-connected macropores. In practice, layers are delimited wherever one of the rating criteria changes by one class or more. Class placements for structure and rupture resistance are combined using different weightings, which are determined by texture. The resulting values are then modified for crust and macropores. A depth-weighted average for class placement is calculated by 10 cm intervals. The index for the 0-30 cm depth weights 0-10 cm 4, 10-20 cm 2, and 20-30 cm 1. The index is a whole integer between 1 and 100.

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A-0389

A Field Book for Describing and Sampling Soils. P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, W.D. Broderson, and J.R. Culver. USDA-NRCS, Lincoln, NE USA

The first, fundamental step in soil resource inventory is the observation and accurate recording of soil information on-site. This field book comprehensively summarizes the standard procedures and terms for describing soils as practiced in the USA. It includes standard abbreviations and criteria traditionally used in recording soils information. Key sections deal with Site Description, Soil Profile / Pedon Description and Geomorphic Description. Other sections include Soil Taxonomy, Geology, geographic Location, common Unit Conversions, and Soil Sampling. Extensive graphics, charts and tables help to organize and clarify terms and ideas. Brief discussions cover new or confusing issues such as major changes in redoximorphic features, cracks, response of chemical indicators, and the use of permeability vs. saturated hydraulic conductivity. The waterproof, pocket-size book is intended to be a standard reference, a tool for training and education, and a practical guide for soil scientists (federal, state, private, and academic), environmental scientists, persons in related natural resource disciplines, and anyone interested in describing land resources.

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A-0390

Soil Conservation Research in Ethiopia. Esayas Dagnew

The Soil Conservation Research Project (SCRP) is operating in Ethiopia since 1981. Since then the project maintains 6 research stations in various agro-climatic zones, and the head quarter with its laboratory and a database management and analysis section. Activities of the research units such as data collected since 1981 are properly documented in the database electronically. Other activities of research units, perceptions of farmers in and around the research units and the achievements are also documented in video films. This presentation will bring you the activities of SCRP since 1981 in 20 minutes video show and the short report on the available database and its formats.

A-0392

Soil Plant Interaction and Plant Available Water to Maximize and Sorghum Crops. Carlesso, R., Petry, M.T., Reinert, D.J., & Reichert, J.M., Agricultural Engineering Department, Federal University of Santa Maria, Santa Maria, RS, Brazil

The objective of this experiment was to identify differences in the total soil water holding capacity, soil available water and plant available water to maize and sorghum plants. Three experiments were conducted in the experimental field of Agricultural Engineering Department of the Federal University of Santa Maria-RS Brazil, during the growing seasons of 95/96 and 96/97 (maize) and 97/98 (sorghum). A set of 12 drainage lysimeters was used. Lysimeters were 156 cm long, 100cm wide and 80 cm deep. An arch rain shelter was used to avoid rainfall on the lysimeters. Treatments applied were two-soil water management (irrigated and terminal soil deficit imposed during vegetative growth) on three soils with distinct textures: clayey, loamy and sandy. Lower limit and upper limit of soil water availability to plants were measured in the lysimeters to determine the plant available water and total soil water holding capacity. Field capacity and wilting point were used to determine soil available water (conventional methodology). Results indicated that the soil water holding capacity was 232 mm, 230 mm, and 146 mm and the soil available water was 62 mm, 55 mm and 95 mm for the clayey, loamy and sandy soil textures, respectively. However, the soil's plant available water to maize, average both years, was 99 mm, 103 mm, and 116 mm. Consequently, approximately 43%, 45%, and 80% of the total soil water holding capacity were available to maize cultivated in the clayey, loamy, and sandy soil textures, respectively. Values of plant available water were 22%, 60%, and 89% higher than soil available water determined by conventional methodology. These results demonstrated that the conventional methodology underestimated the amount of plant available water. Considering a given soil depth, the plant available water to maximize plants was larger in the sandy than for loamy and for clayey soils. Similar amounts of plant available water were observed for sorghum plants cultivated in clayey and sandy soil textures. However, the plant available to sorghum plants in the loamy soil was 46% larger for maize and 278% higher than the soil available water determined by the conventional methodology. These results clearly indicated that there is a soil-plant interaction due to physical, chemical, and biological characteristics which effect the plant available water. The plant available water needs to be determined in the field for each soil types, soil management and crop specie.

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A-0394

Residue production and rain infiltration with a winter cereal green-fallow. R. L. Baumhardt, Soil Scientist, USDA-Agricultural Research Service Conservation and Production Research Laboratory, Bushland, TX and R. J. Lascano, Professor Soil Physics, Texas Agricultural Experiment Station, Lubbock, TX USA

Cotton (*Gossypium hirsutum* L.) is grown extensively on the Texas South Plains; however, it produces minimal residues to conserve soil and water. Residue production can be increased with spring herbicide treatment of winter wheat (*Triticum aestivum* L.) sown after cotton harvest. This practice provides residues and often increases cotton lint yields under irrigation, but herbicide treatment is required and grain production is eliminated. We hypothesized fall seeded spring cereals would produce residues and, because of winter kill, would not require chemical termination. This study was conducted to compare: 1) residue production of different fall seeded spring cereals with chemically terminated winter wheat, 2) effects of different herbicides used to terminate winter wheat on residue production, and 3) residue effects on rain infiltration. Spring oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.), wheat (*Triticum aestivum* L.), and winter wheat were sown in September on an Olton clay loam (fine, mixed, thermic Aridic Paleustoll) at the Texas Agricultural Experiment Station, Lubbock. Spring cereals were "winter killed", while winter wheat was chemically terminated at a residue height of at least 150 mm using either: ***i.*** glyphosate [N-(phosphonomethyl) glycine], or ii. fluazifop [Butyl (R)–2–[4–[[5-(triflouromethyl) –2 pyridinyl] oxy] phenoxy] propanoate]. Residue amount, surface soil water content, and infiltration of rain, taken as the difference of water applied minus measured runoff, were determined following cotton crop establishment. Rain was applied for 60 minutes using a rotating disk type simulator at an intensity of 80 mm h^{-1} and normal drop impact. Residue production averaged 1.15 Mg ha^{-1} for fall planted spring cereals and 1.36 Mg ha^{-1} for winter wheat chemical termination treatments except late termination (2.55 Mg ha^{-1}). Chemically terminated winter wheat produced the greatest amount of residue, but surface soil water content decreased with increasing amount of residue produced. Residues intercepted rain drop impact and infiltration was about 45 mm compared to 25 mm for bare soil; however, no significant difference in either infiltration rate or amount was identified among the residue treatments. The residue benefits of increased rain infiltration and protection from wind erosion are obtained at the expense of using soil water during fallow to grow a green-fallow cereal crop. The data suggest that consumption of soil water for residue production by fall seeded cereal crops could reduce subsequent summer crop establishment under dryland conditions when rain is limited.

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A-0395

Global tension zones of land degradation. Hari Eswaran, Paul Reich, USDA Natural Resources Conservation Service, Washington DC, and Fred Beinroth, University of Puerto Rico, Mayaguez, PR

As the world's population continues to grow, the human induced stresses on biophysical resources grow proportionately. In the richer countries, environmental awareness, the necessity to incorporate ecological considerations in land management and the ability to subscribe to tenets of sustainable agriculture have together contributed to national strategies for a rational use of biophysical resources. The poorer third world countries, on the other hand, cannot implement these 'lofty' ideals and continue on the road to increased degradation, reduced productivity, and a general inability to feed themselves. Using spatial databases (GIS) on global soils and climate and published information on land resource constraints, derivative maps of major land resource stresses, land quality, vulnerability to desertification, and potentials for wind and water erosion, were developed. About 36.5 million km^2 or 27.8% of the earth's ice-free land surface is too dry for sustainable human habitation. About 21.8 million km^2 or 16.6% of the land occur in the cold tundra zone, which are not easily amenable to normal agriculture. Saline and alkaline soils occupy 3.1 million km^2 or 2.3% of the land surface, and soils with low water holding capacity affects 3.4 million km^2 or 2.6% of the total land. There are sloping lands, sandy soils, soils with low water and/or nutrient-holding capacity, soils with high organic matter (peats), etc. Each of these constraints reduces the potential for sustained grain and feed production. An overlay of current population and information on potential increases in the year 2020 identifies tension zones where major soil management interventions would alleviate the problem or impact sustainability. Tension zones were rated on their severity and a map was prepared to show the impacted countries. The conclusion of this study is that famine and starvation of people of some countries are not the result of the innate inability of land resources to produce the necessary food but because of an absence of political will and other socioeconomic characteristics of the countries. At the same time, there are countries, which have exceeded their population supporting capacity and must rely on importation from other better-endowed countries.

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A-0397

Use of soil hydraulic pedotransfer functions for the assessment of soil quality on a european scale. NEMES, A., Research Institute for Soil Science and Agricultural Chemistry (RISSAC), Budapest, Hungary, WöSTEN, J.H.M., Dr., The Winand Staring Centre for Integrated Land Soil and Water Research (SC-DLO), Wageningen, The Netherlands, LILLY, A., Dr., Macaulay Land Use Research Institute, Aberdeen, Scotland and LE BAS, C., Dr., Institut National de la Recherche, Agronomique (INRA), Orleans, France

Intensive agricultural and industrial activities increasingly cause the quality of our soils and waters to deteriorate. Soil water and solute transport models currently applied to investigate environmental processes require data on soil water retention and hydraulic conductivity characteristics. However, the use of these models has often been limited by the lack of accurate soil hydraulic properties. In order to overcome this problem, an alternative to the direct, but often difficult and expensive measurement, is the estimation of hydraulic properties by pedotransfer functions. These pedotransfer functions predict the hydraulic properties from parameters collected routinely during soil surveys. Environmental changes are not restricted by country borders, thus they should be studied in a global context. Understanding this, a project was initiated to bring together the available hydraulic data from different institutions in Europe into one central database. So far, a total of 20 institutions from 12 European countries collaborated in establishing the database of HYdraulic PRoperties of European Soils (HYPRES). The database has a flexible relational structure capable of holding a wide diversity of both soil pedological and hydraulic data. The database is currently holding information of some 5500 soil horizons from 95 different soil types according to the modified FAO soil legend. As these data were contributed by 20 different institutions it was necessary to standardize both the particle-size and the hydraulic data. A novel similarity interpolation procedure was successfully applied to achieve standardization of particle-size data. This allowed the textural classification of all soils according to the FAO/USDA particle-size ranges into 11 different soil textural/pedological classes. Standardization of hydraulic data was achieved by fitting the Mualem-van Genuchten model parameters to the measured $\theta(h)$ and $K(h)$ properties of the individual soil horizons. This information was then used to derive a set of pedotransfer functions applicable to studies at a European scale. Both average class hydraulic properties (class pedotransfer functions) and predictions of the hydraulic properties of an individual soil horizon (individual pedotransfer functions) were derived. As a demonstration of a practical use of the database, a map of the spatial distribution of soil water availibility within Europe is also shown, obtained by linking the class pedotransfer functions with the 1:1.000.000 scale digital Soil Map of Europe. It is envisaged that the database and the derived pedotransfer functions will be a unique source of information for agricultural and environmental scientists.

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A-0398

Factors Affecting the Incidence of Erosion in Upland England and Wales. Marianne McHugh and Tim Harrod, Soil Survey and Land Research Centre (Cranfield University), North Wyke Research Station, OKEHAMPTON, Devon, UK

Soil erosion is an issue of concern worldwide. An increased awareness of the non-renewable nature of soil, coupled with an appreciation of its fragility, has sustained interest in protection of this important resource. In particular, ecosystems at high altitude are at risk from erosion: climate change, overgrazing and increased amenity use are just a few of the potential threats to sensitive upland environments. In spite of this concern, however, in the United Kingdom the causes, true extent and environmental and financial costs of erosion, particularly in non-agricultural land, remain to be determined. The 1996 Royal Commission Report on Environmental Pollution highlighted the "lack of information on the extent and rates of upland erosion" and outlined a need for research into soil erosion. In response to that report, current research in England and Wales is concentrating on addressing these issues. The project outlined here entails investigating the incidence of erosion throughout the uplands of England and Wales. While previous works have lacked a systematic sampling strategy, this project has used a statistically robust and spatially balanced method, based on a 5km grid, to provide 450 sites between the Scottish border and the English channel. Repeated site visits and measurement of morphological and management factors are allowing possible determinants of erosion to be ascertained and valued. Preliminary results indicate that factors such as slope, aspect and altitude do not play major roles in determining the incidence of erosion when considered individually. There is, however, evidence that these do not act exclusively and instead, interact with the other features of eroding and non-eroding sites to determine whether a particular environment becomes susceptible to erosion. These previously overlooked features, which include aspect and slope morphology, work in conjunction with soil type and grazing regime to play pivotal roles in erosion susceptibility. This ongoing research continues to monitor the changing face of upland England and Wales. Precise measurements of gullies and other landscape features are being used to calculate erosion rates. Such data, along with the information on site susceptibility to erosion and with the statistical credibility of this project, will encourage positive remedial action among decision and policy makers and among landowners.

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A-0400

Considering Soil Degradation Issues in Agricultural Modeling for Policies Analysis in West Africa. J. Senahoun, M. Bruntrup, Universitaet Hohenheim, Institut, Stuttgart, Germany, And D. Deybe, CIRAD-Ecopol, Nogent-Marnue, France,

Agricultural policies and also the introduction of new technologies induce many changes in the functioning of farming systems (cropping patterns, inputs use, labor allocation, etc.). But they have also a great impact on soils because the composition of agricultural crops is one of the major determinants of soil degradation. Thus, in order to recommend adequate agricultural policies which associate productivity growth with the maintenance of soil in different ways through so-called bio-economic models which permit a simultaneous appraisal of adjustments in farm household resource allocation decisions that influence both household welfare and agro-ecological sustainability, e.g. in terms of organic matter and macro-nutrient balances. These bio-economic models are built by using the results from a plant growth simulation model (EPIC) in farm models, by including environment amenities in the farmer's utility function, or by incorporating soil degradation measure in farmers' profit function, etc. For an adequate consideration of these interactions between household welfare and sustainability of land use under different scenarios of agricultural policies and technological change in West Africa agriculture, we include a soil loss equation in a programming regional agricultural model which is used to assess the impact of the Structural Adjustment Programme measures (devaluation, liberalism, etc) on the farming system. This permits to capture the impact of different policy measures on input use and output but also on soil erosion. The model is applied to a cotton producing region of Benin (West Africa). Simulations are made to recommend measures which simultaneously encourage crops production and secure the agro-ecological sustainability.

J. Senahoun
A-0402

Soil Degradation Due to Conversion of Forest to Other Land Uses in the Philippines. Victor B. Asio, Department of Agronomy and Soil Science, Visayas State College of Agriculture, ViSCA Baybay, Leyte, Philippines Reinhold, Jahn, Institute of Soil Science and Plant Nutrition, University of Halle, Germany and Karl Stahr, Institute of Soil Science and Site Ecology, University of Hohenhein, Stuttgart, Germany

Soil degradation is one of the most serious ecological problems in the Philippines today. As in other humid tropical countries, the conversion of forest to agriculture and other secondary land uses is considered as the major cause of this ecological problem in the country. Until now, however , very little data have been reported from the Philippines about soil degradation especially on the role of forest conversion to secondary land uses leads, in the long-term to soil degradation. It also aimed at evaluating what soil properties are affected and what the effects are of the present secondary land uses. The adjacent area approach was employed wherein secondary land uses such as coconut area, grassland, bushland, pasture, shifting cultivation and reforestation were compared with the adjacent original forest. Detailed field and laboratory studies involving rock, soil and water samples, field measurements of soil erosion and carbon dioxide evolution were conducted. Results revealed that forest conversion to the other land uses has indeed enhanced soil degradation as indicated by negative changes in several soil properties and increased soil erosion rate. However, it appears that the degradation of the soil was the direct effect of present secondary land uses. In fact, contrary to what is often reported in the scientific literature, some secondary land uses improved the organic matter and nutrient status of the soil, the latter being due to enhanced rock weathering due to burning, cultivation and other human disturbances. This research therefore showed that the widely held view that secondary land uses (e.g. grassland) contribute to soil degradation is not generally true. Among, the agricultural land uses coconut in combination with kudzu (a cover crop) resulted in a soil condition generally comparable to that under forest.

A-0404

Only Trees Should Wear Branches. Kawanga Victor, The Commonwealth Forestry Association (CFA), Zambia Branch

It is naturally important for everyone to be familiar with the fact that plant resources contribute to our welfare in innumerable ways, some direct, some indirect. Knowledge here is the key to control. Important of all is perhaps the fact that every kingdom of plants, every species, forms a unique pact of the diversity of nature which, if once destroyed is lost to us forever. As environmental biology is of a wider scope, it is more important here than in other scientific fields to consider establishing information about the stature of ecological resources. Lack of information and understanding of ecological resources such as forests, birds, soils and other natural resources has affected the availability of suitable teaching and demonstration materials in Zambia. Developing nations, particularly those in the sub-Saharan Africa (SSA), are faced with a serious environmental threat- the destruction of forests and other ecological vegetation of local ecosystems and that of forest depletion. This has adversely affected food production resulting in the growth of food insecurity. In general, wasteful traditional agricultural methods, instincts of survival and population pressure has accelerated the depletion of natural resources. It has been estimated that over the last 50 years or so, 30 million hectares of productive land in sub-Saharan Africa alone has been turned to desert. The task of vegetation studies is the registration of the interrelation (and their effects) between the various organisms and their environment, that is; of all the organic and inorganic factors resulting from the particular location. Through such studies information on the past and present background of the existence of plant communities, the causes producing the various types of plant communities and the effects that such communities have on the environment can be collected.

Kawanga Victor

A-0405

Traditional Knowledge And Recent Developments In Desertification Control In Arid Parts Of India. J.P. Gupta and P.R. Ojasvi, Central Arid Zone Research Institute, Division of Resource Management, Jodhpur India

Recent estimates show that about 32.7 percent of the country's land area is affected by various processes of land degradation. more serious efforts are, however, required to control the Indian arid region which comprises of about 12 percent of the total geographical area of the country. The efforts are, therefore, directed towards combining the socially acceptable traditional knowledge and new techniques for sustainable development. Some of such experiences with farmers of arid region are discussed in this paper. Traditionally farmers used to construct 3-4 feet high earthen bund around their fields to control wind erosion. Tree plantation on these bunds and also shelterbelt plantation resulted in reduction in wind erosion by 50% and loss of nutrients by 57%. Additionally the farmers could save their labour in annual maintenance of the bunds. The community grazing lands (loran, lands) in each village can now be made more productive by improved strains of *Lasiurus sindicus and Cenchrus ciliaris* grasses and other fodder trees and shrubs planted in a silvipasture system. Techniques have also been developed to establish such system on sandy, gravelly and rocky wastelands so that such areas can be used to meet the pressure of increasing livestocks. In place of the traditional small water harvesting 'tanka' of 5000 liters or less, a hydrologically improved 'tanka' of 50000 liters capacity was developed for supplemental irrigation and drinking purposes. Experiences from the management of an arid watershed have shown that control of ephemeral streams by soil conservation structures could increase the ground water recharge and biodiversity conservation in the adjoining areas. Cropping with *Prosopis cineraria* trees in an agroforestry system is an age old practice in the Indian arid region. Systematic practice of cropping with *P. cineraria, Zizyphus mauritiana and Tecomella undulata* have been developed. Such a system could give 51% higher economic returns even under the drought conditions (annual rainfall 210 mm). A technique of circular micro-catchment water harvesting has been found to be very successful in the establishment of tree saplings under rainfed conditions. The techniques to control some problems of recent origin like water logging, pollution due to industrial effluent, degradation of ground water and mined wastelands are also catching farmers attention and acceptance for adoption. More efforts are being made to test and refine the desertification control techniques at farmers' fields for their wider adoption.

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A-0406

The Farmers' View: How Seeing the Local Defines On-Farm Conservation. Ruth Beilin, Senior Lecturer, Department of Environmental Horticulture & Resource Management, Institute of Land & Food Resources, University of Melbourne, Burnley Campus, The Boulevard, Richmond, Australia

Diary farms are among the most intensively managed landscapes in the southwest Gippsland, Victoria. Their farms encompass the area of the former, densely treed Great South Gippsland Forest, which was cleared for European settlement since 1850. Today, these family farms, located on undulating plains and steep hillsides experience severe significant topsoil from the farms to the bays and inlets of the area. This oral presentation concerns farmers from this area, involved in a voluntary compliance, grassroots, community-based, production and conservation movement. As 'Landcare' farm members, there is an expectation among policy makers that conservation practices will ensure on private farmland to create sustainable land use. During a longitudinal study in this area, selected family farmers collaborated through a participatory photo-elicitation process in identifying their 'significant landscapes'. These clearly identify the overwhelming production mandate of their farms and indicate the intimate relationship between the 'look of the land' and management responses; the compliance schemes; the various manifestations of 'conservation' in production landscapes; and the relationship of newer management practices such as agroforestry and revegetation networks to existing production regimes. This presentation uses the farmer's own words in the discussion of their photographs to indicate the complexity of issues facing them as managers of difficult and often marginal landscapes. As an example, the meaning of 'marginal' is examined within the context of production and conservation values. Similarly, several of the farmers develop a critique of tree planting as the major conservation measure associated with Landcare, arguing for better pasture management in steep hillside country. The presentation concludes by examining the implications of this study for programs of public support for private land management, such as Landcare represents. It considers the importance of local farmer action in defining 'conservation' and 'production' in relation to global economic imperatives. It identifies the landscape connectivity, which encourage farmers to envision a regional approach to their farm management.

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A-0408

The effect of tillage on soil drought sensitivity. Cs. Farkas, Research Institute for Soil Science and Agricultural Chemistry of HAS, Budapest, Hungary, Cs. Gyuricza, Agricultural University, Gödöll, Hungary and P. László, Research Institute for Soil Science and Agricultural Chemistry of HAS, Budapest, Hungary

Soil compaction caused by conventional soil tillage systems is one of the main soil degradation phenomena's. Several field experiments are being carried out to study the long-term effect of new, sustainable and soil-conserving soil tillage systems. In Hungary the amount of precipitation in the vegetation period is less than the potential evapotranspiration. Thus, the retention of water in soils has great importance. A long-term field experiment of five cultivation systems was set up at the Gödöll Agricultural University to study the effect of different tillage systems on soil moisture regime and soil sensitivity to drought. The tillage systems were direct drilling, ploughing, disking, loosening+ploughing and loosening+discing. The objective of our study was to estimate the amount of water in the soil, available for plants and to compare it as affected by different tillage systems. Since continuous measurement of soil moisture content is rather expensive, we applied a simulation model to estimate the soil water balance and the plant water uptake. In the studied year maize was grown in the experimental field. The effect of different soil systems on soil hydrophysical properties (soil water retention curve, hydraulic conductivity function) was measured and set as model input. We calibrated the model against the soil moisture data measured 12 times within the vegetation period. Analyzing the measured soil hydrophysical properties measured in different tillage systems we found significant differences in the low suction range. The total porosity of the topsoil increased in case of ploughing (5-10 cm), loosening+ploughing (5-20 cm) and loosening+disking (5-20 cm). The compaction effect of conventional tillage treatments (disking 5-40 cm, ploughing 15-20 cm) was observed. Regarding the durability of the effect of tillage on soil structure we did not find significant effect of tillage after June. The loosening effect of roots and earthworms was valuable from August. The soil input data, therefore, cannot be kept constant within the vegetation period when simulating the soil moisture regime. Most of the simulation models, however, handle the soil hydrophysical properties as unchanged ones. The simulation results showed the favorable effect of tillage systems, combined with loosening on crop growth. The crop yield, collected from plots corresponded to this conclusion.

A-0409

An Integrated Erosion Research Plan to Facilitate Technology Development and Transfer In South Africa: Technology Transfer Framework. H.J. Smith, ARC- Institute for Soil, Climate and Water, Pretoria, Republic of South Africa

Based on the strength and principles of a system modeling approach, the institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC) proposed an integrated erosion research plan to facilitate technology development and transfer in South Africa. The first leg of the plan focuses on both the utilization of currently available information in qualitative erosion assessment techniques as well as the application of quantitative erosion assessment techniques with more detailed data, which, to a large extent, still must be collected. Elements of two main initiatives in soil and water conservation in South Africa, namely *Landcare and Integrated Catchment Management (ICM)* would ideally be targeted by these two erosion assessment techniques in order to provide meaningful answers for decision making. The first objective of these two erosion assessment techniques will be to establish the cause behind erosion. Once objective of these two erosion assessment techniques will be to establish the causes behind erosion. Once these causes have been identified, the way is open to that important step in the whole soil conservation process, namely an investigation into the reasons why land is being misused. Therefore, both *Land care* and *ICM* promote community involvement as an essential element of soil and water conservation. This paradigm poses new opportunities, principles and techniques for specialists, extension officers and soil conservation technicians to become involved with community-based soil conservation activities. The role of specialists would basically be to offer resources and support to community groups and to facilitate groups in order to identify the problems, to develop and identify action plans and solutions and to implement these solutions. However, scientists and other specialists would have to acquire additional skills required in group communication or extension processes, in order to work closely with community workers, sociologists, soil conservation technicians and last but not least, community members themselves. One of the main objectives of the erosion research plan would be to facilitate the implementation and adaptation of sustainable conservation practices and/or erosion control works by the land users.

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A-0411

A soil profile database for rehabilitated opencast coal mined land in South Africa. J.P. Nell and P.I. Steenekamp, Institute for Soil, Climate and Water, Pretoria, South Africa

In South Africa most of the coal which is suitable for opencast mining occurs on the highveld of the Mpumalanga Province, where 52% of all the high potential land in South Africa is found. The area is occupied by relatively deep soils with favourable infiltration and water-holding characteristics and which respond favourably to fertiliser application. The mean annual rainfall of 750-800 mm per annum is considerably higher than the national mean of less than 500 mm. From the 1970's, when opencast coal mining methods were introduced in South Africa, to approximately 1990, contact and transparency between the mining houses and farmers were often at a low level. No monitoring of the measure of success or otherwise of rehabilitation of land was done. Since the introduction of the Minerals Act of 1991, greater participation of interested and affected parties in the drawing up of environmental management programme reports has become commonplace. This, amongst other factors, has led to a growing realisation amongst agriculturists, resource protection officers and mining environmental managers that mining and agriculture should join forces to commission research in order to determine the present and potential agricultural value of rehabilitated coal mined land. The working group concerning agriculture needs in open cast coal mining, considered the soil profile database as the highest research priority. The objectives of the project were, firstly to create a soil profile database by describing and sampling rehabilitated soils on a grid system and storing the data in a geographic information system (GIS) and secondly to analyse the collected physical, chemical and morphological data with the aim to determining the nature, magnitude and spatial variability of those soil parameters which are known to affect plant growth. The mines provided more than 1 600 soil profile pits for classification, sampling, analyses and mapping. Soil compaction or high bulk density is the biggest problem to nearly all the rehabilitated soils that were investigated and it was determine that this has a substantial adverse effect on root development and plant growth in general. The high bulk densities indicate that the initial compaction caused by heavy mine equipment during cover-soil emplacement, is generally not effectively mechanically alleviated in the mine soils investigated. Where soil and spoil acidification has taken place because of mining activity, the visual effects are dramatic. Contrary to the expectations of agriculturists and environmentalists, acidity is generally less of a problem on rehabilitated mine soils than expected, although for certain areas it can be problematic.

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A-0412

Some environmental impacts of modern cultivation methods. T.R. Harrod and A.I. Fraser, Soil Survey and Land Research Centre, Cranfield University, North Wyke Research Station, OKEHAMPTON, Devon. UK

Cultivation methods in UK agriculture are continuously developing to meet the needs of production and any constraints from environmental concerns. Traditionally cultivation began with mouldboard ploughing, often followed by over-winter weathering to form frost tilths, eventually seed beds being worked down by disc or tine harrowing. Drilling or planting then followed, with rolling as the final stage. While the case for reduced tillage is

well appreciated from both the point of view of establishment costs and the environment, enthusiasm for direct drilling, (zero-tillage) introduced during the 1970s, did not survive that decade. Most UK farmers and growers continue to favour a sequence beginning with ploughing. Savings on time or establishment costs have been achieved by use of plough presses, powered cultivations and single pass combination drilling. An almost universal result is very fine and smooth seedbed surfaces. In addition, since the introduction of more effective pesticides, the main arable crops, wheat, barley and rape, are mostly autumn sown. Consequently tilths now are rarely the product of slow weathering of relatively stable aggregates, but rather of mechanical comminution and pulverisation, while autumn drilling means than a protective crop canopy rarely closes before April. Winters are normally mild but wet, with many low intensity rainfall events. All these circumstances combine to make the soil very prone to surface degradation and capping (crusting), followed by a long period with risk of runoff and soil erosion. A number of studies into pesticide and phosphorus movement to watercourses have been carried out across southern England, on a range of soils and crops. Farmers' fields (0.2-5 ha) on slopes between 1 and 10 degrees (2-17%) were monitored. On readily worked, porous, freely draining soils, (e.g. ochrepts, udalfs), much favoured for horticulture and arable farming, runoff has been observed as beginning when rainfall rates reach 1.0-1.5 mm per hour. Such degradation of surface infiltration is of concern on soils with naturally high hydraulic conductivity (of the order of centimetres per hour). Primarily their hydrology has changed from a groundwater to a surface water regime. There are implications for pollutant transfers, water quality, flooding and aquifer recharge, as well as for the farmer and the agronomy of his crops.

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A-0413

Evaluation of Farmland Degradation Induced by Coal Mine Activity. Krzysztof Boron, Slawomir Klatka, Department of Soil Reclamation and Peat Bogs Protection, Agricultural University Krakow Krakow, Poland

Degraded areas requiring land reclamation arise as a result of various industrial technologies. Soil productivity has been taken as a indicator of farmland degradation and reclamation effectiveness. A quantitative soil productivity index, the Fuzzy PI Model developed by Zheng Hu and R.D. Caudle & S.K. Chong (International Journal of Surface Mining and Reclamation 1992) has been examined on example of Coal Mine "Szczyglowice" in Upper Silesia, Poland. The PI method is based on Neil?s equation describing the relationship between soil productivity index and various physical and chemical properties of soil. A series of parameters are taken into account in this method, such as: soil texture, bulk density [g/m3], penetrometer value [MPa], infiltration [cm/h], potential available water content [%], hydraulic conductivity [cm/h], macroporosity [%], pH, organic matter [%], electrical conductivity [dS/m.], root media depth [cm], aggregate stability [%], sodicity, stone content [% volume]. The original model has occurred inadequate for evaluation of farmland degradation induced by Coal Mine "Szczyglowice" exploitation activity. The basic problem was soil surface subsidence which involved water table movement and soil -water relationship changes in soil profiles. From this point of view the original Fuzzy PI Model was improved and results for the new one were compared for investigated area. The tested area was covered with square nets of 200 m. side length. Corners of squares were stabilized and leveled. In each of corners soil samples were taken and water table level has been found and observed for dry and wet seasons (1996 and 1997). The necessary for PI method properties of soil were tested in laboratory. The isolines of PI values were drawn for original and modified method as well. The original PI method has been extended and soil sorptivity as an important factor was introduced to the model. The improved soil productivity index occurred very flexible and effective tool for evaluating farmland degradation, can be use for predicting the productivity effectiveness of reclaimed mine soils and undisturbed area as well.

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A-0415

Watershed Management Policies, Processes, on-the-ground delivery and local action - Rhetoric and Reality. Dr. D. Uma Maheswara Rao and B. P. Sinha, Division of Agricultural Extension, Indian Agricultural Research Institute, New Delhi, India

Managing agro-ecosystems using watershed approach cuts across communities, revenue villages, forests, hills, streams, catchments, cropping systems, concerns, interests, aspirations, disciplines, line departments, etc. and need a concerted approach for sustainable use of land and water resources. The policy makers and development managers plan and design well meaning projects for watershed management but their on-the-ground delivery and translation of the lofty ideals into realistic work processes meets with partial success. All the great efforts, through taking lessons drawn from earlier experiences of several approaches - sectoral approach, intensification approach, innovation approach and integrated approach to management of watersheds, by carefully selecting various project components and adopting an integrated approach in meticulously planning and designing watershed management projects. One such well designed project is Doon valley integrated watershed management project spanning over 250 villages covering an area of 1854 sq. m. in Tehri and Dehradun districts of Uttar Pradesh. The Doon valley watershed project emphasizes on "the evolution of a participatory 'process-oriented' approach, aimed at developing community activities to sustain the increased natural resource production systems introduced by project activities, encouraging convergent planning and strengthening the skills and institutional capacity of the rural communities." Though the Doon valley watershed project achieved considerable success in a few micro-watersheds, as evidenced in a recent study, and demanded the committed services of development oriented staff at grassroots level. As the English would say, there's many a slip between the cup and the lip, projects like these would remain a rhetoric in the absence of functionaries' sensitivity to understand the grave realities of the peculiar dynamics of people's participation and agrarian caste relations in Indian villages. Whereas, philosophy and policy guidelines can guide to evolve an approach for conservation programs at project level, on-the-ground delivery of these conservation programs through mobilizing local people and eliciting their participation for taking appropriate local action is quite another task for the grassroots level development functionaries and the local people as well. Project functionaries' orientation towards development functioning, convergent planning accommodating the indigenous skills of villagers with their technical expertise, their motivating-empowering leadership style in eliciting people's participation would play a crucial role in accomplishing the degree of land stewardship sufficient to sustain our 'global farm.'

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A-0417

Socio-economic Constraints in Sustainable Agriculture and Indigenous Knowledge of Soil and Water Conservation of Tribal Communities in North Eastern States of India. U.C. Sharma, ICAR Complex for N.E.H. Region Barapani, Meghalaya, India

The north eastern states of India, having a total area of 255, 090 sq. km., are predominately hilly and inhabited by number of tribes. With increase in population, their needs multiplied and the tribal community changed from hunting to nomadism, pastorlism, shifting cultivation and settled cultivation. About 14.5 % of the total geographical area is under cultivation and shifting cultivation involves 1466 thousand ha of area at one time or the other. It has caused deforestation and results in annual loss of 88346, 10.66, 0.37 and 6.05 thousand tonnes of soil, nitrogen, phosphorous and potassium, respectively. The practice was sustainable when shifting cycle used to be 25-30 years but now it has become uneconomical and reduction in this cycle to 3 to 7 years. This shifting cultivation is not only a form of land use but implies the whole nexus of people's attitude, self-image and tribal identity. The other socio-economic constraints to sustainable agriculture are; land-tenure system, small holding sizing, hilly terrain, poor communication system, acidic soils (> 95%), high rainfall (>2500 mm), high humidity, lack of finance etc. However, there are some indigenous land use systems, evolved by tribal farmers through their ingenuity and skill, which are eco-friendly, economically viable with well founded soil and water conservation base. *Zabo* land use system is a combination of agriculture, forestry, livestock and fisheries and is followed by *Chakhesang* tribe. The system has forest land on the upper slope of hill; desiltation tank, water shortage and livestock-yard in the middle and rice fields down the slope. The *Apatani* tribe has a unique system of rice cultivation involving efficient water management with minimum soil loss through erosion. The 'Agriculture with Alder (*Alnus neplansis*)' is an agro-forestry land use system followed by *Angami, Chang, Chakhesang, Yimcheungar* and *Konyak* tribes. The alder is a non-leguminous nitrogen fixing 943 to 184 kg N ha^{-1}) tree. Spreading nature of the roots of alder prevent soil erosion. 'Bamboo Drip Irrigation' system is a unique example of carrying water through hilly and rocky terrain through bamboo pipes. The system is followed by *Jaintia* and *Khasi* tribes. The soil loss through erosion varies from 1.2 to 2.3 t ha^{-1}, the benefit-cost ration from 1.43 to 1.90 and carrying capacity from 20 to 55 persons per sq. km. in indigenous land use system as compared to 40 to 130 t ha^{-1} soil loss, 0.60 benefit-cost ration and 9 to 12 person per sq. km. carrying capacity in shifting cultivation. All the technical aspects, basic principles involved and reasons for their being sustainable for centuries have been studied, analyzed and discussed.

A-0418

Role of Women in Sustainable Agriculture Production: My Experiences as Farm Woman in Soil and Water Conservation in *Kandi* (dry) Areas. Sudesh Sharma, c/o Dr. U.C. Sharma, ICAR Research Complex for N.E. H. Region, Barapani, Meghalaya India.

In India, the woman are major contributors to Agriculture production efforts, observed FAO of the United Nations. There is need to recognize the role, the women are already playing in productive agriculture in India, to study their problems and opportunities and identify new technologies based on women's knowledge and experience. This will enrich their efforts and the national development potential. To address the production problems in India, the interaction between women farmers and the professionals is necessary. Being keen observers, the farm conservation. In Indian context, the women are actively involved in decision making and can highly influence the introduction of new technologies for higher productivity. The *Knadi* area is characterized by low annual rainfall (up to 750 mm), deep water table and undulating topography. The production is risk prone due to high variability in rainfall and its distribution. During rainy season (July/August), there is soil erosion on sloppy lands; while during winters, the soil moisture is not even sufficient for germination of crop seeds, resulting in extremely poor crop productivity. The construction of low cost water-harvesting structures, with sand

stones (freely available) embankments, has been suggested. The rain water is harvested and utilized as life saving irrigation for winter crops. This also reduces run-off and soil loss through erosion. The fields should be prepared across the slope to reduce soil and nutrient loss through erosion and formation of rills and gullies. Field preparation for winter crops of wheat, barley gram etc. is an important operation. The field is ploughed before the sun-rise to receive dew, which falls in an important operation. The field is ploughed before the sun-rise to receive dew, which falls in late night hours during September / October and soil surface is levelled with heavy leveller for retention of moisture in the top soil and reduce evaporation. This is repeated at intermittent periods. The upper portion of the sloppy field is sown with leguminous crops requiring less moisture and lower slope with wheat, barley etc. as lower slopes contain relatively more moisture. During the period between harvesting of maize or bajra crops and sowing of winter crops, the animals (cattle, buffaloes, goats, etc.) are fastened in the fields during night for addition of dung and urine in the soil to enhance soil fertility. The addition of organic matter improves physical condition and moisture content of the soil. Methods have been suggested for soil and water conservation and increasing crop productivity and intensity.

Sudesh Sharma

A-0421

Black oat (Avena strigosa Schieb) straw management effect on weed growth and soybean emergency. Eltz, F.L.F. & Bortoluzzi, E.C. Soils Department, Federal University of Santa Maria, Santa Maria, RS, Brazil.

Most of weeds are controlled with herbicides in the no-till system, but straw may have an influence on weed growth and soybean emergency, as well. Oat is a major crop during winter season in Rio Grande do Sul State, Brazil, and the management of its straw is highly variable. However, little information is available about how this management affect crops and weeds. The objective of this experiment was to study the influence of the oat straw management on weed supression and soybean emergency. The experiment was carried out in 1997, at the Federal University of Santa Maria, Santa Maria, RS, Brazil, on a typic Hapludalf soil. A completely randomized blocks design was used in a split-plot distribution with five replications. The main treatments applied to the straw were: (T1) harvested; (T2) not managed, stand-up straw; (T3) rolled with a knife-roll; (T4) disked; (T5) mowed; (T6) without straw and no weeds control; (T7) without straw and no weeds. The split treatments were with and without herbicide control of weeds (post-emergency). The variables analysed were weed density (15 days after soybean sowing - DAS) and weed biomass (84 DAS), and soybean emergency rate index (SERI). Soybean was sowed 24 days after treatments (DAT) were imposed to the oat straw. There were no statistical differences among T1, T2, T3, T4, T5 and T6 for the weed density, while T7 had no weeds. *Brachiaria plantaginea* density was greater for T3 and T4 (30 and 33 plants m^{-2}) than T7 (zero plants m^{-2}). Weed control using a post-emergency herbicide promoted an average weed biomass reduction of 6 times, in relation to treatments without weed control. Among treatments without weed control, weed biomass for T4 and T6 was higher than for T1, T2, T3 and T5. These results indicates that T4 and T6 were not efficient in weed control. *Brachiaria plantaginea* was the main weed contributing to total weed biomass SERI was similar for T1, T2, T3 and T5, which was 28% greater than for T7. SERI was influenced by straw presence, but not by the straw management.

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A-0422

Conservation technologies and green food production in severely eroded sloping land of South China. Li Dingqiang, Guangdong Institute of Ecoenvironmental and Soil Sciences, Leyiju, Guangzhou, Guangdong P. R. China and Yao Shaoxiong, Guangdong Soil and Water Conservation Committee, Guangdong, P. R. China

The area of soil erosion in South China covers 799000 Km^2, two thirds of it lacks nutrient and nearly all the soils are insufficient of nitrogen and organic matter, 78 % and 58% of it lacks phosphorus and potassium, respectively. The soil erosion area in Guangdong province is 11381.23 Km^2 and covers 5.58% of the total territory area. The annual erosion yield is 85.41 million-ton and the average erosion modulus is from 7215.68 to 7335.5 T/ Km^2·a. after near half a century's conservation practice, the fruitful achievements have been gained. The approaches to control soil erosions focus on combination of engineering and biological measures. But there are still some problems, such as the gravity gully erosions (Benggang) have been well controlled whereas sheet and rill erosions are still exited in some of the hilly lands, and the land productivity in the traditional soil erosion controlling areas is low. In recent years, the application of conservation technologies in the extensive agricultural exploitation with the high investment of fund and technique have thoroughly controlled soil erosion in this area, and have successfully achieved sustainable land use. These conservation technologies include: (1) The high-quality and mechanized constructed terrace eliminated the former rills and gully and lessened the erosion yield to the tolerance values; (2) The implication of agricultural technology on water economizing improved the agricultural productivity; (3) The technique of coupling of water and fertilizer on new reclaimed sloping land increased the soil fertility and soil erodibility; (4) The protection of bio-diversity enabled effect use of potential agricultural resources; (5) The restoration of ecosystem and the green (organic) food production improved the quality and raised prices of commodities and improved eco-environment. Through the agricultural exploitation and green food production, the soil erosion in this area is totally controlled. A typical experience in Wuhua county of Guangdong Province is analyzed in this paper. In an agricultural zone of 50 Km^2 with the support of government, the guidance of scientists, the investment of the enterprises and the implement of FARM (FAO Agricultural Resource Management) Program, the local farmers are more easy to accept and adopt conservation technologies. The promised effects will be reached in the near future.

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A-0423

Socio-Economic Evaluation of and Indigenous *Ngoro* Conservation Tillage System of SW Tanzania. B. Kayombo and J. Ellis-Jones, Botswana College of Agriculture, Gaborone, Botswana and Silsoe Research Institute, Bedforshire, U.K.

A socio-economic evaluation was undertaken in 1994-96 to examine the productivity of an indigenous conservation tillage system called *ngoro,* a farming system which has evolved over some two hundred years, compared to the use of ridges in Mbinga District of southwest Tanzania. This evolved a Participatory Rural Appraisal (PRA) in late 1994 followed by monitoring of nine farmers from two villages over a 12 month period selected as being representative of farmers with different socio-economic backgrounds and access to resources. Interviews were also held with each farmers and other community leaders in January 1996. The evaluation was carried out from farmer's perspective using criteria established by them as being important. It was concluded that although the system is efficient at controlling soil erosion, increasing soil moisture at critical times of the year and maintaining soil fertility, the problems associated with it, notably decreasing fallow periods and high labor requirement, indicate declining use other than for the traditional center of the ngoro. The immediate future challenge is to build productivity enhancing improvements into the present system without destroying its unique advantages.

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A-0425

Use of a Physically-Based and Distributed-Parameter Model and a Geographical Information System for Soil and Water Management in a Tunisian Semi-arid Region. Mrs. Lamia Laajili Ghezal, Ecole Superieure d'Agriculture de Mograne, Tunisie

Soil losses affect soil productivities, hydraulic and agricultural infrastructures and soil environment. To cure this, an appropriate and sustainable land use is needed. This can be obtained by predicting soil responses to specific soil managements , especially in terms of soil losses and regeneration. To make easy the choice between different land uses protecting soil against water erosion, a methodology which integrate the effects of soil and water conservation techniques on soil is to develop. The use of physically-based and distributed-parameter models for simulation and prediction of soil losses, can be useful for the elaboration of soil and water conservation techniques schemes. In this work, a physically-based and distributed-parameter model the ANSWERS (Beasley and Huggins, 1991) was used on a 40 ha watershed in a Tunisian semiarid region with realistic parameters based on soil and land surface characteristics and vegetation cover. The distributed data was obtained using a geographical information system GRASS

(USACERL, 1993). The results given by the ANSWERS model and GRASS, were used to build an expert system for soil and water conservation techniques based on a decision three approach (ALES, 1992; Laajili Ghezal et al., 1998). Three criteria were used to build the expert system, slope and land use. The first criterion is erosion using four soil erosion classes based on the tolerance concept. (Troeh et al., 1991). The second one is the slope, considering four slope classes as defined by Arnoldus 1977. The last one is the land use, which is an important criterion to advise the choice of vegetation and farming system. It includes ecological and soil environmental data. Nevertheless, economical, social and cultural conditions might adjust the final choice of the soil and water conservation management. This methodology was applied for one specific autumn event and a scheme of soil and water conservation techniques is presented. The ANSWERS model was used to predict soil erosion for the elaborated scheme, using estimated parameters based on literature data. The results show that the proposed scheme weakly affect hydrological components (runoff after management represents 93% of the runoff without management) but significantly the erosion component, (soil losses after management represents 38% of those without management). The use of this methodology seems to be a good tool for soil and water conservation techniques of small watersheds. However, the accuracy of estimated parameters especially the predivitive situation could affect considerably erosion results. An investigation of the relation between parameter values and the management is useful.

A-0427

Soil Erosion, Greenhouse-Gas Emissions and Climate Change: Using WEPP-CO2 to Model the Impacts in Mato Grosso State, Brazil. Antonio J.T. Guerra, Department of Geography, Federal University of Rio de Janeiro, Brazil, David Favis-Mortlock, Environmental Change Unit, University of Oxford, UK and Flavio G. Almeida, Department of Geography, Federal University Fluminense, Brazil

Present –day policy decisions regarding greenhouse-gas emissions will have implications for the worldwide environmental problems which face future generations. Among these is soil erosion. Anthropogenic emissions of greenhouse gases have already had a discernable effect on global climate (Inter-governmental Panel on Climate Change, 1996). Any changes in the amount, intensity and timing of future rainfall will certainly affect the extent and severity of erosion. Increases in rainfall at times when cropping patterns leave the land unprotected are likely to result in increased erosion. The magnitude of such increases will in part be the result of present-day decisions regarding future greenhouse-gas emissions. This paper makes use of CO2-sensitive version of WEPP to estimate the impacts of greenhouse-gas emissions on future erosion rates at a hillslope site in Mato Grosso State, in the Centre West region of Brazil. The site is in an area with severe present-day erosion problems. These result from the intensive cultivation of soybean on highly erodible latosols. The original vegetation cover in the area was cerrado (savannah): since this has been cleared, soils at some locations have completely lost their A-horizons. Mean annual rainfall in this area is around 1 550 mm, with the rains mostly concentrated between November and April. Corn cultivation leaves the land largely bare during the months of October to December, at the beginning of the high-rainfall period in the southern summer. In addition to on-site degradation, off-site effects of this erosion include water pollution and increased siltation in the area's rivers. Output from General Circulation Models (GCMs) is used here to construct base scenarios of future climate of the WEPP- CO2 simulations. Using the MAGICC model (Climatic Research Unit, 1997), this GCM output is then adjusted in accordance with scenarios of future global greenhouse-gas emissions. The resultant scenario data is then used to perturb time series of daily data generated using CLIGEN. WEPP- CO2 is then run using this data.

Antonio J.T. Guerra

A-0428

Socio-Economic Elements of and Land Water Conservation: The Ghana Experience. V.A. Quayson & F.M. Tetteh, Soil Research Institute of CSIR, Kwadaso-Kumasi, Ghana

Worldwide, many forms of land use has led to land and water degradation. These forms include: agricultural land use, forestry, mining, industry, urban and peri-urban development etc. More than 97% of the worlds food comes from the land resources as such the urgent need for its conservation for future generations. Globally degradation of agricultural land by erosion, salinization and water logging it causing the irretrievable loss of an estimated 6 million ha/yr. In Ghana, about 70% of the population are engaged in agriculture. The rate of land and water degradation has been increasing over the years. The issue of land and water conservation in Ghana is therefore a necessary basis for accelerated growth in agricultural production. The government of Ghana showed great concern by initiating the "Environmental Action Plan" in 1988 to address the issue. In the past various interventions on land and water conservation issues placed very little emphasis on the socio-economic elements, it was then a top-down approach. Of late the realization has come that land water conservation issues fall in the realm of social-micro economics. This paper examines the issues of socio-economic elements that positively and negatively affect the issues under land and water conservation from pre-independence to date in Ghana. It looks at social groups, land tenure, property rights, agricultural practices, rural poverty, community activities, problem ranking, beliefs, taboos, gender analysis, infra-structure, stakeholder involvement, financing etc. The paper goes further to emphasize the importance of integrated approach which is site-specific in soil and water conservation measures. Above all the roles of all stakeholders are critically speit out in land and water conservation measures bearing in mind strongly the socio-economic elements of the people of Ghana.

V.A. Quayson

A-0429

Dynamic Simulation of Land Use and Soil Erosion in Leoss Hilly Regions of Shaanxi and Shanxi Provinces on the Leoss Plateau in China. Shao Mingan and Zhang Hanxiong, National Laboratory of Soil Erosion and Dryland Agriculture, the Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, Yangling, Shaanxi, China

Soil erosion in the hilly region of Shaanxi and Shanxi Provinces is very severe. Unreasonable land use is the main reason to cause the severe erosion. There have been many research reports on the prediction of soil erosion in this region and most of them use regression analysis to predict small-scale erosion of fields or farms. Erosion control practice is made based on the prediction. However this analysis does work well on a large-scale prediction that is most useful for the regional erosion control and sustainable agriculture on the Loess Plateau. In this paper, long-term changes of land use and soil erosion on a large scale are simulated by using a simulation model with systematic running and regulating mechanism. The model is based on the theory of system dynamics. It includes 35 level equations, 70 rate equations, and 185 assistant equations, 45 table functions, and 196 parameters. The results show that in the loess hilly region land use for farming, forestry and grass industries are nonlinear in mechanism and they interrelate each other. This suggest that the structure of land use be adjusted gradually to keep it in dynamic balance. The study also indicates that land use pattern is the key factor influencing the soil erosion in the region. It is possible to reduce the erosion to the minimum by reasonable land use and effective management. To implement erosion control and rational land use is the most suitable agriculture practice to make farming, forestry, and grass industries develop harmoniously and to keep ecological environment well in the loess hilly region.

Shao Mingan

A-0430

Process Modeling of Splash Erosion on Hillslopes on the Loess Plateau in China. Zhanbin Li and Mingan Shao, The Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, Yangling, Shaanxi, China

Based on the experiments of simulated rainfall on the hillslopes on the Loess Plateau in China, a theoretical model for calculating the kinetic energy of single raindrop was developed to calculate the kinetic energy of rainfall. Formulate both for single raindrop and for rainfall event are presented in this paper. The results show that the overland flow on land surface increases with the continuation of rainfall and so does the area producing runoff producing and then the effects of raindrop impact on surface of the hill slope decreases. The rate of splash erosion decreases gradually with the rainfall continuation. A physically-based formula predicting the area of runoff production is also provided in this paper. During the rainfall it is the combination of the overland flow and the canopy on the hillslopes to affect the splash erodibility of soil. The effects can be quantitatively evaluated by the simple equation presented in this paper. The overall results indicate that (1) the peak rate of splash erosion is related to rainfall intensity, rainfall kinetic energy, and slope gradient S and (2) the average rate of splash erosion during individual time period for variable rainfall intensity varies with the rainfall intensity in a time period and rainfall duration of runoff producing area in the period.

Zhanbin Li

A-0431

Soil ecology of a drainage basin in Gazipur District, Bangladesh. S. F. Elahi, M. S. Choudhury, S. M. G. R. Nabi, M. F. Hossain, Department of Soil Science, University of Dhaka, Dhaka, Bangladesh.

Study on soil ecology was conducted in the Pirujali village of Bhaowal Gazipur Union Sadar Thana under Gazipur district. The area has a small drainage basin that is washed mainly by rainwater. Water drains through a constricted channel into river Turag. Emphasis was given on the status of micronutrient elements required for plant growth. These were potassium, calcium, magnesium, iron, manganese, copper, zinc and sodium. Study showed that intensive cultivation was practiced in the whole area and the soils were disturbed extensively. This feature was evident when the content of different nutrients was measured which had no lateral trend. The clay character of the soils dominated the nutrient content. The nutrients were in adequate supply. All the nutrients were considerably above the critical limit for plant growth. It is possible that in some cases, toxic limits may be encountered. The moist condition of the soils had favorable influence on the organic matter content. This feature helped in the retention of nutrients

in the clay-organic complex. Soil ecology of the area showed that the agricultural production might continue in this are for several more years without an intensive monitoring of nutrient supply. Replacement of major nutrients as fertilizers and manure would be enough to sustain adequate crop production.

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A-0432

A Comparison between Ecological and Conventional Rice Farming Systems in Bangladesh. S. F. Elahi, M. F. Hossain, Department of Soil Science, University of Dhaka, Dhaka, Bangladesh, S. K. White, IACR Rothamsted, Harpenden, UK, M. Hossain, S. Sarker, Q. K. Alam, PROSHIKA, I/1 GA, Dhaka, Bangladesh, J.L. Gaunt, IACR Rothamsted, Harpenden, UK, J. Rother, NRI, Chatham, Maritim, UK

General trends in Asia indicate that rice yields are declining. Long-term research plots in experimental stations, which tend to give greater yields than farmers' fields, have found they need to increase the fertilizer input to maintain yields. Similarly, farmers are finding it increasingly difficult to maintain productivity using current management practices, this is mostly due to a decline in soil fertility and organic matter. Integrated farming practices are now becoming more attractive to rural communities. Organic practices declined with the increased access to inorganic fertilizers, which provided a ready supply of nutrients to crops. In Bangladesh PROSHIKA, an NGO, has been promoting ecological farming as an integral part of their social development program. They provide information and training on organic management practices. This paper considers the effects on the soil properties of a minimum of 3 years eco-farming as compared with conventional farming practices. The investigation into the two farming systems is being conducted on farmers' fields in 4 different locations, e. g., Gabtali, Shibgonj, Daulatpur and Dhamrai, in Bangladesh. This 3-year investigation began in May 1997 and initially a base-line soil survey was conducted with samples from the plough layer taken from all 4 locations. The soils were analyzed for macro and micro-nutrients, together with physical properties. Due to the complexity of the farming systems a nutrient budget will be constructed from information on inputs and offtakes from the fields of the different farming systems. Preliminary data from the base-line soil survey showed that long-term eco-farming management led to a low bulk density of 0.94 g cm^{-3}. Overall eco-farming resulted in a larger range of bulk densities (0.94 g cm^{-3} to 1.33 g cm^{-3}) as compared to conventional farming (1.1 g cm^{-3} to 1.29 g cm^{-3}). Across the four villages the average of major nutrients analyzed, N. P, K, Ca, and Mg were greater in eco-farming systems as compared to conventional systems. Additional benefits of eco-farming reported by farmers were increased ease of tillage and greater number of anthropods.

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A-0433

Nitrogen management for no-till corn in succession to black oat. Carlos Alberto Ceretta and Claudir Basso. Soils Department, UFSM. Santa Maria, RS, Brazil

Nitrogen fertilization for corn is done in part at seeding and the remaining as side dress when plants are 40 to 60 cm high. For no-till and in the succession oat/corn, lower N availability in the initial development stages of corn may occur due to immobilization. As an alternative, part of the N could be applied before corn seeding, but by increasing N availability at the early corn stages, when absorption by corn is low, there could be N losses. The objective of this paper was to study N management's for corn cultivated after black oat, and the mineral N in the soil during corn development. This work has been conducted since 1996 at the Federal University of Santa Maria, on a Hapludalf with 11% of clay. The treatments consisted of the following N management's: 00-00-00, 00-30-90, 30-30-60, 60-30-30, and 90-30-30 kg N ha^{-1} applied before seeding - at seeding - as side dress. For the first year only, the N application before seeding increased mineral N levels in the surface soil layer, in the early stages of the corn development. This occurred because the total precipitation since N application before seeding until corn seeding was of 58 mm for the first year and 243 mm for the second year. For the first year, the application of 30, 60 and 90 kg N ha^{-1} resulted in increments of, respectively, 10, 13 and 18 kg of corn grain per kg of applied N compared to the traditional N management, which had an increment of 9 kg of corn grain per kg of applied N. For the second year, due to intense rainfall, the application of N at seeding and the remaining as side dress resulted in greater grain yields. This shows a greater efficiency of N utilization by corn when availability is increased at the early development stages. However, during years with intense rainfall, the application of N before seeding may have reduced efficiency.

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A-0434

Wetlands Of Storage Reservoir Islands. B.R.Grigorjan and T.A.Fashutdinova, Kazan State University, Kazan, Russia

Water lifting and big area flood (and storage reservoir creation) during hydroelectric plant dam construction stipulated the formation of great amount of islands. Wetlands - biogeocenosis periodically flooded or saturated by water, are broadly represented on the islands. The main component of wetlands, determining their functioning, is the soil coverage. We began investigating of Kujbishev storage reservoir island ecosystem in the whole variety of its components of attended aqual and superaqual geochemical landscape of storage reservoir, including island soil coverage, coastal low-water and land biota, bottom layers and water masses. The islands soils are formed in quickly changing conditions of water-air and oxidation-reduction conditions, determined by strong daily fluctuations of water level in storage reservoir not registered in non-regulated river. These fluctuations are caused by hydroelectric plant working peculiarities and drive together-away phenomena. The islands level hight determines, in existing water level fluctuation swing, differences of developing soils saturation here. They form a ontinuous line, beginning from representatives for which rather important part is played by atmospheric water supply, and up to the representatives, which development is determined by systematic flood and continuous additional floods. Island soils belong to two supertype groups: intrazonal and zonal. Intrazonal soils - are those which formation and development is closely connected with storage reservoir functioning peculiarities. The process of intense aquisition of hydromorphism symptoms is still going on in these soils. Inside this group there are three sub-groups, which soils differ by correlation of ground-fluvial and atmospheric factor in creation of their water regime. The soils that are not connected with ground waters and are not subject to floods continue to develop in the zonal direction.

B.R.Grigorjan

A-0435

Monitoring of diffuse phosphorus exports from agricultural soils: effects of rainfall intensity. Fraser, A. I., Harrod, T.R. And Haygarth, P. M., Soil Survey and Land Research Centre (Cranfield University), North Wyke, Okehampton, Devon UK, Soil Science Group, Institute of Grassland and Environmental Research, North Wyke, Okehampton, Devon

Phosphorus (P) inputs to freshwaters from agricultural soils can play a crucial role in accelerated eutrophication. The control of P transfer from agricultural soils is, therefore, important in reducing the proliferation of algal scums and aquatic plant growth. The form and magnitude of P transfer from agricultural soils is determined by spatial and temporal factors. Work to date has focused on the monitoring of peak discharge events, rather than the pattern of P transfer before, during and after discharge. Here we present data from the observation of P transfer during winter rainfall from arable and grassland soils in the UK; particular reference is made to the effect of rainfall intensity on the magnitude and form of P transfer. Discharges along selected hydrological pathways from grassland lysimeters on impermeable soils (haplaquets) were monitored during winter periods. Low intensity rainfall of 0.4 mm hr^{-1} was sufficient to generate discharges from soils reached field capacity. Total phosphorus (TP) transfer rates were highest in composite flow (overland flow + interflow to 30 cm) from undrained soil, reaching 2 g ha^{-1} hr^{-1}. Total P exports along the same pathway from the drained soil were considerably lower (mean transfer rate of 0.08 g TP ha^{-1} hr^{-1} as opposed to 0.35 g TP ha^{-1} hr^{-1} from the undrained lysimeter). Sites for overland flow and drain-flow monitoring of P transfer were selected within fields ranging from 0.2-3.8 ha on conventionally-managed arable land. Sites were situated on highly porous soils (eutrochrepts), described as 'excessively drained' by the USDA soil drainage classification. However, their susceptibility to erosion, owing to the ease of detachment of sand and silt particles under rain impact, which 'caps' the unprotected soil surface. Overland flow was observed when rainfall intensity approached the modest rate of 1.5 mm hr^{-1}. Low intensity rainfall (<2 mm hr^{-1}) produced mean TP transfer rates of 30.5 g ha^{-1} hr^{-1}. In higher intensity rainfall (>9 mm hr^{-1}) mean TP losses of 537 g ha^{-1} hr^{-1} were observed. Higher intensity rainfall increased rates of TP transfer from both grassland and arable soils. However, the contribution of low intensity precipitation to annual TP exports along from both systems was considerable. In the case of the grassland soil, 93.8% from the undrained lysimeter and 95.5% from the drained lysimeter could be attributed to rain events $\leq$2 mm hr^{-1} in the 1996-7 drainage season. This may be explained by the fact that low intensity precipitation accounts for many more hours per drainage season than higher intensity rain.

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A-0439

A vision of 21st Century Agro-Environmental Farming—Integrating Quality and Environmental Management Systems. Liu Chuang, Resource Economics and Social Sciences Division, Natural Resources Conservation Service, USDA, USA

The paper will propose: To implement a conservation certification process in agricultural production based on international quality and environmental management standards. It further proposes that USDA joins with selected volunteered farms to test the feasibility of the approach in the United States for 3 years. If this approach can be accepted by farming community, this integrated farming system of quality and environmental management should become one of the featured alternatives for the farm bill in the year 2002. "Quality and Environmental Management System on Sixty Danish Farms" was a major conservation project initiated by the Danish Agricultural Center in 1994. This was

a three-year project involved in applying the quality standards of ISO 9002, and environmental management standards of ISO 14001(equivalent to British Standards BS 7750). The project goals were: To improve the economic results; improve resources management; demonstrate quality products; evaluate certification; and evaluate the role of agricultural advisers in the entire process. A quality certificate was given to a farm when it developed the proper quality and environmental requirements in its Quality Manual ready for implementation in the farm. The success of Danish farm certification program: The project was completed in 1997. Favorable responses were received from farm advisers and farmers involved in the project. "Out of [final] total 55 farmers receiving their ISO 9002 and ISO 14001 certificates, 43 farmers will continue with their management systems and keep their certificate running - and from 1998 on, they will pay for the certification themselves." Twenty more farms will start their certification process in the 1998. The potential benefits to conservation organizations, namely: Farmers' planning becomes more efficient as they have a definite set of goals and processes to work with; A good process for farmers to educate and instruct employees and suppliers; Helping farmers and NRCS employees and partners who help implement conservation measures learn of the requirements of quality control processes; Third party auditing provides follow-up and monitoring with minimum burden to NRCS; Farmers make clear linkage of their activities with farm and environmental legislation; The direct and personal educational process of the project will be beneficial to limited resources farmers; and NRCS effectiveness and efficiency in providing conservation technical assistance will be evaluated through the project. This knowledge and experience will help NRCS develop better education and information modules for training employees for more effective conservation of SWAPA and cultural resources. Benefits to participating farmers are multiple: To improve the profitability; improve the environment and resources management; demonstrate the quality process in farming including planning, production, and product quality assurance; obtain quality certification, and this might form the basis of the green payment, and potentially higher prices; and Reduce risk of regulation and potential liability. How does a conservation organization prepare and develop the project? Step 1: Authorize a project feasibility study team; Step 2: Select participating farms; and Step 3: Educate and train the participating farmers. The cost for certification and audit of all participating farms in the first year; the continuous assessment or audit for the next two years; and the total cost, including personnel cost and farmers' training cost, for the entire project for 3 years. Recommendation: To place this project proposal into the future legislative proposal.

Liu Chuang

A-0441

All rills are Equal, but some are more Equal than others: modeling the initiation and Development of Hillslope Erosion. David Favis-Mortlock, Environmental Change Unit, University of Oxford, UK, Tony Parsons, Department of Geography, University of Leicester, UK, John Boardman School of Geography and Environmental Change Unit, University of Oxford, UK and Bruce Lascelles Department of Geography, University of Leicester, UK

When rain falls on a hillslope, that fraction which does not infiltrate is removed by the action of gravity. The efficiency of this removal varies markedly from point to point on the hillslope: that transport much of the flow. Rills are also central importance for erosion, since soil lost during the formation of rills accounts for a large proportion of the erosion taking place on hillslopes. An appropriate representation of rill flow and erosion is therefore vital for any model of hillslope soil erosion. In models such as WEPP and EUROSEM, overland flow – following Meyer and Wischmeier (1969) – is conceptualized as consisting of rill and interrill components. Rill and interrill zones are viewed as possessing distinctly different hydraulic characteristics, with different combinations of erosive processes predominating in each zone. Rill flow is assumed to occur in channels, whose cross-sectional areas can change as a result of erosive flow and deposition. However, the notional separation of rill and interrill processes in this conceptual framework fails to acknowledge the physical link that exists between the processes operating in two zones. In addition, its use in erosion models necessitates a logical contradiction. Since the hillslope's surface is seen as consisting of rill and interrill zones, at least one rill must be assumed to exist at the start of a simulation. In addition, practical restrictions of model design mean that existing channel elements cannot be altered in length during a simulation, and new channels cannot easily be added or removed. This static view of the hillslope erosional system is in contrast to the observed dynamism of an eroding hillslope during a rainstorm. The smallest rills (mircorills') are essentially ephemeral, forming when upstream microtopography concentrates flow and being destroyed when deposition or micro-piracy alters this flow. Larger rills are less transient, but still wax and wane in importance following the vagaries of upstream activity. As a result, the balance between rill and interrill zones is shifting and its boundaries indistinct. This paper describes experimental and modeling work, which aims to capture this dynamism. Using ideas from theoretical studies of self-organizing systems, a model has been developed which conceptualizes runoff as a series of discrete 'packets' moving over a grid of microtopographic heights; the resultant flow modifies the microtopography and leads to the formation of microrills and rills. Associated experimental work makes uses of rainfall simulation and digital photogrammetry on a long flume.

David Favis-Mortlock

A-0442

Field survey and monitoring for understanding accelerated erosion and its impacts, and for devising sustainable land use policies. R Evans, Department of Geography, Anglia Polytechnic University, East Road, Cambridge, UK

Good quality information on the extent, frequency and rate of accelerated erosion, be it initiated by cultivation or by grazing, is needed if a sound assessment of erosion risk is to be gained; if the economic and social costs of erosion are to be evaluated; and if sensible environmental protection policies are to be designed and carried out. That information needs also to be based on reality, that is, on what is actually happening in the cultivated field or the grazed landscape. Plot-based research may be scientifically valid and give a good understanding of the processes involved in erosion, but models based on such research may not give realistic appraisals of the severity of erosion and its impacts on the landscape and hence inappropriate conservation techniques may be devised. Because models may suggest erosion rates are much higher than they actually are, farmers may rightly not understand why conservationists want them to protect their soils, for they cannot see the impacts of erosion nor does erosion impact upon the way they work their land. Often, therefore, proposed conservation techniques are considered not economic to the farmer, so they are not taken up unless there is a financial inducement to do so. Also, because the stripping of topsoil is considered by many, because of the predicted high rates of erosion, to be the major reason for the loss in soil productivity, the true cause, the decline of nutrients in the soil as they are removed by crops, is not recognised. In many parts of the world the important impacts of erosion are not on the farm, they are downvalley - for example, flooding, damage to property, sedimentation of rivers and reservoirs, pollution of water supplies by sediment, nutrients and pesticides - and farmers are not necessarily aware of these impacts. The problems may be particularly great in those countries where agriculture is highly mechanised with high fertiliser and pesticide inputs and which also have laws governing the quality of water which are hard to meet because of runoff from the land. Without a realistic appraisal of erosion and sedimentation the best means of controlling runoff, erosion and sedimentation may not be arrived at. It may be that encouraging farmers to use techniques devised to control erosion is a less satisfactory way of tackling the problem of accelerated erosion and its impacts than the bringing about of sensible land use policies by social, economic and political means. Sound land use policies may not only cut down the chances of erosion occurring but will be more sustainable over the longer term. Erosion in the UK will be discussed in the light of knowledge gained from field-based survey and monitoring techniques. The implications of these findings for devising sensible and sustainable land use policies will also be described.

R Evans

A-0444

Working with the farmers to alleviate soil fertility problems: Collaboration between the National Soil and Water Conservation Programme and ICRAF's network programmes in Kenya. Loice M. A. Omoro, Ministry of Agriculture, Soil and Water Conservation Branch, Nairobi, Kenya

Soil erosion and reduced soil fertility are the most common forms of land degradation widely encountered among the small scale farmers of Kenya. In the tropics, soils are often susceptible to these forms of degradation due to the biophysical characteristics of such environments. The problems are exacerbated by poor management of the farms due to the limitations in financial resources. Many technologies to address these problems are being exploited by various research and development agencies. Until recently, extension and research activities did not incorporate farmers in the development and dissemination of any type of technology that would address the farmers' needs and aspirations. However, with the advent of Farming Systems Research (FSR), Participatory Rural Approaches (PRA) and other participatory techniques, the role of the farmers as consumers of these technologies in the development and dissemination of these technologies has been recognised. This paper will discuss how the Ministry of Agriculture, Agroforestry Research Network for East and Central Africa (AFRENA-ECA) ,a Network of ICRAF are working with the farmers together as partners in on-farm research and extension activities. The paper will discuss the network's activities in the Western part of the country to illustrate this collaboration. The activities described include the on-farm trials and adoptions of the simple and cost effective technologies. The technologies include: biomass transfer -whereby biomass from shrubs and tree species' are applied on the farms, planting of nitrogen fixing shrubs of short duration to decrease the fallow period in the improved fallow technology, use of barriers and incorporation of the biomass on the farms to improve fertility in hedgerow planting and the use of shrub species to stabilise the terrace banks for soil conservation. The roles played by the extension agents and the farmers are discussed. The farmers' perceptions of the technologies as well as specific responses by the farmers are given to illustrate the positive attributes of the technologies the farmers have experienced. On the whole, there has been a realisation that some emanate from the collaborative activities which are: (i) *innovation selection for research by farmers*-the farmers are able to identify innovation for research. There were ten shrub species that the farmers had observed to be able to alleviate soil fertility problems. One of these shrubs, *Tithonia diversifolia* was intensively studied and has been incorporated in biomass transfer technology, similarly *Sesbania sesban* in improved fallow technology studies. (ii). *participatory M&E*- the farmers have been able to jointly undertake participatory monitoring and evaluation of technologies and are able to discern which technologies

suit them best. (iii). *Diffusion of technologies*- there has been high incidences of cross transfer of technology among the farmers; for instance, in the biomass transfer technology, 1000 farmers adopted the technology within 5 months whereas only 37 farmers were involved in the research in the beginning. (iv). *adoption and adaptation of technologies*-the farmers are able to adopt and adapt technologies to suit their circumstances from their own observations. For instance, the farmers opted to apply the biomass transfer technology to high value horticultural crops rather than the conventional staples such as maize; in some instances have modified the research designs and methodology. The collaborative venture between research, farmers and the extension staff highly minimises the delay in information transfer from the three different levels. Therefore, development process may be relatively faster than over reliance on specified channels of technology transfer such as through extension service.

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A-0446

Tillage erosion in the Humid Tropics: Rates, effects on Soil Properties , and Approaches to Reduce it. Dr. Keith Cassel and Bir B. Thapa, Department of Soil Science, North Carolina State University, Raleigh, NC USA

Large amounts of soil are eroded annually from tilled, hilly upland soils in the humid tropics. The contributions of tillage operations by animal power to the net movement of soil downslope are only now beginning to be recognized as major contributions to soil degradation. Two studies on Oxisols in the Philippines were conducted to evaluate the rates of soil translocation and erosion as affected by tillage operations. In addition, the effect of several management systems. Study 1 evaluated soil translocation for all combinations of two tillage systems (moldboard plow, ridge) and either the presence or absence of closely spaced contour grass barrier strips. After 20 tillage operations associated with growing 4 corn crops over a 2-year period, the SMDUs were manually recovered using sieves. We assumed that soil material was translocated at the same rate as the SMDUs. Downslope soil translocation was directly related to slope length, percent slope, and tillage method. Analysis of soil samples (0 to 20 cm) four years after the study began indicated concentration gradients with elevation for pH and selected chemical elements. In general, the soil was more degraded at the highest elevation on the landscape and at the highest elevation in the tilled land between adjacent contour grass strips. Study 2 was a field simulation that allowed us to evaluate the effects of soil slope on soil translocation for three animal powered tillage systems: contour moldboard plowing; moldboard plowing up and down slope; and contour ridge tillage. Mean actual soil displacement distance ranged from 24 cm for the 25% slope for the contour ridge tillage system to 134 cm for the 36% slope for up and down moldboard plowing. Using these values we estimate that the mean annual soil flux ranges from 85 kg m^{-1} yr^{-1} for contour ridge tillage to nearly 400 for up and down slope mold board plowing. Contour ridge tillage alone or in combination with contour grass strips have the potential to dramatically reduce the rate of soil degradation in the humid tropics.

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A-0447

Measuring Progress – Landcare and Integrated Catchment Management in Australia. Edward Power, Principal Officer, Land Management and Planning, Department of Natural Resources, Toowoomba QLD Australia

In Australia, Landcare and Integrated Catchment Management are perceived as major forces for achieving sustainable natural resources management. Over the last ten years the community and the Commonwealth and State governments have provided financial and other resources to Landcare and Integrated Catchment Management groups. To a large measure Government has adopted a top down approach with its support and direction for Integrated Catchment Management. Now governments and community groups are legitimately questioning what has been achieved with resources invested in Landcare and Integrated Catchment Management. A strategic focus on outcomes and improved monitoring, review and reporting are now required of Landcare and Integrated Catchment Management. The rationale, driving forces and direction of performance measurement of Landcare and Integrated Catchment Management are examined in this paper. Performance and its measurement are contrasted for smaller catchments and relatively larger catchments. In smaller catchments, one or several natural resource issues such as dryland salinity and soil fertility decline maybe of economic significance and this influences the selection and use of performance measures. However, in larger catchments where there are multiple natural resource issues but no one issue stands out, a concise set of performance measures is required which in aggregate indicate the condition of the natural resources, how organizations are performing and environmental, social and economic outcomes. These performance measures must be appropriate to the scale of the catchment but are part of a suite of indicators, which range from the paddock/ site level to the national/ international level.

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A-0449

WEPS-Lite: Use, Operation, and Applications. John Tatarko, Res. Assist. Professor, USDA-ARS Wind Erosion Research Unit,Throckmorton Hall, Kansas St. Univ. Manhattan, KS USA

The Wind Erosion Prediction System (WEPS) is a process-based, continuous, daily time-step, wind erosion model. WEPS is being developed in response to customer requests for improved wind erosion prediction technology and is intended to be a replacement for the Wind Erosion Equation (WEQ). WEPS will primarily be used for wind erosion prediction, design of erosion control systems, and as a research tool. The WEPS model and software have recently been encapsulated in a simple, graphical user interface, known as WEPS-Lite. WEPS-Lite, through its interface, offers the user the benefit of simplified operation by limiting user inputs and field descriptions. The graphical user interface requests information on field geometries, location, soil, and management practices with the complexity level of these inputs determined by the user. Outputs from WEPS-Lite can be presented in tabular and graphical forms. Outputs include information on total soil, suspension, and PM10 loss from the field, off site effects, weather, and surface conditions for the simulations. Options for periods of reporting are also available.

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A-0451

Potassium release and low molecular organic acids adsorption in soils materials from soils cultivated with *Coffea arabica* L. Giuliano Marchi, Marcelo R. Malta, Vladimir A. Silva, Enilson B. Silva Francisco D. Nogueira, Paulo T. G. Guimarães, Marx L. Naves, Luiz R. G. Guilherme.

The coffee culture have great economic importance and in Brazil the potassium (K) recommendation method have focused the K-exchangeable of soil samples. This method lack in avail soil release capacity of K to plants. K-nonexchangeable extracted by boiling HNO_3 is commonly used to avail your quantity in the soil but without consider your kinetics. Kinetics studies of potassium release from soils can improve our knowledge about its availability in plants rhizosphere. The present study, carried out in 1998, was undertaken to investigate the kinetics of potassium release and to compare with two organic acids adsorption. Citric and oxalic acids effects were studied after kinetics in two soils: Dusky Red Latosol (DRL) and Dusky Red Structured Earth (DRSE) and in your fractions, clay, silt and sand, in HPLC. The results showed in DRSE the low K release with high oxalic acid adsorption and the inverse results happened in DRL clay fraction. Both DRSE and DRL sand fraction the K release is as higher as adsorption of oxalic and citric acids respectively. The other samples didn't had good correlation in this case. These results explain the low response in DRL K fertilization, in S. S. do Paraíso city, M.G., Brazil, admitting the coffee plants exudes low molecular organic acids in quantity to release adsorbed K in clay or present in crystalline complex of soil.

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A-0452

Accelerated Erosion Associated with Infrastructural Development for Rural Settlements in South Africa. H.R Beckedahl & M Moodley, School of Applied Environmental Sciences, University of Natal, Scottsville, Pietermaritzburg, South Africa.

Increasing demand for vehicular access to individual homesteads in rural settlements has resulted in the rapid proliferation of poorly cited tracks in many of the densely populated rural areas of the KwaZulu-Natal and Transkei regions of South Africa. The passage of vehicles across natural areas modifies the surface roughness and infiltration capacity of the soil in addition to causing soil compaction. Consequently, runoff is concentrated as potentially erosive confined flow within the ruts, accentuating the downslope translocation of sediment by wash processes. The study further shows that accelerated soil erosion is not confined merely to the ad hoc development of tracks to informal dwellings. The injudicious siting of cut embankments, road culverts and the poor maintenance of road gutters frequently result in accelerated soil erosion forms. These range from collapsed embankments to gullied road verges, to piped and gullied hillslopes. The present work argues in favour of a fourfold morphogenetic classification of these accelerated erosion forms. Selected case studies show that these forms develop at rates of soil loss varying between 4.3 t/a to 65 t/a. The question of reclaiming erosion damage versus initial preventive measures is explored using cost-benefit analysis. It is argued that optimal development is achieved where infrastructure is cited so as to both concentrate usage and minimise the combination of implementation and environmental costs. It is shown that much of the off site damage could have been avoided with a significant cost saving had local geomorphic processes received due consideration at the time of construction.

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A-0453

Financial Incentives to Achieve Sustainable Land Use: A Demonstration Project in Northeast Germany. Kalettka, Th., Helming, K., Mueller, K., Institute of

Socioeconomics, Center for Landscape and Land Use Research, Muencheberg, Germany

Economically sound agricultural practices often contradict ecological and aesthetic land management objectives. Financial incentive programs are one possibility to promote more sustainable land use practices by identifying sensitive areas and providing financial incentives to landowners for preventing landscape degradation. These incentive approaches require knowledge of the interaction between land management techniques and the natural environment, as well as the determination of ecological standards. The paper describes a project in Germany involving the creation of a state-administered financial incentive program. The demonstration project for application of this program is the young Pleistocene landscape of northeast Germany. Predominately an agricultural region, the terrain is characterized by "potholes", or glacial depressions which collect surface water run-off. Potholes are ecologically important for wildlife habitat and perform microclimatic functions, as well as providing an aesthetic feature to the landscape. In agricultural regions, the potholes may degenerate to eutrophic levels due to agricultural runoff and soil erosion. The objective of the demonstration project is to prevent and reverse the degradation of the pothole landscape due to agricultural practices. The demonstration project includes the following elements:& #61623; collection of the community and societal preferences for ecological evaluations  development of a method for the valuation of the ecological standards  creation of a informational manual to assist landowners in measuring the environmental impacts  development and implementation of a comprehensive transfer system  establishment of an expert panel to provide decision-making support and foster program implementation. It is hoped that the success and lessons learned from this project will encourage a further investigation of other innovative methods to preserve and enhance natural environments.

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A-0454

Effects of Soil Surface Conditions on Runoff and Sediment Delivery from Interrill Areas. Andreas KLIK, and Angelika S. ZARTL, Department of Hydraulics and Rural Water Management, University of Agricultural Sciences Vienna, Austria

Soil erosion processes are divided into two major components: interrill and rill erosion. On interrill areas detachment and transport of soil particles can be observed. Interrill erosion processes are mainly affected by raindrop impact and flow interactions occurring in rain-impacted shallow flows. The objective of this study was to investigate various effects of different parameters on runoff and sediment delivery from interrill areas. We studied six agricultural used Austrian soils, ranging in texture from silt clay loam to silt loam, at three rainfall intensities (40; 60; 80 mm h^{-1}) and three slopes (7.5; 12; 16.5 %). Rainfall simulations were carried out in the laboratory under controlled conditions. Three different initial soil surface conditions were exposed to simulated rainfall events with durations between 60 and 120 minutes: 1) seedbed – air-dried, aggregated soil < 2 cm; 2) wet and sealed soil surface; 3) dry and crusted soil surface. Soil loss, runoff, splash water and splash sediment were measured at 5 min intervals throughout each experiment. Before and after each rainfall simulation soil water content and shear stress were measured. Major physical, chemical, and mineralogical soil properties of the investigated soils were determined. Particle size distribution and aggregate stability of delivered sediment were analyzed as well. Data showed the importance of initial soil surface conditions and shear stress as well as rainfall intensity and slope steepness on runoff and soil loss.

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A-0455

Multiscale simulation of land use impact on soil erosion and deposition patterns. Helena Mitasova, Geographic Modeling Systems Laboratory, Department of Geography, Lubos Mitas, National Center for Supercomputing Applications, Douglas M. Johnston, Department of Landscape Architecture, National Center for Supercomputing Applications, Geographic Modeling Systems Laboratory, University of Illinois-Urbana, Urbana, IL USA, Douglas M. Austen, Watershed Management Section, Illinois Department of Natural Resources, Springfield, IL, USA

Sustainable use of natural resources requires coordination of conservation efforts between a diverse group of individuals and agencies which view and manage the landscape at different scales, from field level by a farmer, to entire watersheds by state or federal agencies. To better support the multilevel management we propose a methodology for watershed characterization and process-based modeling at multiple, spatially variable scales. This approach is aimed at modeling with spatial detail and resolution which make the best use of available data and which are appropriate for the complexity of conditions at a particular location. The distributed soil erosion model SIMWE (SIMulated Water Erosion), based on the Monte Carlo solution of bivariate water and sediment flow continuity equations, is being extended to support modeling with spatially variable resolutions. The implementation uses multipass simulations, starting from a low resolution for the entire watershed and continuing with linked-in simulations performed at higher resolutions within subareas where more detailed data are available and their use is necessary due to the complexity of terrain/land-use configuration. The SIMWE model is designed for applications in areas with spatially variable terrain, soil and cover conditions enabling the capture of spatial aspects of watershed internal behavior. Using the outlined concept and tools, we investigate the impact of land use on erosion and deposition patterns in two different study areas: (a) a pilot watershed in Illinois, that has recently been selected by landowners, non-government organizations and state agencies for implementation of sustainable watershed management practices; and (b) a military installation with a combination of natural areas and severely damaged training locations. We perform multiscale simulations for the current conditions aimed at identification of important sediment sources and sinks, and we evaluate the use of the results for finding effective spatial distributions of conservation measures at a hierarchy of scales.

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A-0458

Applying the SWAT model as decision supporting tool for land use concepts in peripheral regions in Germany. Fohrer, N., Eckhardt, K., Haverkamp, S. and H.-G. Frede, Justus-Liebig Universitat Giessen, Gieben, Germany

In the Lahn-Dill- Bergland in the hilly midlands of the state of Hessen, Germany, agriculture is retreating from landscape due to employment alternatives in various branches of industry and marginal conditions for agricultural production. Thus the amount of fallow land is increasing. To stop this development a collaborative research project (SFB 299) with 19 departments involved was founded at Giessen University in 1997 to develop new concepts of land use and evaluate their economical and ecological consequences. The economical model PROLAND (Möller et al., 1998) is optimizing land use by maximizing agricultural income. It proposes spatially distributed land use options which are evaluated in terms of ecology with ELLA (Weber et al., 1998) and with regard to hydrological changes with the SWAT model (Arnold et al., 1993, 1995). All three models are GIS-based and exchange data via GIS. The continuous-time, grid cell watershed model SWAT (Arnold et al., 1993; 1995) was tested for typical conditions in the project region and a sensitivity analysis was carried out. The Dietzhölze (81,8 km²) and the Aar watershed (61,1 km²) were used to calibrate and validate the model. Based on a DEM with 40 m mesh size, watershed boundaries and division into subbasins were derived with TOPAZ (Garbrecht and Martz, 1997). Land use maps (Landsat TM scenes) and a digital soil map (resolution 1: 50 000) of Hessen (HLfB, 1998) were provided with a raster width of 25 m for the model runs. All relational databases which are implemented into SWAT (Arnold et al., 1993; 1995) such as weather, soil, tillage and crop data were substituted by regional data sets. Different land use scenarios were proposed by PROLAND (Möller et al., 1998) for the two watersheds. The evaluated with regard to their effect on the hydrological balance was carried out with the SWAT (Arnold et al., 1993; 1995) model.

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A-0461

Cumulated soil erosion effect on maïze grain production. Contribution of manure and fertilisers to acid ferrallitic soils rehabilitation in the Burundi high populated hills (Central Africa). Theodomir Rishirumuhirwa, Soil scientist, Ecole Polytechnique Fédérale de Lausane, Labo.IATE, Ecublens, CH Lausanne, Suisse and Eric Roose, Soil scientist at Orstom, Labo. LCSC, Montpellier, France.

Most of the soils of humid tropical mountains of Burundi are very acid ferrallitic soils, deficient in N and P, with very poor food production capacity. On the Central Plateau of Eastern Africa, a very dense population (200 up to 1000 inhabitants /km²) has developped on steep hillslopes (up to 60%) a banana farming system based on recycling all residues under the banana plantation and intercrops cultivated around the home and the cowshed. During 3 years, runoff and soil losses were measured on 6 runoff plots, 8% slope, under banana trees of various densities. Rishirumuhirwa (1997) demonstrated that using banana residues on the contour lines reduced runoff and erosion to acceptable levels. But soil conservation alone is not enough to maintain the food production, when the population doubles each 25 years. The authors tried to improve the soil production potential by manure and mineral fertilisers on agronomic and runoff plots. Test plants where bean, maïze and casava which are the most important food crops with bananas. On agronomic plots, a dressing of 3-6-9 t/ha/year (dry matter) of farm manure increased significantly the production of the 3 crops. Contrary to all expectations, a dressing of 1 -2 -3 -4 t/ha of dolomite did not increase the production. On runoff plots having lost by sheet erosion a total of 0.15, 17, 58 to 154 t/ha/3years, the maïze grain production was decreasing from 1500 kg , 1000, 600 down to 0 kg/ha /year. With a dressing of 6 t/ha of dry manure the yield of dry grain decreased from 2800, 2600, 2000 down to 326 kg/ha. With a complementary dressing of N60+P60+K40 the grain yield increases from 4000 down to 730 kg/ha on not eroded plots. Bringing 500 kg/ha of dolomite reduced slightly the maïze production. Two important conclusions. Sheet erosion has a drastic negative effect not only on the yield of the year but also a cumulative effect on the production soil ability for the future. Secondly, with manure and a complemental mineral fertiliser, it is technically possible to

feed as much as 1000 people / km², but the problem is socio-economic : who will pay for the necessary fertilisers?

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A-0462

Soil and water conservation, land use and management entre Rios provincial service. J. Cerana, I. De Los Santos, E. Albornoz, G. Villanova, Entidad de Programación del Desarrollo Agropecuario, Subsecretaría de Desarrollo Agropecuario, Calle Alem Paraná, Entre Ríos, Argentina.

The Entre Rios Province is located in the De la Plata River basin, Mesopotamia region, Argentine Country,. The lands form characteristic is a undulating topography, 2 to 12 % slope in the agricultural areas. The soils in order of importance by extension, are identifiqued as Argiudolls, Pelluderts, Ochraqualfs and Psaments.(FAO 1973). The management of soils that farmers do, make worse the natural soils and landscape conditions, producing water erosion process (sheet, rill and gully), with a year average of 18 $Mg.(hm^2)^{-1}$ soil lost. Result of them are 1.5million hectares moderately and severely eroded. The Entre Rios Government, has improve different policy on last years, to reverte this situation, responsible of.the 30,5 millons dolars agricultural production yearly lost. Numbers of actions have been apply, the Nacional Conservation Subsidies to incentive the conservation practices through National Law Nº 22428, together a credit to salve the conservation cost and the loan of special machinery to reduce the perform time. From 1989, the Law Nº 8318, propose deduction of territorial tax, to make easier the conservations works. Recently, to speed up the actions, was presented the Soil and Water Conservation, Land Use and Management Entre Rios Provincial Service SECUSA Project by means of SAGPYA to the International Development Bank, IDB Project Provincial Agricultural Development AROO61.PROSAP. The Project will contribute toward improving the Entre Rios´s population standar of living through the reducction, prevent and control of soils water erosión and the quality and efficient use of water on 400.000 hectares by provision of a Soil and Water Conservation Provincial Service. Promote the sustainable utilization of renewable natural resourses by the introduction of appropriate soils conservation and watershed management methods, so that they will contribute to better economic and social devolopment. The site characteristic description by USLE inform a rainfall-runoff factor R average of 600 and soil erodibility factor K 0.5 for Agiudolls and 0.3 for Pelluderts, slope length L largest than 200m and slope steepness S between 2 to 12 percent. The project identified four main courses of action i) Strengthening and equiping of public provincial conservation service; ii) Public and Provincial investment in self-financing agricultural works; iii) Sustainable agriculture and control of water erosion proces; iv) Improvement of interagency coordination. The activities including: a) Technology transfer hiring consultants for the preparation of watershed plans and aid to make the individuals farmer´s plan (participated planning), b) Ensure the conservation action with peoples educatives programs. c) Improvement of available technology by mean of the adaptative investigation. d) Control systems and monitoring soil and water quality. The technological stock of practices include: Terraces and vegetative waterway, Conservation tillage, Crops rotation, Development of nutrient management programs with proper fertilization diagnostic techniques, Crop residue and livestock waste management, Protected crops and Integrated controls of plages. Five farm models was analysed to check the proposal goodnes, with FARMOD and COSTAB software. The estimated total cost is 4.6 US$ millons.

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A-0463

Influence of Vegetation on Soil Loss by Wind Erosion. Dean V. Armbrust

Most wind erosion control measures are designed with some form of vegetative surface cover. These systems may employ shelterbelts, strip cropping, growing crops, and crop residues in various combinations or alone. This presentation will discuss examples of how these vegetative control measures impact the wind energy near the soil surface and how that alteration effects the amount of soil movement by wind.

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A-0464

Potential of conservation tillage to sequester carbon in Australian soils. H.B.So, School of Land and Food, The University of Queensland, St Lucia, R.C.Dalal, Queensland Department of Natural Resources, Indooroopilly, K.Y.Chan, Wagga Wagga Agric Institute, NSW Agriculture, Wagga Wagga, N.M.Menzies, School of Land and Food, The University of Queensland, St Lucia and D.M.Freebairn, Queensland Department of Natural Resources, Toowoomba, Australia.

Organic matter content is one of the major determinants of soil quality, and degradation of soil organic matter is well recognised as an adverse effect of cultivation. However, the consequent release of CO_2 and resultant contribution to the global greenhouse gas problem has received less attention. In the context of the need to reduce CO_2 emission, to reduce the global greenhouse gas problem, and to maintain soil quality to sustain food production, the role and relevance of current soil cultivation practices and their impact on soil organic matter need re-examination. An estimation of the current contribution of agriculture and land clearing to Australia's greenhouse gas emissions, and the current rate of adoption of conservation tillage in Australia, will be presented. Against this, a preliminary estimation of the contribution of cultivation of Australian soils to the emission of CO_2, and a review of long-term tillage trials conducted under Australian conditions will be discussed with a view to estimating the potential of reduced or conservation tillage to sequester carbon in cultivated sub-tropical and tropical soils.

H.B.So

A-0465

Soil Erosion Control for Improving Soil Organic Carbon Content on Tropical Sloping Lands in Asia and the Pacific. Frits Penning de Vries, Adisak Sajjapongse, Anthony Dowling, and Eric T. Craswell, IBSRAM, Bangkok.

Land shortages have forced millions of poor farmers in the Tropics to utilise steeplands that are normally considered too fragile for cultivation. National agricultural research institutions in 15 countries in Asia and the Pacific have recognised the problems of erosion risk and declining soil fertility, and co-operate together in research networks, ASIALAND and PACIFICLAND, to seek solutions. Network research on long-term experiments reveals that current farmer practices lead to declines in productivity, soil erosion and declines in soil organic carbon. The carbon content of the surface soil declines due to loss of the surface soil layer by erosion and the mining of native soil fertility as cropping is intensified. Network testing of a wide range of sustainable land management practices reveals that erosion and runoff can be significantly reduced, and the decline in organic carbon checked, using contour planting of hedgerows of shrubs, crops or grasses. The best results are obtained if strategic nutrient inputs are used to boost plant productivity and replace nutrients exported in the harvested products. The carbon savings may be considerable, adding weight to the case for greater investments in marginal areas like the steeplands.

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A-0466

Comparing GLEAMS, RUSLE, EPIC and WEPP Soil Loss Predictions with Observed Data from Different Tillage Systems. Manuel R. Reyes, K. D. Cecil, C. W. Raczkowski, G. A. Gayle, G. B. Reddy, Agricultural and Biosystems Engineering, North Carolina A&T State University. Greensboro, NC USA

In 1993, we started the Tillage, Runoff, Agricultural Chemicals and Erosion (TRACE) Project at North Carolina A&T State University (A&T). We installed TRACE experimental field plots at the A&T farm located in Greensboro, North Carolina. The design of the TRACE field plots is a randomized complete block design with four tillage treatments and four replications. The tillage treatments were: conventional tillage (CT), strip tillage (ST), no-tillage controlled traffic (NC), and no-tillage full traffic (NF). Runoff volumes and soil losses were measured from these plots since May 1995. We also collected data to evaluate the performance of various erosion prediction models. Input data for the erosion prediction models were collected locally, from literature and from the users manuals. This paper presents a comparison of the soil loss predictions of the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS), Revised Universal Soil Loss Equation (RUSLE), Environmental Policy Integrated Climate (EPIC), and Water Erosion Prediction Project (WEPP) Models with three years of 'TRACE' measured soil loss data from four tillage treatments. We concluded that for the four tillage treatments, none of the four models predicted soil loss satisfactorily. We qualify, however, that this conclusion is *very limited* since it is only based on three years of measured data.

Manuel R. Reyes

A-0472

Local Agroforestry Techniques for Land Stewardship. Mr. Praveen. N. and Dr. B.K. Narayana Swamy, University of Agriculture Sciences, G.K.V.K., Bangalore Karnataka, India

Since decade's soil has been degraded and lost efficiency of production due to soil erosion, run off water, indiscriminate use of water, chemical fertilizers and pesticides. Few local methods for land stewardship has assumed very great significance such as augmenting biomass production through optimum use of natural resources with introduction of perennial tree species, simultaneous and continuous cropping with animals in a temporal sequence and efficient management. High expectations have been raised in recent years about the potential of agrogforestry for land stewardship. Nitrogen fixing trees and shrubs are fast growing, improve soil fertility and serve as cover, fodder and green manure can substantially help to develop land stewardship. So it meets the joint criteria of productivity, practicability and sustainability. Agroforestry potent to be the most efficient and integrated system for land stewardship. This system believed to increase the organic matter levels of the soil. Litter cover alone reduces soil erosion by 95 per cent and increases water holding capacity as compared with bare soil. Studies showed that trees integrated in to cropping system has influenced the growth and yields of corn plants. The most viable land stewardship is to promote soil conservation, minimize nutrient losses and maintaining productivity through application

of low-cost local agroforestry methods. There is need for systematic and organized research into the various facts outlined above in order to generate quantified data that shall have immense value for field application. The primary concern of land stewardship should be to keep up the production level of the arable crops, to achieve it agroforestry is the best solution. The following criteria are worth considering for planting trees for land stewardship like Non-interference with arable crops. Easy establishment, fast growth and short gestation period, non-allelopathic effects on arable crops. Ability to fix atmospheric nitrogen. Easy decomposition of litter, ability to withstand frequents lopping, multiple uses and high returns, ability to generate employment. It is difficult to select species having ability to fulfill all the above criteria. Therefore, the researchers and extension workers can allot certain points for each of the criteria in consultation with the farmers who have taken local action for land stewardship on their fields and select the species which score more points.

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A-0473

Women Participation to Local Action For Land Stewardship. Miss Komala, C.N. and Dr. B.K. Narayana Swarmy, University of Agricultural Sciences, G.K.V.K., Bangalore - Karnataka, India

Women have always been responsible for a major share of food production in Asia, so their role in local action for land stewardship is crucial. The largest number of working women in India are engaged in farming operations either as cultivators or as agricultural laborers. Nearly 50 percent of the population of India are women. The contribution of farm women in agriculture is estimated to be 50-60 per cent both in terms of labor and economic output in India. Though the Government had been encouraging women at different levels, women were not yet to join the main stream of local action for land stewardship. In addition to the Governments rural development policies, local communities, research and development institutions have to play a greater role in the promotion of socio-economic development of the rural women community. Women's importance in local action for land stewardship is of significance to land stewardship, research and extension. Extension is directed to male farmers. It is generally assumed that land stewardship managers and decision makers are men who will pass on information to their wives if they need it, and invisible barriers often prevent women from gaining access to extension information and activities of land stewardship. Hence, based on research studies developed some strategies for women participation. To improve women participation in local action for land stewardship men and women should be viewed as equal partners both at the home front and at the farm level. Researchers need to identify and understand women's role in the land stewardship and generate technologies suitable for women farmers. Extension services to provide more appropriate technologies to women farmers and select the best strategy for reaching them. Strategies to improve farm income through stewardship should be evolved involving professional women experts in every stage like research, decision making , technology development and transfer, The knowledge and skill transfer to rural women should be in line with their socio-economic conditions and literacy status. Increased employment of women in research and extension systems should be encouraged.

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A-0475

Flume experiments for determinating rill hydraulics, erosion and rill patterns. Tingwu Lei, State Key Laboratory for Soil Erosion and Dry land Farming on Loess Plateau, Institute for Soil and Water Conservation, Chines Academy of Sciences, Yangling, Shaanxi Province, PR China and Mark A. Nearing, USDA-ARS National Soil Erosion Research Laboratory, West Lafayette, IN USA

A series of flume experiments were conducted to understand shallow water hydraulics, erosion in rills as well as morphological patterns of a rill as affected by rill bed slopes and inflow rates. The soil used was Cecil soil, a sandy loamy soil. Four flow rates, 1, 2, 3 and 4 gallons per minute and 4 slopes, 1%, 3%, 5% and 7% were adopted in the experiments. The velocities, rill widths and sediment concentrations at the outlet were recorded and analyzed with multivariable regression method as functions of slopes, inflow rate and/or their interactive terms. Rill widths changing along the rill with certain periodical patterns were visually observed. A mathematical model is advanced to describe these changing patterns of rill width.

Tingwu Lei

A-0476

Hydrological and morphological method for research and computation of soil erosion and river sediment parameters. Nelly N.Bobrovitskaya, State Hydrological Institute, St.Petersburg, Russia

Water erosion over the watershed slopes and sediment yield from rivers and temporary streams comprise a general process of erosion and accumulation. It is suggested to use the microwatersheds of the hollows as research objects to study water flow and sediments transport. These hollows may have the following hydrological and morphological definition: they have their microwatersheds either natural or resulted from anthropogenic impact; they occupy the upper position in the hydrographic system; they are spread over all types of soils and subsoils as well as top cover and roughless down the slopes; they have longitudinal profiles and cross-sections variable over slopes as well as pathway network of I-III types which is connected with the lower links of the hydrographic network and has a capacity for self-organization; the subwatershed of the hollow is characterized by its integrity. A method has been developed for a field study of water outflow and sediment yield of different links of the hydrographic network with the use of land and remote-sensing methods. As a result, extensive information has been collected on the formation of water outflow and sediment yield down the plowed slopes during snowmelt and rainfall floods, which made it possible to develop a graphic and analytical model of sediment yield formation down the slopes. This model was later used as a sub-model in a mathematical model of sediment transport at different links of the hydrographic network, including small, mid-sized and large rivers and a temporary pathway network down the slopes. On the basis of these methods an assessment has been made for a number of large river basins in Russia (Don, Volga, Ob, Lena, Amur, etc.) on possible changes in the erosion rate slopes in case of climate change. Besides, sediment transport parameters obtained from the models, are used an assessment of sediment yield as a factor of nutrients and pollutants transportation.

Nelly N.Bobrovitskaya

A-0479

Composting for Home and Industry. Keith Hoddinott, Aberdeen Proving Grounds, MD.

A call for papers is issued for a symposium on the procedures and materials involved in composting as used at homes, in industry and for waste disposal. This symposium is sponsored by ASTM Committees D-18 on Soil and Rock in cooperation with the Composting Council. The symposium will be held October 28-29, 1999 in New Orleans, Louisiana. In recent years, composting has been used as a treatment option for a variety of home, industrial, and commercial wastes. New technologies and equipment have improved for monitoring, handling and processing of the material. This symposium explores the current methodology, equipment, and state of the art of composting. The information presented at this symposium will be of importance to engineers and scientists involved with remedial technologies, municiple officials dealing with a mounting solid waste problem, landfill operators, waste handling and disposal personnel, extension specialists, managers in agricultural operations, as well as, the average gardener and home owner. Therefore, original papers which represent innovative approaches to topics listed below are solicited. The symposium will be organized into three concurrent sessions over two days concerning the topics outlined above. The presentations will be of a 15-20 minute long. We are also soliciting interest in an exhibiters hall. More information is available from the Symposium Chairperson: Keith Hoddinott, US Army Center for Health Promotion and Preventive Medicine, ATTN: MCHB-TS-EHR, Aberdeen Proving Grounds, MD 21010-5422, 410/436-5209, FAX 410/436-8170. Prospective authors are requested to submit a title, a 300-500 word abstract by 28 October 1999 to Dorothy Savini, Symposia Operations, ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. For additional forms call Ms. Dorothy Savini at 610/832-9677. A Special Technical Publication (STP) based on the symposium proceedings is anticipated by ASTM. Main authors will receive a complimentary copy of the volume(s) containing their papers. The main author is the author corresponding with the ASTM publication staff. All published authors may purchase reprints of the papers at cost. The deadline for all manuscripts is 28 August 1999. Papers will be considered for inclusion in the STP even if presentation at the symposium is not possible. The paper submission deadline will be rigidly enforced. All papers not submitted to ASTM by this deadline will not be accepted for the STP. If a paper is submitted after the deadline it may be forwarded to the appropriate ASTM journal to be considered for publication.

A-0480

Profitable Innovative Fertilizing Practices for Sustainable, Site-Specific Soil Fertility Management With Special Reference to Phosphate Rock use in Sudano-Sahelian West Africa. J. Lamers, M. Bruentrup, A. Buerkert, F. Heidhues, Institute for agricultural economics and social sciences in the tropics, Hohenheim University, Stuttgart, Germany

Water deficiencies may play a definitive role in the short run, but the main deficits of the acid, sandy soils predominating in the Sudano-Sahelian West Africa for increasing productivity are the low amounts of organic matter and mineral nutrients, specially Phosphorus (P). This means that crop response to other nutrients is often limited by the absence of P in these soil types. Food security, poverty alleviation and development of the agricultural-based economies in this region can only be anticipated by production increases of the land already under cultivation. Despite the availability of vast amounts of phosphate-rock (PR) deposits in many countries of the region, the use of fertilizer enhancing materials is one of the lowest in the world and rising too slowly to have significant impact of food production in the near future. The use of imported fertilizers is profitable for cash crops, but given the low output prices infrequently for coarse grains. The productivity of staples can be increased by fertilizers, but an increased use will augment the weeding labor requirements, which represents a predominate bottleneck already. Consequently, fertilizer use must be accompanied by labor-easing practices for the gains from the use of fertilizers will be realized. The devaluation of the regional currency (FCFA) in 1994, stimulated agricultural exports, but has increased prices of imported mineral fertilizers. The com-

bined impact of economic reforms, the devaluation and population growth are likely to stimulate demand in food production, but increases pressure on a risky and variable agricultural resource base as well. Therefore, research is challenged more than ever before, to provide profitable, socially acceptable and environmentally sound innovations to farmers in this part of the world. This study specifically analyses the profitability of PR and other innovative fertilizing practices for sustainable, site-specific soil fertility management in Sudano-Sahelian West Africa. It uses data collected during four years in five different locations in Western Niger representing the Sudano-Sahelian in the North till the Sudano-Guinean zones in the southern parts of the West African Semi-Arid Tropics. A second main source of information were previous studies on farming systems, labor demands and prices of inputs and outputs. Profitability was estimated via partial budget (gross margins and net returns), capital budget approaches (internal rate of return and net present value of incremental returns) and risk analysis.

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A-0483

A non-parametric analysis of qualitative and real-valued information for erosion modelling: a case study from Ethiopia. P.J. Albersen, M.A. Keyzer, and B.G.J.S. Sonneveld, Centre for World Food Studies (SOW-VU), Amsterdam, The Netherlands

The application of conventional erosion models is seriously constrained in areas where data scarcity prevails, alike developing countries where emerging socio-economic problems caused by soil erosion require immediate action. Sonneveld and Albersen (forthcoming) proposed an alternative approach for erosion prediction by using an ordered logit model (Greene, 1991) relating expert opinions on erosion hazard to information at hand on soil, climate and land use characteristics. The model uses an intermediate continuous variable whose range is partitioned into adjacent intervals to estimate the ordinal classification. This approach, however, has two limitations. First, the boundaries of the classes are indirectly measured which impedes a clear quantitative interpretation towards measurable policy targets. Secondly, the additive function used in the logit model restricts the accommodation of the non-linear relationships that occur in the erosion process. This paper aims at a quantitative characterization of the qualitative classes and investigates the functional form of the relationship that exists between the real valued data and limited information on explanatory variables. The technique used in this study is a non-parametric analysis that applies a kernel density regression (Bierens, 1987) to characterize and visualize a data set that containing variables on the water erosion process. It estimates missing values on unvisited sites while its flexible functional form allows to closely follow the observed data and reveal non-linear relationships. It is amenable to statistics in that it generates information on the likelihood density and 'fit' of the estimate. The analysis is facilitated by 3-D graphs that map the dependent variable out against two independent variables, for fixed values of other independent variables while information on statistics is shown in surface plot and ground plane. The study uses data on soil and land characteristics and some real-valued data on soil loss obtained by the Soil Conservation Research Project (SCRP; courtesy of Centre for Development and Environment, Bern) in Ethiopia. Numerous qualitative observations on erosion hazard are obtained via a questionnaire that was completed by nine Ethiopian and international soil erosion experts related to the SCRP. They gave a qualitative assessment on a scale of five (1=no erosion, 2=slight, .., 5=extreme) to well-described sites under six different types of land uses. The non-parametric technique estimates the missing quantitative dependent variables for each qualitative observation to generate a distribution of real-valued data for the qualitative classes. Further, we examine the shape of the regression curve of the 3-D graphs and propose a functional form describing the relation between real-valued soil loss and limited explanatory data.

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A-0484

Validation of New Generation Soil Erosion Models Using Cesium-137.

Traditionally, soil erosion models have been validated using sediment discharge data. Such data provide no information regarding the spatial distribution of erosion and deposition within the watershed. We usedcesium-137 to assess the long term spatial distribution of soil erosion and deposition within a small watershed near Killeen, Texas. Cesium-137 is a by- product of post-World War II nuclear testing. It has been deposited as fallout on watersheds around the world where it is bound semi- permanently to soil particles. Increases or decreases in cesium- 137 in the soil profile are directly related to sediment deposition and soil erosion, respectively. The erosion/deposition patterns derived from the cesium measurements were used to evaluate the capabilities of two process-based models that predict the spatial distribution of erosion and deposition. The Unit Stream Power Erosion and Deposition (USPED) model predicts erosion and deposition for a steady state transport capacity limited case of sediment transport. The SIMulated Water Erosion (SIMWE) model is based on the solution of sediment flow continuity equations used by the Water Erosion Prediction Project (WEPP)in a general, bivariate form, suitable for complex terrain. Comparisons of cesium measurements with the modeled distribution of erosion and deposition provide insights into the relative importance of various phenomena influencing erosion and deposition patterns and processes.

A-0485

Runoff and Sediment Yield Simulated from Goodwin Creek Watershed Using AnnAGNPS. R. L Bingner, F. D. Theurer, C. V. Alonso, and W. Merkel, USDA-ARS-NSL, Oxford, MS USA

Long term evaluations of best management practices that control runoff and sediment yield from watersheds, can be assisted using simulation models. Goodwin Creek Watershed (GCW), located in northern Mississippi, was simulated for 10 years using a deterministic simulation model, AnnAGNPS (Annualized Agricultural Non-Point Source pollutant loading model). GCW contained 14 instream measuring stations for runoff and sediment yield. Each measuring station represented an outlet of one or more nested subbasins, which were each simulated separately and routed to each outlet using AnnAGNPS. Each subbasin was described using the topographic analysis package, TOPAGNPS, and then integrated with AnnAGNPS, to determine input parameters. Storm event rainfall was measured individually from one raingage for the entire watershed. Results will show the applicability of AnnAGNPS to simulate the runoff and sediment yield on a daily and yearly basis. The results will also demonstrate the applicability of the model to determine risk assessments for large watershed systems. This modeling tool can be utilized by personnel in action agencies, such as NRCS, involved in evaluating the overall watershed response to BMP's. In addition, other action agencies such as the USCOE can apply this model to other channel modeling components with the AGNPS 98 watershed evaluation tool to the design and placement of instream grade control or bank protection measures. These tools are important in reducing the pollutant loadings associated with implementation of effective erosion control measures within ungaged watersheds. An increased understanding of the interrelationship between watershed processes can result as improved modeling tools, such as presented in this study, are developed.

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A-0486

Land Use Planning for Sustainable Land Use - The Haziness of a Paradigma. Dr. Eckehard Fleischhauer, Ministerialrat retd., Federal Ministry for the Environment, Bonn, Germany

Whatever the concept of sustainable development encompasses, everybody will agree that sustainable land use (SLU) is one of the imperative presuppositions. If so, it has to be defined what SLU really and operationally means and how SLU can be planned on a regional level. Political goals are crucial as well for the definition of SLU as for the planning approaches. The paper will address important contemporary objectives in the European Union - particularly for economic growth, increasing employment and adjusting agriculture - which strongly affect land use development. Main issues for discussion regarding the quality of land uses and landscapes are: - diffuse and direct substance inputs into the ecosystems with impacts for the balancing functions of the substance and energy flows - particularly the effects of acidification, eutrophication and accumulation of persistent toxicants, - consumption of land for uses linked with a loss of the balancing functions named before and of the natural habitat functions for biodiversity, - disturbances of the water infiltration and retention capacity of the land caused by the alteration of the vegetation cover and surface sealing. In order to tackle land use problems which arise on one side from economic demands for land conversion and on the other side from requirements to protect the steady states of substances and energy in ecosystems and the resilience and identities of landscapes in all countries of the European Union a sophisticated land use planning system has been established in the course of the last decades. The paper will briefly describe the interlocking of the planning procedures for urban, agricultural and infrastructural development with the planning means for nature conservation and the avoidance of land pollution. In this context the importance of formal rules for the consideration and weighing of economic claims and ecological needs has to be stressed. Legal backing of measures appropriate to achieve the objectives of nature conservation, reliable regulation for land use planning and the endeavor of people and non-governmental organizations as stakeholders in the struggle for preserving the natural environment are effective instruments and powers in high-developed countries. They have not at least to compensate deficiencies of ecological knowledge due to the complexity and time dimension of natural processes. Some examples from the Northern European regions will show both the tasks of defining land and landscape quality and approaches to meet the objectives of land use planning for sustainable land use. It seems to be on time to analyze the concepts of land development and the experiences with land use planning procedures and the institutional cooperation in developed countries in more depth and with methods which incorporates ecological, economic, social, legal and political criteria for the assessment whether sustainable land use can be achieved.

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A-0487

Multi-Agency Partnerships Supporting Soil and Water Conservation. Robin Shepard, Water Quality Coordinator and Assistant Professor for Natural Resources, University of Wisconsin-Extension, and Department of Agricultural

Journalism, UW-Madison, Don Baloun, Assistant State Conservationist, USDA, Natural Resources and Conservation Service - Wisconsin

Current restructuring of conservation programs at the state and federal levels provide opportunities for building new educational initiatives and multi-agency partnerships. In Wisconsin, the agencies responsible for soil and water conservation programs have formed a unique partnership that supports land and water education through the state. In 1997, University of Wisconsin - Extension, in consultation with state and federal agencies and public and private sector partners, formed a collaborative approach to sharing financial and programmatic resources. This multi-agency partnership focuses on delivering educational programming along river basin lines and specifically includes: Pooling agency resources of over $1 million in funding from: the Wisconsin Department of Natural Resources; the University of Wisconsin-Cooperative Extension Service; and the Natural Resources Conservation Service through the Environmental Quality Incentive Program (EQIP) of the Federal Agricultural Improvement and Reform Act of 1996 (The 1996 Farm Bill); Delivering educational assistance using a network of basin educators who focus on manageable geographic areas and target audiences; Making available local competitive grant programs for implementing education programs that are part of overall conservation efforts at the county and soil conservation district levels; Forming an interagency Land and Water Education Team to provide overall coordination of educational programs, local staff training and interagency collaboration of program and financial resources; Identifying and strengthening the statewide supporting programs local soil conservation efforts. This presentation will describe how multi-agency partnerships were achieved, benefits from such efforts and impacts.

Robin Shepard

A-0488

Environmental McCarthyism and the Precautionary Principle-What can we learn from the past while seeking alternate solutions? D. Brook Harker, PFRA, Analytical Division, Agriculture and Agri-Food Canada, Regina, Saskatchewan, Canada, and Darrell R. Corkal, PFRA, Water Quality Unit, Agriculture and Agri-Food Canada, Saskatoon, SK, Canada,

Throughout history, mankind has been quick to suspend conventional rules of reason and justice when the public good was otherwise perceived to be unduly threatened. While sometimes for the better, multiple examples exist to devastating effect. During the era of McCarthyism in the mid 20th century, for example, one had simply to be accused of being a communist, and the onus was on the accused to prove otherwise a virtually impossible task. In more recent times such sentiments have shifted to environmental topics like the effect of agriculture on soil and water quality, with agri-chemicals as the surrogate suspect in a relationship it is said might negatively affect humankind and the entire ecosystem. The stakes have clearly risen with such claims, but the basic issue remains the same at what point is there sufficient evidence to warrant action, and when is it imprudent to do so? In today's classical science, the null hypothesis is the general principle of evaluation that is, unless a change can be documented, nothing beyond chance is assumed to have occurred. It is similar to the >innocent until proven guilty dictum of criminal law. But some think that where the environment is concerned, the time has come to abandon the null hypothesis in favour of a far more conservative approach, labelled the Precautionary Principle. This viewpoint holds that the environment is too hard to understand and too difficult to fix, to justify assuming there is no negative effect until society has irrefutable evidence to the contrary. Moderate interpretations of this approach propose that society should place less emphasis on traditional risk assessment and cost/benefit analysis, while still allowing such techniques to be used to effectively compare alternatives. In its harshest application, the precautionary principle might require new products to prove they have no negative effect on any aspect of the environment before approving their introduction. Some people feel that the classical scientific approach has failed to identify real agri-environmental hazards, hence the need to invoke the precautionary principle. They say that action is needed now and warn that to wait for absolute proof is to invite disaster. Others believe this philosophy is simply a veiled form of Environmental McCarthyism. They caution that such steps are unduly alarmist, aimed at bypassing rigorous scientific technique while imposing personal agendas. What can we learn from the past, while still being open minded enough to invoke changes in procedure where warranted? The answer surely lies somewhere between these two points of view.

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A-0489

Surface Runoff and Soil Losses from Conventional, Strip and No-Tillage Systems. Godfrey A. Gayle, C. W. Raczkowski, M. R. Reyes, G. B. Reddy, Department of Natural Resources and Environmental Design. North Carolina A&T State University. Greensboro, NC USA

In the Piedmont, considerable research has been conducted showing the benefits of conservation tillage over conventional tillage. Most evaluations have mainly focused on the benefits of conservation tillage with respect to rainfall capture and retention, but few have directly evaluated runoff and erosion. Therefore, in 1993, we started the Tillage, Runoff, Agricultural Chemical and Erosion (TRACE) field experimental project. The design of the TRACE field plots is a randomized complete block with four tillage treatments and four replications. Reported in this paper are three years of runoff volume and soil loss measurements for three tillage systems: Conventional (CT), and Strip (ST) Tillage, and No-Tillage Controlled Traffic (NC). We found that: (i) average annual runoff volumes for CT, ST, and NC were 417, 383, and 314 mm respectively; (ii) average annual soil losses for CT, ST, NC were 89, 7, and 3 tons/ha, respectively; and (iii) for the entire three years, 90% of the soil loss for CT (242 tons/ha), 40% of the soil loss for ST (8.4 tons/ha), and 28% (2.5 tons/ha) of the soil loss for NC were due to a series of storms which occurred from July 16 to 30, 1997 totaling 269 mm.

Godfrey A. Gayle

A-0490

Soil Strength Related To Soil Management And Combine Tire Traffic. V.R. Silva, D.J. Reinert, J.M. Reichert. Federal University of Santa Maria, Brazil

Soil strength has long been recognized as affecting root growth and amount of energy needed to break soil. Soil strength is related to compaction, and also to soil bearing capacity, leading one to seek for high soil resistance to support loads without restricting root growth. The objective of this study was to evaluate the increase of soil strength caused by combine traffic zone on a clayey Haplortox (470 g kg^{-1}) under no-tillage and chiseling soil management for summer and winter cash crops. For both areas, soybean was seeded in November of 1997 and harvested in April of 1998. The soil strength was measured at two times after soybean harvest, using a hand held penetrometer connected to an inside datalogger storing data each 15 mm soil thickness. Soil moisture was measured each time and varied from first to second soil resistance measurements. The soil strength was measured in both soil management, at the combine's front tire tracks and at no-traffic areas (adjacent to tire tracks). At the time of first measurement, soil moisture was higher and overall penetration resistance data were lower than 1800 kPa. No-tillage areas had higher soil resistance since the state of compaction was higher than chiseled areas, especially from 7.5 to 17.5 cm depths. When soil moisture was high, the cone index was 1.6 times greater for no-tillage than for chisel, while when soil moisture was low this difference was of 3.0 times, implying greater state of compaction. After combine tire trafficking, the soil resistance increased significantly for 5 to 25 cm depth at chiseled area as compared to no-traffic area. For no-tillage, the increase in soil resistance was low, implying low additional compaction. The effects on compaction were amplified when soil moisture was low, clearly indicating the need to quantify the complicated relationship - soil moisture vs state of compaction vs tire pressure vs soil strength vs potential soil strain. The soybean yield was not affected by soil management indicating that actual state compaction of no-tillage is not limiting to soybean production.

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A-0491

Soil quality of very fragile sandy soils from South Brazil. T. J. C. Amado, D.J. Reinert, J. M. Reichert, C. Aita. Federal University of Santa Maria, Brazil

Very fragile sandy soils have long been known as have high erosion susceptibility, low water retention and low mineral storage. There is significant area of these soils at south Brazil where substitution of native grass field by grain production in conventional tillage(CT) caused an intense degradation to an extreme of no-vegetated sandy surface (NVSS). This study aimed to measure indicator toward assessment of soil quality under various land uses. The study were carried out at a farm selected due have NVSS (around 400 ha) and soil Quartzipsamment. The annual average precipitation is 1511 mm with regular distribution. It was evaluated four land use: 1 - Eucalyptus forest (nine years, 40 g kg^{-1} clay); 2 - Native grass field (40 g kg^{-1} clay); 3 - NVSS (20 g kg^{-1} clay); 4 - CT(30 g kg^{-1} clay). The measured soil physical indicators in 0-3, 5-8 and 10-13 cm depths were Ksat, porosity, water retention curve, bulk density. Water aggregate stability was measured for 0 to 5 cm depth. The measured soil chemical indicator in 0-2.5, 2.5-5, 5-7.5, 7.5-10 and 10-20 cm depths were total organic carbon (TOC), total nitrogen (TN), Ca, Mg, Al extracted by KCl and, K and P extracted by Mehlich-I. The physical attributes indicate extreme state of degradation at NVSS, with almost 980 g kg^{-1} sand where the water retention is mainly stored in larger soil pores between 288 µm and 48 µm with very high saturated hydraulic conductivity. In NVSS was observed complete absence of aggregation. Water aggregate stability rank was Eucalyptus > Native grass field > CT. The soil physical differences among soil use were closely related to TOC at soil surface which in turn looks like to be the driven force resist soil degradation. The Eucalyptus forest was the system more efficient to retain soil TOC with stock of 15.7 Mg ha^{-1} higher than NVSS, in 0 to 20 cm depths. The greater proportion of CEC of these soils is due to TOC, thus, the low TOC of NVSS represented a significant lost of soil CEC causing soil exchangeable bases leaching leaving high Aluminun saturation. The later restricts plant growth, reduces soil cover, creating an environment prone to wind erosion.

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A-0492

The Verde River Watershed: A Changing Landscape. John Parsons, Verde Natural Resource Conservation District, Camp Verde, Arizona USA

The Verde River Watershed covers 6,600 square miles in the heart of central Arizona. One of the state's largest perennial streams, the Verde River is free-flowing for about

125 miles before reaching Horseshoe Reservoir near Phoenix. The watershed is a major source of water for the Phoenix metropolitan area. Population of the watershed is currently around 125,000 people. Major cities include Camp Verde, Cottonwood, Payson, Prescott, and Sedona. The watershed is also home to four Indian Communities. Almost two-thirds of the watershed is managed by the U.S. Forest Service. Another 23% is in private ownership, with 10% in State lands, and the remaining 2% in American Indian lands. Major trends within the Verde Watershed include: rapid population growth; Increasing water uses; Urbanization of agricultural lands; Changes in natural resource uses (Grazing, Timber, Mining, Recreation). Efforts to Protect the River include: Wild & Scenic River designation (1984); Verde River Greenway established (1986); Riverbed sand & gravel operations cease (1989); Verde River Corridor Project completed (1991); First Verde Watershed Conference (1992); Verde Watershed Association formed (1993). Verde Watershed Association (VWA): Organized by diverse stakeholder base; Common interest is maintaining the river ecosystem & local economy; Community-based & locally led; Members include landowners, business operators, environmentalists, Natural Resource Conservation Districts, towns, cities, counties, state & federal agencies. VWA accomplishments include: Watershed conferences; Verde Cooperative River Basin Study; Newsletter to 4,000; Website (www.verde.org). Major natural resource challenges include: Reduced river flows; Water supply problems; Wastewater disposal; Water quality degradation; Riparian areas declining. Major socioeconomic challenges include: Anti-federal sentiments; Fragmented leadership; Increasing litigation; Decreasing commodity use; Agricultural sustainability. In summary, the Verde Watershed faces these crossroads questions: Will local people control the watershed's destiny?; Can the challenges be met?; Will the river ecosystem survive?

John Parsons

A-0493

Physical indicators of soil quality on management systems from Cerrado Region in Minas Gerais State, Brazil. M.L.N. Silva, N. Curi, Universidade Federal de Lavras, D.E. Stott, USDA-ARS National Soil Erosion Research Lab, West Lafayette, IN USA, A.N. Beutler, Universidade Federal de Lavras, J.C. Cruz, and I.A. Pereira Filho, Empresa Brasileira de Pesquisa Agropecuária – Centro Nacional de Pesquisa de Milho e Sorgo (Embrapa-CNPMS), Sete Lagoas, Minas Gerais, Brasil.

The soil is a natural resource important to tropical ecosystems. Various forms of soil degradation can occur over time if management is inadequate. The direct consequences of soil degradation are erosion, productivity reduction, and loss of ecosystem sustainability. The use of physical indicators of soil quality is an important strategy for evaluation of sustainability of management systems. This study aimed to use soil phusical characteristics to assess the soil resource placed under management systems commonly used in the cerrado region. The study was conducted at the EMBRAPA-CNPMS station in Sete Lagoas, Minas Gerais, Brazil. The regional climate is considered to be savanna seasonal tropical, or type Aw (Köppen). The soil is an allic, very clayey texture, with gentle undulated relief. It is classified as a Dark-Red Latosol in the Brazilian soil taxonomic system, or as an Acrustox in the U.S. system. The native vegetation is semideciduous tropical cerrado. The management systems studied were: conventional till with disk plow, conventional till with harrow, and no-till under continuons cultivation with corn, and conventional till with disk plow, and no-till corn and bean rotation. A site remaining under the native cerrado was included for comparison. The sites had been under the current management systems for 6 years. Values for the geometric average diameter ranged from 1.94 to 4.42 mm. The penetration resistance ranged from 0.56 to 4.92 MPa, and permeability measurements were 4.6 to 115.0 mm h-1. The higher values for penetration resistance were registered in the 20 to 30 cm depth. The organic matter content had a significant positive correlation ($P < 0.05$) with the geometric average diameter ($r = 0.95$) and permeability ($r = 0.96$), and a negative correlation with the penetration resistance ($r = -0.92$). Based on this study, it was concluded that no till management resulted in bigger, more resistant and more porous aggregates. This was probably due to the increased organic matter in the no-till. The no-till sites however also exhibited more penetration resistance and lower permeability than the other systems. This is probably due to winter dry period, difficulty in building-up a crop residue layer at the soil surface.

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A-0494

Development of the long term hydrologic impact assessment (LTHIA) WWW systems. Kyoung Jae Lim, Bernard A. Engel, Department of Agricultural and Biological Engineering, Purdue University, Budhendra Bhaduri, and Jon Harbor, Department of Earth and Atmospheric Engineering, Purdue University, West Lafayette, IN USA

In urbanizing watersheds, conversion of non-urban land uses to urban areas leads to increased imperviousness and consequently increased runoff. Urban areas have been recognized as a significant source of Non Point Source (NPS) pollution. Several models have been developed to assess event-specific non point source loading from urban areas. LTHIA/NPS is a Curve Number (CN) based model which can be used to predict long-term runoff and non point source pollution from urbanizing watersheds. The LTHIA/NPS model was recently linked to the ArcView® Geographic Information Systems (GIS) to effectively analyze the spatial and temporal characteristics of runoff and NPS pollution. A user-friendly LTHIA/NPS WWW interface is being developed using Java/Java Script, HTML, and CGI Scripts. Land use and soil maps will be provided on the WWW and precipitation data can be accessed from databases for a number of weather stations in the US. This interface will provide easy access to the model and improve understanding of the results through graphical representation. Users will be able to simulate the impacts of land use changes on runoff and NPS pollution and examine the results via their WWW browser. This WWW-based tool can be used to assess long-term hydrologic impacts of land use change by educational institutions as well as land use planners, and other environmental professionals.

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A-0495

Dynamics of Contaminants from Snow Melt and Rainfall Runoff Entering Surface Tile Inlets on Lacustrine Landscapes. Daniel Ginting, John F. Moncrief, and Satish C. Gupta

Much of the soils in the upper Midwest require improved drainage for profitable crop production. In landscapes that have Aprairie potholes@ (no outlet) water that accumulates must be drained quickly to minimize delayed field operations in the spring and crop stress during the growing season. Risers from subsurface plastic tile opened at the soil surface provide a direct pathway for runoff and potential contaminants to enter rivers and lakes. Little is known about the dynamics of soluble and particulate pollutants that are delivered to these inlets that may remained ponded for several days. The watersheds of two prairie potholes 44.3 and 51.7 ha in size on a lacustrine landscape were cropped in a corn-bean rotation under a chisel plow based conservation tillage system from 1995 to 1998. Tillage operations were: 1) fall chisel plowing, spring field cultivation, and summer row cultivation for soybeans following corn and 2) spring field cultivation and summer row cultivation for corn following soybeans. Soils are clay loam in texture and have very poor drainage. Runoff and associated pollutants(Suspended Solids-SS, Chemical Oxygen Demand-COD, Total phosphorus-TP, Particulate Phosphorus-PP, Dissolved Reactive Phosphorus-DRP, Ammonium-AN, and Nitrate-NN) were measured . The runoff volume was measured with automated water velocity sensors and pressure transducers. Water composite Agrab samples@ were taken with an automated sampler every 2 hours. A few major snow melt and rainfall runoff events were responsible for most of the losses and resulted in ponded water at the inlet for 3 to 4 days. During snow melt events most of the TP was in the DRP form and the relative proportion increased with time. The NN concentrations also increased with time. The SS and COD concentrations were small. During rainfall runoff events SS and COD concentrations were much higher than in snow melt and decreased rapidly with time. Most of the TP was in the PP form. The NN concentrations were similar to snow melt but the increase with time was not consistent. The losses were small due to the small volume (based on a per area basis). In summary the ameliorating effect of the particulate settling in the ponded water at the inlet reduced these losses. In contrast, increased concentrations of soluble constituents with time increased these losses.

A-0496

The Mississippi Delta MESA Program. S. M. Dabney, USDA-ARS, National Sedimentation Laboratory, Oxford, MS USA, R. A. Rebich, U.S. Geological Survey, Pearl, MS USA and J. Pote, Mississippi Water Resources Research Institute, Mississippi State, MS USA

The Mississippi Delta, comprising about 17000 km2, has some of the most productive farmland in the United States. The primary crops are cotton, soybean, corn, rice, and catfish. In 1994 the Mississippi Delta Management Systems Evaluation Area project (MDMSEA) was initiated as a unique partnership of federal, state, and local agencies and landowners to develop innovative and competitive farming systems that simultaneously increase or maintain profitability while improving quality of surface, shallow groundwater, and lake water resources. The approach taken was to closely monitor land use of the watersheds of three oxbow lakes, closed basins draining into cutoff river meanders, and determine the impacts of best management practices (BMP's) on water quality; fish growth; and crop yields. By working with closed systems, the impacts of land use on receiving waters is being assessed without confounding influences of upstream influences. The primary research agencies involved in MDMSEA are the USDA Agricultural Research Service, the U. S. Geological Survey, and the Mississippi Water Resources Research Institute. There are 11 land owners and at least 15 other agencies and organizations directly involved in the project that is part of a national program entitled Agricultural Systems for Environmental Quality (ASEQ). One of the watersheds has been managed with a combination of agronomic and structural practices, one with only edge-of-field structural practices (filter strips and slotted-board risers), while the third catchment has received no structural practices. Specific BMP's evaluated include: conservation tillage, cover crops, grass filter strips, slotted board risers (to pond water on the fields during the winter), and innovative weed control and precision agriculture technology. Results obtained to date indicate that BMP's have improved water quality and fish production in the lakes. A weed_sensing sprayer has reduced herbicide applications and appears attractive to farmers. No nutrient or pesticide problems have been observed in shallow groundwater. A socio-economic component to the project has determined local attitudes and knowledge about

agriculture's impact on the environment and its importance to the community.

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A-0497

A new surface dust-sampler, called "Kunstra-Sampler" and the comparison between this and the standard method in Germany. Hannoschöck, Eric ; Höke, Silke & Burghardt, Wolfgang, University of Essen, Institute of Ecology, Applied Soil Science, Essen, Germany

In urban and industrial areas surface dust are emitted from soil. These soils are mostly contaminated by heavy metals or other kinds of harmful substances. Until now in Germany dust deposition measurements are done in a height of 1.5 m (Bergerhoff-Method, VDI 2119, Sheet 2). The input of atmospheric matter is determined over a planned period of measurement by exposing the collection pots. With this standard method the amount of dust entry into the urban soils is not determined exactly because the dust transport below a hight of 1,5 m is not collected. The aim of this work is the development of a new dust sampler at the surface. The two main requests on the sampler are: 1. Direct and precise measurement of dust deposition on soils; 2. Supply of enough material for further analyses. These demands are solved by the "artificial lawn" Sampler (Kunstra-Sampler) developed at our institute. The Kunstra-Sampler has a surface area of 0,12 m² and a volume of 20 litre. The length of the blades of grass is 2 cm. The developing of this sampler is part of the project "Release and Deposition of Surface Dusts on Industrial Areas". The investigation of the samples will be done on different heavy metals, grain size, Carbon-Nitrogen-Sulphur (CNS) etc. The analyses will focus on the quantitative and qualitative relationships between all kinds of heavy metals and the grain sizes of these dusts.

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A-0498

Physical and compressibility parameters as affected by phosphate adsorption in tropical soils. Reginaldo B. Silva, Jose M. Lima, and Moacir . Dias Junior· Department of Soil Science, Federal University of Lavras (MG) - Brazil

High phosphate adsorption in oxidic tropical soils changes the charge balance on surface of particles and can increase dispersion. Consequently, it can affect pore size distribution, aggregate stability and resistance to compaction. In order to measure the effect of phosphate sorption on compression curves and consistence parameters, a Dark Red Latosol - LE (very fine, allitic, isothermic Typic Hapludox) and a Cambisol- C (very fine, isothermic Oxic Distropept) were sampled at 0-3 and 27-30 cm depth, at Campos da Mantiqueira Region, Minas Gerais State, Brazil. Phosphate solution was added to half of the samples so that the P adsorption capacity could be reached. Preconsolidation pressures were obtained from compression curves, which represents the bulk density of soil as a function of log of applied load. Liquid, plastic, and contraction limits were also measured for each sample under both P and no P conditions. The results showed a shift on compressibility curves towards lower preconsolidation pressures as moisture increased and P was adsorbed to samples. The shift was more pronounced on LE samples, mainly at 0-3 cm depth. Phosphate adsorption decreased the load support capacity of soil and changed consistence parameters, decreasing the range of friability and, consequently, affecting traficability and workability of soil.

Reginaldo B. Silva

A-0499

Science and Technology for Conservation Planning and Assessment. Fernando Pruski , L.N. Rodrigues, D. D. Silva, UFV, Dept. De Eng. Agricola, Universidade Federal de Vicosa, Vicosa, MG, Brazil

A new method was developed to estimate the maximum runoff depth under conditions of natural rainfall using the intensity-duration frequency equation to calculate the intensity of rainfall and the Green-Ampt to estimate the water infiltration in the soil. Knowing the intensity and duration of rainfall it was possible to calculate the return period using the intensity-duration frequency equation. The runoff was determined subtracting the intensity of rainfall from the infiltration velocity during the interval of time that the intensity of rainfall was bigger than the infiltration velocity. The method was analyzed for different conditions of soils and rainfalls and the results were very close to those observed.

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A-0501

Impact of waste water irrigation on indigenous AM fungi populations in Central Mexico. Ortega-Larrocea Pilar, Siebe-Grabach Cristina, Departamento de Edafología, Instituto de Geología, Universidad Nacional Autónoma de México, México D. F, Bécard Guillaume, Laboratoire de Mycologie Végétale, Université Paul Sabatier, Toulouse, France.

Since the beginning of this century, waste water from Mexico City is used to irrigate agricultural soils (more than 85 000 ha in the Mezquital Valley), without any previous treatment other than primary sedimentation. Pollutant concentrations in the sewage have increased specially during the last 30 years due to a larger discharge volume from industries and the indiscriminate use of detergents. As a consequence, heavy metals and phosphorus are accumulating in the soil, specially in the arable layer. The effects of soil contamination on the indigenous AM fungi populations are studied in eutric Vertisols and mollic Leptosols (FAO) irrigated for more than 85 years, and in the same soil types irrigated for 5 years. Statistical analyses of variance show that the soil type is determinant to cause an impact on the AM fungi: after more than 85 years, spore abundance in soils is considerably decreased in Vertisols. In the case of Leptosols, the impact of this pollution is probably masked since leptosols show a larger heterogeneity in several soil properties. Also the number of spores in soil is negatively correlated to heavy metal (Cr, Cu, Zn, Pb, Ni) and phosphorous concentrations in all cases. Abundance of spores of AM fungi populations can be a bioindicator of the impact of this disturbance.

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A-0502

Herbicide Banding and Tillage System Interactions on Sediment, and Phosphorus Losses in Runoff. N. C. Hansen, J.F. Moncrief, and S.C. Gupta, University of Minnesota, West Central Experiment Station, Morris, MN USA

Runoff from agricultural fields delivers sediment and phosphorus (P) to receiving surface waters. Conservation tillage is a management approach that reduces upland erosion and associated P transport. Losses of water soluble P may be high with conservation tillage unless both runoff volume and sediment loss are reduced. Herbicide banding is a management option that can reduce herbicide application rates and costs by as much as one-half. The objective of this study was to assess the impacts of herbicide banding on the quantity and quality of runoff water for three tillage systems. The experiment involved quantifying runoff , sediment, and phosphorus losses from plots on a cropped hillslope for two years. The herbicides alachlor and cyanazine were either broadcast or band applied to plots managed with a moldboard plow, chisel plow, or a ridge till based system. All treatments were mechanically cultivated one time. Treatment effects on runoff and contaminant losses were different for the periods before and after the cultivation. Runoff, sediment, and P losses occurring before cultivation were consistently less for the chisel plow and ridge till treatments than for the moldboard plow treatment, mainly due to residue cover in the conservation tillage treatments. Similarly, the band treated plots had lower pre-cultivation runoff, sediment, and P losses than broadcast treated plots. Weed cover between the rows for the banded treatment had the largest effect on runoff and sediment losses from the moldboard plow treatment. For runoff events occurring after cultivation, there were no differences among tillage or herbicide application method on sediment or P losses. However, the fraction of total P lost as soluble P in post-cultivation runoff was higher than for the period before cultivation. Corn grain yields were not affected by herbicide application method but were lower for the chisel plowed plots than the other tillage systems in 1997.

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A-0503

Erosion Control through use of Synthetic Gypsum. B. H. Wallace, L.D. Norton, and R. Woodward, Purdue University, USDA-ARS-NSERL and Middlefork Farms

Synthetic gypsum is a byproduct of scrubbing stack gases for pollution control from coal combustion. It is formed in the scrubbing process to precipitate sulfur thereby improving air emissions. This product has primarily been used in the wallboard industry to create drywall. Through joint cooperation between Indianapolis Power and Light, local farmers, Purdue University and the USDA, a study is being conducted to explore the benefits of using byproduct gypsum as a soil amendment. Ongoing field studies are being conducted in Sullivan County, IN where the synthetic gypsum was surface applied using a spreader. A local farmer applied the gypsum to parts of several fields using different rates of gypsum (1T/A, 1.5 T/A, and 5 T/A). We conducted a rainfall simulator study using plots that were 6m x 1m on a 5 percent slope. Using a rainfall simulator at constant rainfall rate (55mm/hr), runoff samples were collected until steady state was reached. For this study, infiltration rates, soil loss, surface sealing and crop yields were scrutinized to determine the effects of synthetic gypsum. We also compared tilled plots and no-till plots under synthetic gypsum on erosion. The data indicates that infiltration rates have increased, soil loss has decreased, and some noticeable yield increases were found under the synthetic gypsum applications to soils when compared to control plots. Surface sealing plays a major role in the promotion of water intake, because synthetic gypsum increases the electrolyte concentration on the surface of the soil, flocculation is increased during rainfall events. This prevents the dispersion of clays on the surface, which can clog the surface by forming a crust, thereby allowing water to infiltrate into the pores found in the surface. So, this promotion of water into the soil increases the infiltration rates and reduces soil loss. Using a GPS and yield monitor, precise yields were recorded. Although there are many factors attributing to yield variations in a field, the corn plots showed noticeably less yield variation and higher

where synthetic gypsum was applied to the soils. This research benefits both the electric power industry and agriculture by finding practical uses for byproducts.

B. H. Wallace

A-0504

Structure and Dynamics of Soil Invertebrates from Tropical Forest converted to Pasture or Agrosilviculture Systems. Antony, L. M. K., Department of Ecology, National Institute for Amazon Research (INPA), Manaus, Amazonas, Brasil.

The vertical distribution and dynamics of soil invertebrates from five systems was studied: 1) intact upland forest (FOREST); 2) pasture established in 1982 with *Brachiaria humidicola*, abandoned in 1987 and in 1991 converted to agrosilvicultural system (ASIIB2); 3) *Brachiaria* pasture established in the early 80's, abandoned in 1991, soil with accentuated degree of hydromorphy (PA2); 4) *Brachiaria* pasture established in 1982, abandoned in 1987; area covered with secondary vegetation (PA6); 5) *Brachiaria* pasture, established in the early 80's, still under use (PA15). All systems were established over yellow latosol, approximately 50 km North of Manaus, on interstate BR-174, Central Amazon (2º 30' S; 60º 01' W). Two field collections of soil fauna were carried out (during the rainy and dry seasons of 1994). In each system, soil cores (106.2 cm^{-3}) were taken from a 50-meter transect, at 5 m intervals and 0-5 cm, 5-10 cm, 10-15 cm and 15-20 cm depths. In the rainy season, the Forest constituted the most favorable system to the soil invertebrates, with the highest mean density (28,451 $Ind.m^{-2}$), mean number of groups/sample unit (4.9) and total number of groups/depth (17). In the remaining systems these parameters were: ASIIB2 (23,881; 3.6; 10); PA2 (9,184; 2.8; 9); PA6 (10,740; 3.6; 11); PA15 (14,979; 2.2; 7). In the dry season, the Forest continued to present the highest number of groups/sample unit (6.2) and total number of groups /depth (17), but was only second highest in mean density (25,812 Ind. m^{-2}). In contrast, PA2 had an amazing population increase (37,918; 3.3; 9), overcoming all systems: ASIIB2 (18,134; 2.5; 8); PA6 (19,501; 3.2; 11); PA15 (25,670; 3.5; 13). Acari was the dominant group in all systems, constituting 60% minimum and 77.4% maximum of total catch. Collembola generally followed, (between 1.6% and 30.2% of total catch), supplanted only in the system PA15, by Psocoptera in the rainy season (8.5%) and Homoptera (21%), Formicidae (10.5%) and Psocoptera (1.8%) in the dry season . Except for the Forest and the Agrosilvicultural system ASIIB2, abundance and diversity were higher in the dry season. A sequence of biotopes was observed - from the most favorable to the least favorable to the maintenance of group diversity - which appear to reflec the consequences of each type of land and soil use: Forest - Secondary forest (PA6) - Agrosilvicultural system (ASIIB2) - Recently abandoned pasture, soil with hidromorphic conditions (PA2) - Old pasture, still under use (PA15).

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A-0505

Identification of Flowpaths and Variable Source Areas of Runoff Using the Soil Moisture Routing Model. Jane Frankenberger and Ravi Narayanan, Department of Agricultural and Biological Engineering, Purdue University, West Lafayette IN USA

Surface runoff is the primary transport mechanism for many nonpoint source pollutants including pathogens, sediment, and most commonly-used pesticides. The identification of flow paths for surface runoff and of source areas for the runoff can therefore contribute to effective watershed protection strategies. Most surface runoff in humid, well-vegetated areas is generated on specific areas of the landscape that become saturated, rather than occurring uniformly over the watershed. Few tools are available for identifying these variable source areas, which depend on the complex topographic and soil patterns in a particular watershed. Soil Moisture Routing Model was developed to assist in making management decisions related to nonpoint source pollution, based on the identification of variable source areas. It is a physically-based water balance model that predicts saturation excess overland flow in watersheds with shallow sloping soils. It combines elevation, soil, and land use information within a geographic information system, and predicts both soil moisture and surface runoff throughout the watershed. The model was originally developed for application in the Catskill area of New York state, where steep slopes and soils that are shallow to a fragipan or bedrock cause shallow subsurface flow. This flow typically generates surface runoff in areas where flow paths converge or the slope decreases. It was applied on a 170 ha watershed in New York state, and both streamflow and soil moisture predictions were found to correlate well with measured values. This study will test the model application over a wider geographic area, on Midwestern watersheds with suitable hydrologic characteristics based on topography, soil, and land cover. Although elevation changes are slight in many Midwestern watersheds, percolation to ground water is often impeded by a fragipan or dense till layer, and flow over the impermeable layer may be an important factor in predicting soil saturation. Predicted runoff will be compared to observed stream flow values and field observations of the watershed. The model can be used to identify intermittent streams used in setback requirement for certain pesticides, and to evaluate the effectiveness of setbacks in reducing the transport of nonpoint source pollutants to streams.

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A-0506

Mathematical model of solid particles transport by water flows on slopes. Gendugov V.M., Kuznetsov M.S., Fless A.D., Mechanic-mathematicalFaculty, Faculty of Soil Science, Moscow State University, Moscow, Russia.

On the base of mechanics lows of polyphase mediums, which are presented by Sen-Venan's approximations and by familiar equations (continuity of flow and its compounds, momentum) theoretical model of transport of particles and their different size aggregates was elaborated. The revealed conformity can be used for theoretical analysis and for investigation of migration and accumulation of erosion products and related to them pollutants in slope agrolandscapes. The research is executed through the financial support of Russian Fund of Fundamental Researches (project 96-05-65459).

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A-0507

Overwinter Changes to Vehicle Ruts and Natural Rills and Effects on Soil Erosion Potential. Lawrence W. Gatto, Geological Sciences Division, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH USA

A vehicle traveling overland can compact and rut a soil. A compacted soil has reduced infiltration and hydraulic conductivity and thus increased surface water runoff volumes and lengthened runoff periods. Ruts can act as natural hillslope rills and can channelize surface runoff, which increases its sediment transport capacity. Erosion from rutted forest roads is 2-4 times higher than from unrutted roads. This increased soil-erosion potential on trafficked soil is a major concern on military lands where training maneuvers are conducted. Fourteen military training areas are located where significant seasonal soil frost forms. Our research objective is to determine the effects of soil freeze-thaw (FT) cycling on the hydraulic geometry of and soil density and strength in ruts and rills. Results from laboratory experiments on a rill and on wheel ruts showed that the hydraulic radius of rill and rut channels was reduced by FT-induced soil slumping along channel sidewalls and that FT cycling increased infiltration, reduced soil density, and decreased compression and shear strength in ruts. To test these results in nature, we established research sites at Yakima Training Center (YTC) in south-central Washington in December 1995 and at Ethan Allen Firing Range (EAFR) in northwestern Vermont in October 1996. This presentation addresses the results of the studies at EAFR. We established the EAFR plots on an east-facing hillside with slopes that varied from 7 to 31% and with 12 natural rills and gullies for comparison to ruts. Soilfrost depths and soil temperatures, unconfined compressive strengths, soil-water contents and standard weather data are collected on-site. Initial trafficking was done in October 1996 with an Abrahms tank and a wheeled vehicle; the plots will be re-trafficked again in October 1998 after additional instrumentation is added to the plots. Results to date show that 1) the unconfined compressive strength of the soil in tank ruts decreased by 60%, in wheel paths by 50%, and in untrafficked soil by 29% due to soil FT cycling; 2) scattered sidewall slumps occurred along some of the deeper rills; 3) a distinct v-shaped, 11-cm-deep rill formed in a tank rut on a 31% slope, while soil adjacent to that rut showed no evidence of rill initiation; 4) some ruts showed the beginnings of rills, and pockets of sediment were deposited in these ruts due to intermittent flows; and 5) wheel-path surfaces did not change. Our research results will be useful in modelling winter processes in soil-erosion models.

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A-0509

Management systems for scoured terraces in south-western Uganda for wood production, reduced erosion and soil fertility enhancement. By: Raussen, T., Siriri, D. and E. Akyempong, C/O ICRAF – AFRENA Project, Kabale Uganda

High population density, beyond 400 inhabitants km^{-2} in some areas of the Kigezi highlands in the Southwest of Uganda have led to land-use systems which often exceed the carrying capacity of the land. Low crop yields and a severe deficit of wood products affect the livelihood of small-scale farmers. Soil degradation due to erosion and depletion of nutrients have rendered much of the land unproductive and farmers have abandoned cropping these fields. Most hills in the area are terraced and degradation processes also happen in this 'micro-environment': the upper part of the terrace becomes infertile due to erosion and downward cultivation of the land. Yields on the upper half of the terraces are typically only 25% of the total terrace' yield. Soil physical characteristics, high bulk density, low conductivity and heavy texture appear to be the main cause of low yields although some gradient in soil nutrients are also found. Unlike crops, agroforestry trees and shrubs, e.g. *Alnus acuminata* or *Calliandra calothyrsus* planted in blocks on the scoured sections of the terrace, perform well attaining pole size with heights well beyond 3 metres after 2 years. A thick carpet of litter builds up under Alnus in particular protecting the soil, altering infiltration rates and soil structure. Competition with adjacent crops is low for Alnus but higher for Calliandra. Farmers who have been involved in the research appreciate the wood products from lands, which they could not use profitably before. Suggestions are being made for the transfer of some biomass from the woodlots of the upper parts to the cropped lower part of the terrace. In

December 1998 the woodlots will be felled and crops planted to assess the impact of edaphic alterations under the fallows. Eventually a rotational woodlot system will be tested on the upper terraces. If adopted on a watershed scale, such systems may considerably reduce above ground water flow and soil degradation while providing substantial amounts of wood products.

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A-0510

Runoff potential water resources of two taditional water harvesting techniques in the arid regions of Tunisia. Chahbani Bellachheb, Arid Regions Institute-Medenine-Tunisia

Water and soil are the basic elements of any dry-farming agriculture activities. The importance of these two elements is more appreciated in hot and dry regions. In these regions soil and water are scarce and Man should know how to optimize their use and conservation. In the arid regions of Tunisia, the runoff water represents an important part of the water resources. In these regions Man uses different techniques of water harvesting for: Soil conservation and erosion control, water valuation for various agricultural and domestic uses. Calculations of the runoff water potential resources for different values of annual rainfall, have been done for two widely used water harvesting techniques: the small retention dams (Jessours) and the storage water tanks(Fesguias and Majels). The calculations are based on recorded or measured data of hydraulic and hydrological parameters. Several new formulae of the author were also used. The results obtained show the low water use rate hen considering the potential runoff water resources during the humid and very humid years. The rates are: -during humid years: 10% for the storage tanks and 30% for the retention dams,-during very humid years the rates are respectively : 6% and 15%. These rates are responsible for dangerous floods, soil erosion and water loss in the sea and arid salty depressions(Sebkhats or Garaats). Therefore applied research is being undertaken at the Arid Regions Instiute(Medenine-Tunisia) to avoid the negative effects of the runoff of this water and to improve their use efficiency and conservation within the context of a traditional dry farming system.

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A-0511

Farmers' innovations in arid regions of central and southern Tunisia. NASR Noureddine and CHAHBANI Bellachheb, Arid Regions Institute - Medenine-TUNISIA and REIJ, Chris, Amsterdam, Holland

In central and southern Tunisia there is an important patrimony of indigeneous water harvesting techniques(Jessours, Fesguias, Mgouds, etc…).These techniques are the basis of the development of both dry and rainfed agriculture. With the socio-economic changes since the beginning of the 20 th century, appear many problems and the income of production systems based on the water harvesting techniques is no longer able to cover the basic needs of the farmers. This paper presents the objectives, the actions and some preliminary results of a project (Indigeneous Soil and Water conservation in Africa) funded by the Dutch Government . The key topics of this project are : Farmers innovators, participatory technology development (PTD) , participatory research approach(PRA) and gender aspects.

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A-0512

Evaluation of almond biodiversity of cultivars grown in a germoplasm collection field of South Italy. Donato De Giorgio, Istituto Sperimentale Agronomico, Bari – Italy

Italian almond cropping, once flourishing, has suffered an increasing indifference from farmers in the last thirty years, losing most of precious local almond patrimony, naturally selected over time. Several autoctonal cultivars had origin in Apulia, a region of southern Italy. They were often formed from selected genotypes and cropped by man as an important source of income. With the introduction of more lucrative crops and because of foreign production, almond tree cultivar patrimony has suffered a strong genetic erosion, losing numerous genotypes of great interest. During the years 1967-1968 the Experimental Agronomic Institute collected the local variety patrimony in a germoplasm collection field located at Bitetto-Bari (south Italy), which was then enlarged by the collection of new national and foreign varieties and of the ones of new constitution. At present the collection includes 205 cultivars, among which 82 are of Italian origin, 42 of foreign origin and 73 of new constitution. These last were produced by the Institute with a program of genetics improvement, starting from local stock. Since the beginning of growth, phenology, production and carpology of the whole variety collection were monitored to detect specific characteristics of each cultivar and follow their evolution over time. To evaluate the adaptation degree of the whole genetic patrimony, the most relevant meteorological parameters were also recorded in a meteorological station located in the same field. In this paper we examine the field biodiversity and analyse the principal characteristics of each cultivar. At present in Italy and especially in some regions of southern Italy, such as Apulia, there is an interest return of almond tree cultivation, because of the adaptation degree and the production quality of local varieties. These are well suited to be cropped in hill areas, they provide a good income and contribute to natural conservation of landscape.

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A-0513

Effect of the soil management and moisture in the modelling of additional soil compaction of three latosols. Marcos Koiti Kondo, Moacir de Souza Dias Junior, Department of Soil Science, Federal University of Lavras, Minas Gerais State, Brazil.

The additional soil compaction occurs when the applied pressures on it is larger than the preconsolidation pressure, making the soil to deform along the virgin compression line. The virgin compression line is the place where the additional soil compaction happens. The objectives of this study were: (i) validate the model proposed by Dias Junior (1994); (ii) propose a model to quantify soil mechanical resistance and; (iii) evaluate the effect of soil uses and moisture in the virgin compression line and in the compression index of three Latosols under the conditions of annual crop, natural forest and cultivated pasture, located in Lavras (MG). This study was conducted throughout 1996 and 1997. For each one of the studied conditions five undisturbed soil samples were taken in with three replication, in the depths of 0-3 and 27-30 cm. Samples were analyzed in an uniaxial compression test. It was also collected disturbed soil samples, with three repetitions in each condition, to determine the plastic limit. It was demonstrated that as soil moisture increases, the virgin compression lines were shifted down and to the left, showing an increase in the soil compaction susceptibility, however, the mechanical resistance to be overcome by the roots system decreased. The compression index didn't differ for the annual crop and natural forest in the surface layer, but for the cultivated pasture in both depth and natural forest in the 27-30 cm depth. For these conditions, the area of deformations were different for the three types of soils. In this study the final soil bulk density and the compression index followed the Dias Junior (1994) models. In general, the soils under natural forest in the layer of 0-3 cm were more susceptible to soil compaction due to their larger values of the maximum compression index. The compression index values were overestimated when obtained by Larson et al. (1980), models when compared with the ones obtained in this study.

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A-0514

Surface Cover Subfactor for Gravel-rich Surface. Chia-Chun Wu, Associate Professor, Dept. of Soil & Water Conservation Technology, Nat'l Pingtung Univ. of Science & Technology, Neipu, Pingtung, TAIWAN

Crop and management factor (C) is probably the most sensitive parameter in the Universal Soil Loss Equation (USLE). It represents the effect of canopy as well as ground covers on soil loss. With proper cover protection, velocity and transport capacity of the surface runoff can be greatly reduced. As RUSLE (Revised Universal Soil Loss Equation) became available, C factor started taking more complex form with the consideration of prior land use, canopy cover, surface cover, surface roughness, and soil moisture. No matter how complicated it gets, surface-cover subfactor (SC) still maintains an exponential decay function as its ancestor does. For gravel-rich surfaces situated on sedimentary-rock formation like Taiwan, the applicability of SC subfactor becomes significant from the viewpoint of soil loss estimation. Four unit plots with the slope-length of 22.13m and steepness of 9% were installed for soil loss measurements. Gravel with mean diameter of 20mm was used to achieve 25-, 50-, and 75% ground coverage. A bare plot with 0% gravel cover served as check plot. Total of 93 erosion events from three consecutive years were observed. Results of this study indicated that SC subfactor did not decay as fast as either USLE or RUSLE suggested. The C factor in USLE underestimates soil loss ratio from 32% to 6% as ground cover increases. On the other hand, the SC subfactor in RUSLE underestimates from 46% to 64% as ground cover increases. In addition, the empirical coefficient b in RUSLE SC factor can significantly change the performance of SC subfactor from underestimation of 64% to overestimation of 81%. More detail research for non-erodible ground cover surely is needed.

Chia-Chun Wu

A-0515

Examination of Canopy Cover Subfactor for Long-stem Plants. Wen-Jaur Chang and Chia-Chun Wu, Professor and Associate Professor, Dept. of Soil & Water Conservation Technology, Nat'l Pingtung Univ. of Science & Technology, Pingtung, Taiwan, Neipu, Pingtung, Taiwan

C factor; known as the crop and management factor; has served a major role in the days of USLE to estimate the crop canopy effect on erosion process. As the knowledge of erosion mechanics advances, C factor has gone through a total face-lift in RUSLE to cover the effect of crop canopy, surface cover, prior land use, soil rougness, and soil moisture. No matter how complicate it becomes, C factor still constrains to the value of unity to reflect the maximum exposure of soil to erosion. However, the concept that this constrain implies was unable to justify for long-stem plants like betel nuts. Conceptual theory based upon the conservation of mass was first derived to distribute the rain falling upon betel nut's canopy to those physical quantities contributing to erosion process. Field measurements were then carried out to validate the theory. Results from this study did not support the current concept of canopy cover subfactor. Betel nut's canopy cover appears to yield better protection against erosion for high intensity rains. In addition, the canopy cover subfactor for betel nut plants under low intensity rains can be greater than unity as the fall height reaches to certain level. Therefore, the canopy cover subfactor module embedded in RUSLE, as well as the concept of unity needs to be further investigated.

A-0518

Increasing Water Productivity in rice cultivation: Impact of large-scale adoption of direct seeding. T.P. Tuong, R. Cabangon, International Rice Research Institute (IRRI), Manila, Philippines, N. bin Abdullah, and B.T. Eow, Muda Agricultural Development Authority (MADA), Ibu Pejaba, Ampang Jajar, Alor Setar, Kedah Darul Aman, Malaysia

Rice accounts for about 80% of the total food grain production in Southeast Asia. Future rice production will increasingly face water scarcity and competition. But currently rice culture is highly inefficient in water use. It is imperative for food security in Asia to identify rice production systems and practices that are less water-demanding or use water more efficiently than the conventional transplanted rice (TPR). This study assessed the impact of the large scale adoption of wet seeded rice (WSR, sowing of pre-germinated seed to puddled soil), dry seeded rice (DSR, sowing of dry seed to dry or moist soil) on the amount of irrigation water and water productivity (kg of rice produced per unit volume of water input). Water balance components were monitored in 3 irrigation service units (ISU, about 50 ha each) from 1988 to 1994 in Muda River Irrigation Scheme, Malaysia. In each ISU, we also recorded crop establishment method, the progress of farming activities, and rice yield of individual farmers. The same exercise was carried out in 1996 for 14 irrigation blocks (400 to 1280 ha each). Yields from WSR, DSR and TPR were not statistically different ($p<0.05$), thought DSR yielded about 10% less than WSR and TPR. Dry seeded rice could make use of early rainfall during land preparation and crop establishment, advanced the crop season about one month and reduced the length of the irrigation period considerably compared to TPR. The amount of irrigation water thus declined sharply and the water productivity increased as the area of DSR increased. Wet seeding also reduced the irrigation period and irrigation amount, but not significantly different compared to TPR. Statistical models were used to relate irrigation water input and irrigation water productivity to the percentage of area under WSR and DSR. Constraints to adoption of DSR and WSR were discussed.

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A-0522

Use of the RWEQ to calculate soil losses in the German Federal State Mecklenburg-Vorpommern. R. Funk, B. Winnige, A. Saleh

The Federal State Mecklenburg-Vorpommern covers about 23.000 qkm along the Baltic Sea. The climatic conditions are influenced in the north by the land-sea wind systems and in the east by the transition to continental climate. The soils were formed in the last glacial period and show a wide spectrum concerning their substrates and hydrological features. Changes by men (esp. draining) influenced properties of soils strongly in the last decades. More than 13.000 qkm of the land are used for agriculture. Main crops are cereals (522.000 ha), rape (172.000 ha), corn (116.000 ha) and sugar beet (34.000 ha). So, here are many variations that influence susceptibility to wind erosion in time and space. A model is needed which evaluates the actual wind erosion disposition with a minimum on input data's on the one hand and which is flexible to react fast to changing conditions on the other hand. These requirements are neccesary for administrations to get information about potential environmental damages and make planning easier. The wind erosion risk for the whole State was calculated by using a GIS-based mapping method, where main factors of the RWEQ were integrated. Basis for the estimation is the Medium Scale Agricultural Site Mapping (MMK, scale 1:25.000) which gives the spatial structures for calculation and includes soil types and hydromorphy types. Weather data's were received from long-term recordings of the Meteorological Service. Data's of soil management and grown crops were derived from statistical and actual data's as average of one mapping unit. As a result maps of soil loss per time period and maps of critical field lengths were received.

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A-0521

Conservation Action: Sustaining Our Land and Water Participatory Technology Development in Watershed Management. N Nagaraja, Danida Advisor, Karnataka Watershed Development Project, Bijapur, G M Varadaraju, Asst.Professor of Agri.Exten., University of Agricultural sciences, GKVK Bangalore, India

A watershed is defined as any surface area from which, rainfall is collected and drained through a common point for sustainable land development and to conserve water. A drainage basin represents wide variety of landholders for improvement in agriculture. This expected outcome is not sustaining because of the inappropriateness of technology due to complex and risk prone environments. This demands participatory mode of technology development. Government and other agencies are trying to develop the deteriorated environments on watershed basis for sustainability. However, the case studies of watersheds show adoption of technologies by farmers is marginal due to inappropriateness at individual farmers level. Contour bunds are not adopted because of small and scattered holdings. In vegetative bunds vetivar grass is not preferred as it serves as host to striga, a deadly weed in jowar fields. Grassed waterways are not accepted due to drying in summer. Even wider diversion drains are rejected as it inundates adjoining fields. Check dams and farm ponds have limitation among small farmers. Hence, integration of station based research and on farm research ensuring peoples involvement is an immediate necessity to enhance the acceptance of soil and water conservation practices. Participatory technology development is the process of combining the indigenous knowledge and research capabilities of the local communities with that of research and development institutions in an interactive way in order to identify, generate, test and apply new techniques and practices and to strengthen the existing experimental and technology management capabilities of the farmers. Farmers do participate when they perceive, understand and observe tangible benefits of technologies. The PTD strategy involves the scientists, extension workers and farmers in the following manner. 1. Problem identification through careful analysis of felt and unfelt needs of farmers. 2. Search for solutions, which encompasses prioritizing possible solutions in the backdrop of indigenous and advanced knowledge. 3. Design experiments that suit the farmers purposes and to strengthen their capacity to handle the technologies. 4. Assessment of research outcome for appropriateness. 5. Communication of results among farmers Participatory technology development in watershed is not a substitute for station based research or extension worker managed on farm trials. It is a complimentary process ,which involves linking the power and capabilities of agricultural science to the priorities and capabilities of farming communities to develop productive and sustainable watershed development system .

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A-0523

Landcare - basis for policies and action for conservation of land, water and vegetation resources in Australia. Graydon Findlay, Department of Natural Resources and Environment, Victoria, Australia

The successful formation of community based Landcare groups across Australia in the 1980's and early 1990's created the environment for policy makers at the Federal and State level to develop strategies and programs which aimed to raise the long term productivity and ecological sustainability of Australia's land, water and vegetation resources. The number of Landcare groups in Australia expanded to 1400 in 1992 and 2200 by 1995. Landcare quickly became an "in-word" and was used to describe a range of National, State and Regional plans, community advisor groups, funding programs and educational / awareness raising activities. The paper focuses on the impacts of these plans, advisor groups, programs and activities, examines their role in getting conservation action on the ground, looks at recent initiatives aimed at increasing empowerment of regional and catchment (watershed) community groups and canvasses the need for innovative ways of helping to sustain local Landcare groups and Landcare group leaders if the ever increasing number of groups are to be successful in improving the productivity and management of the natural resources in their area and catchment.

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A-0524

Soil Malnutrition and Holistic Approach For Sustainable Soil Use. Tag Elsir Basheer Abdalla, Khartoum, Sudan

Food shortages are generally blamed on either drought or excessively high rainfall accompanied by flooding and erosion. The most serious menace to future production is depletion of their fertility through plant nutrient depletion or exhaustion with subsequent reduction of biomass, organic matter and reduced microbiological activity, particularly in arid and semi-arid areas. Soil is a natural resource non-renewable in the short term or very difficult to renew, and expensive either to reclaim or to improve following erosion or physical and chemical degradation. This natural resource is a legacy for coming generations and therefore it is our duty to maintain it for the future. The task for all people concerned with soil must be to direct their interests not just to the physical (soil

physicist), chemical (soil chemist) and biological (soil biologist) aspects that affects soil use, that is to adopt a Holistic Approach for sustainable global farm, taking in consideration the production of hygienic foods and fodders according to ISO criteria. -; Professor of Environmental Technology & Microbiology, -Secretary General of Sudanese Soil Science Society, -Chairperson of Natural Science Committee of Sudanese National Commission of UNESCO, -MAB/IHP Programmes Rapporteur of Sudenese National Commission of UNESCO

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A-0525

Mechanical Integrating and Scaling Devices for Measurement of the Roughness Components of Soil Erodibility. Stephen D. Merrill, USDA-RS, Northern Great Plains Research Lab, Mandan, ND USA, Chi-hua Huang, USDA-ARS National Soil Erosion Research Lab, West Lafayette, IN USA, Ted M. Zobeck, USDA-ARS Cropping Systems Research Lab, Lubbock, TX USA, Donald L. Tanaka, USDA-ARS, Northern Great Plains Research Lab, Mandan, ND USA

Standing and prostrate crop residues act together with soil surface microtopography to determine the roughness component of soil erodibility. Saleh has introduced the chain method to soil erosion research. The foreshortening of a roller chain laid upon the soil surface integrates the degree of soil roughness over the length of the chain. A single, very fine chain could exhibit scale indeterminacy by reporting a similar roughness value for both a surface with many small roughness elements (RE's) and one with a lesser number of large RE's. Merrill has shown through a computer simulation study that scale indeterminacy can be overcome by use of a set of chains in which the linkage length of each chain is part of an approximate geometric progression. It was also concluded from this study that the chain set would give information about the Afractal character@ of surface roughness. Fractal character is defined as the size distribution of RE's at lesser scale than the upper dominating size scale of RE's. Thus, the chain set is a mechanical integrating and scaling device. We have compared chain set measurements with datasets produced with a laser microtopographic scanner. Chains in our set were from ANSI standard roller stock 92 cm in length with linkage lengths created by spot welding to be 0.48, 0.95, 1.91, 3.81, 7.62, 15.24, and 30.48 cm. Both randomly rough soil surfaces created in the lab and tillage-disturbed surfaces in the field have been comparatively measured. Two wind erosion-relevant indices were calculated from laser scanner datasets, percent of surface sheltered from abrasion and elevation standard deviation index. From measurements on randomly rough soil, it was found that chain set roughness parameters correlated much better with percent of surface sheltered than with standard deviation index. This paper will discuss the extension of the chain set concept to erosion-relevant measurement of standing residue structures. Chain-like devices with suitably lightweight and wide segments that are flexibly linked together would be unrolled over the surface. The current research emphasis on introducing crop diversity into dryland cropping systems indicates need for practical assessment of soil erosional risk, particularly for crops with fragile and nondurable residues.

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A-0526

Interrill and rill erosion on a sandy loam soil as affected by tillage and consolidation. J. Miguel Reichert; Marcos J. Schafer; Flávio L.F. Eltz; and Elemar A. Cassol. Soils Department, UFSM, Santa Maria, RS, Brazil; and Soils Department, UFRGS, Porto Alegre, RS, Brazil.

Short and long term consolidation affect rill and interrill erosion processes. No-tillage increase the consolidation and soil surface coverage, thus reducing soil and water losses. Parameters of physically based erosion models must be quantified for diverse soil types and managements. On a sandy-loam (surface texture) Hapludalf, with about 9% slope, the following treatments were evaluated: conventional tillage (CT), consolidated (2 months) CT (CCT), no-tillage (for 6 years) (NT), and NT without residue (WNT), with 6 replications. For interrill erosion, simulated rainfall of 65 mm h^{-1} was applied for 90 min on 0.5 by 0.75 m plots. For rill erosion, rills of 0.2 by 6.0 m with metal borders were prewetted with simulated rainfall and water flows (12 to 60 L min^{-1} for conventional tillage, and 24 to 120 L min^{-1} for no-tillage) were applied. Runoff and sediment were collected at the lower end of the plots. Rill and interrill erosion parameters were calculated using WEPP procedures. For interrill area, the detachment rate, sediment concentration and total soil loss were greater for CT and CCT than for NT and WNT, due to increased soil shear strength as measured with a Torvane. Interrill erodibility (Ki) was 1.77 x 10^6 kg s m^{-4} for CT. Rill erodibility (Kr) was 0.0089 kg N^{-1} s^{-1} and critical shear stress (τ_c) was 1.92 Pa for NT, and Kr was 0.0038 kg s m^{-4} and τ_c was 2.63 Pa for CCT. These two parameters could not be determined for no-tillage treatments. Mean weigh diameter of eroded sediment was greater for CT than for the short (CCT) and long term consolidated treatments (NT and WNT). The increased soil strength with consolidation decreased Kr, increased τ_c, and reduced the size of eroded sediment. For most rill flows, the flow regime was turbulent (Re > 2000) and supercritical (F >1). Residue on the soil surface (NT) increased the friction factor (f) for low flows, compared to high flows. These results indicate that efficient control of erosion occurs on no-tillage only with adequate surface coverage, and that natural consolidation modifies soil erodibility and shear strength.

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A-0527

Changes in physical and chemical properties of fen soils induced by long-term drainage and rewetting within the last years. Jutta Zeitz and Andreas Gensior, Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät, FG Ökologie der Ressourcennutzung, Berlin, Germany

Fen soils in the eastern part of Germany had been used very intensively for agriculture during the past 30 years. More than one-third of the fodder, needed for animal husbandry, was provided by these areas. Focused towards economic independence and high productivity, the management of fen soils had led to a drastic decrease of soil fertility. The main reason for the complex cause-effect mechanism was the lowering of the ground water level to permit intensive utilisation. This effective drainage made the sites accessible at all times also for machines with high weight and pressure index. The degradation and drying out of the fens were increased by intensive grass cultivation with regular cutting three to four times each year. Also through the high calcium carbonate content which is due to the calcareous till from the glacial till plains, that are around the fen soils and through the relatively dry climate in the eastern part of Germany the soil degradation was reinforced. In the course of this agricultural use of fen soils, the physical and chemical parameter changed to such an extent that the peat substrates undergo pedogenetic differentiation. This enables their description by means of prognostic soil horizons. The paper presents the results of extensive long-time investigations about changes in pore volume, pore characteristic based on water retention curves, saturated conductivity, relationship C_t/N_t, pH, ash content and selected nutrients including heavy metals in dependence on soil horizon and kind of peat. Some comments will be given on the new soil classification of the FRG that considers this processes of soil degradation and their difference in comparison to the FAO or US Soil Taxonomy. Due to the soil degradation the agricultural use was no longer profitable and the damages to the environment were no longer acceptable. New concepts for land use of fen soils are demanded, which correspond to economic and social aspects, as well as to ecological demands within the meaning of sustainable development. Therefore the DBU (German federal foundation for environment) promoted a interdisciplinary research project titled „Restoration of a degraded fen by cultivation of reed as industrial plant using purified waste waters". In this project a exemplary restoration site of 10 ha was established on a degraded fen in the Sernitz-Welse-lowland (100 km NNE of Berlin). After planting typical fen vegetation (reed, sedge), the degraded fen was reflooded using water of a receiving stream. From the viewpoint of soil conservation one of the most important aims of the project is the reactivation of the natural functions of the fens as element sink and water source in the landscape. For soil science questions a special experimental area (6250 m^2) on the investigation site was constructed to investigate the element fluxes and to make out a balance-sheet. In four different depths the composition of soil solution, redox potential, the soil temperature and soil physical parameter were measured. The paper presents primary results gained in the last two years caused by reflooding of this former degraded fen for the parameter redox potential, pH, nutrients and pollutants in the soil water and in the peat. First conclusions as far as the environmental compatibility are proposed.

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A-0528

Geographical information system for the assessment of the trafficability of rewetted fen soils. Michael Knieper and Jutta Zeitz, Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät, FG Ökologie der Ressourcennutzung Berlin,

With an acreage of 1,470,000 peatlands take up 4.1% of the total face of the Federal Republic of Germany. The areal portion in the state of Brandenburg, where the test region "Nuthe-Nieplitz" lowland is located, amounts to 211,000 acres or 7.3% of the state surface area. At present more than 95% of the fens are used agriculturally. Particularly due to long-term agricultural utilization in connection with drainage measures these peatland soils are strongly degraded concerning their soil function (location for agricultural production, water reservoir, nutrient sink etc.). In order to counteract these negative consequences, especially those of peat mineralisation, a rewetting of the soil is necessary, i.e. an adjustment of the ground water levels according to the ground water levels of natural fens. A rewetting requires immediately transferable knowledge of the trafficability to carry out measures for the utilization , maintenance, and protection due to agriculture. A planned procedure is necessary to resolve conflicts concerning a competitive and environmentally compatible (especially concerning soil protection) agriculture. The instrument we use for this task is a geographical information system (GIS). Our project "trafficability of peatlands under conditions of their protection and appropriate use" supported by the "German Federal Foundation Environment" "DBU" (Deutsche Bundesstiftung Umwelt). Agricultural engineers and laboratory assistants of landscape preservation participate alongside our special field of ecology of resource utilization. The main assignment of our cooperative partners was to establish the required load-carrying capacity for various vehicles as well as to assess the technique concerning its capacity, function, energy and cost. Our purpose was to evaluate the shearing strength as a relevant parameter for the load-carrying capacity, to draw up categories of load-carrying capacities for different biotopes, to make a widespread assessment of the load-carrying capacity of fens within the test region, as well as the

cartographic presentation of the categories of load-carrying capacities on the basis of biotope types and ground water levels. We mapped the fen soils and leveled the height of three representative experimental areas in the "Nuthe-Nieplitz" lowlands (50 km south-west of Berlin). All data was included using a GIS. The soil moisture (Time Domain Reflectometry), the density of vegetation and the shearing strength were measured at various points of time. Biotopes were interpreted using aerial views (CIR). In that way the shearing strength relevant for the load-carrying capacity was evaluated according to types of biotopes, density of vegetation and soil moisture. Parallel to these measurements, the ground water levels were registered automatically. Subsequently, the soil moistures relevant for the trafficability were defined using these sequels of ground water levels and those stated in the literature. Maps for the trafficability of the representative biotopes were drawn up derived from the soil moisture. A scenario of the consequences of different ground water levels on the trafficability were depicted. These maps of the trafficability must be analyzed using the GIS-functionality overlay in order to evaluate differences in the areal distribution and alterations in the individual categories of trafficability. These results form the basis for industrial management as well as political guidelines for the allotment of funds.

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A-0529

A Comparison of Manual versus Computer-Assisted Drainage Delineation Methods for Hydrologic Unit Map Development in the Illinois River Basin of Northwestern Arkansas. Gregory P. Stanton, Hydrologist, U.S. Geological Survey, Little Rock, Arkansas USA

Drainage basin, or hydrologic-unit maps are necessary components of many natural-resource studies such as flood assessments, water-quality sampling, water-use reporting, watershed-protection, conservation planning, and resource management. Watersheds identified by 11-digit codes and ranging in size from 40,000 to 250,000 acres (about 60 to 400 square miles) are monitored or managed by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), the U.S. Geological Survey (USGS), the U.S. Environmental Protection Agency (USEPA), and several other federal and state agencies. Most states presently are working to further delineate watersheds into 14-digit subwatersheds, which typically are 10,000 to 40,000 acres (about 16 to 60 square miles), in size. NRCS is leading a national effort to complete the 14-digit subwatershed delineation process nationwide by the year 2002. Historically, watershed delineation has been accomplished by manually marking drainage divides on 1:24,000-scale topographic quadrangles; however, this process is very time-consuming and requires digitization of each map sheet. Through the advancement of Geographical Information System (GIS) technologies, computer-generated maps such as Digital Raster Graphic (DRG) images and Digital Elevation Models (DEM) of topographic quadrangles have been made available for most of the U.S. Using computer-assisted methods, the USGS has successfully delineated 14-digit level subwatersheds in the Illinois River Basin in northwestern Arkansas using DRGs and DEMs at two spatial scales. The resulting automated delineations were then compared to manual delineations from 1:24,000-scale topographic quadrangles. The computer-assisted methods were applied to two separate elevation data sets: one comprising an elevation grid derived from 1:100,000-scale USGS Digital Line Graph (DLG) hypsography, and the other consisting of mosaicked USGS 1:24,000-scale level-2 DEMs. The computer-assisted method using the mosaicked 1:24,000-scale level-2 DEMs produced satisfactory results whereas the method using 1:100,000-scale DLG elevation data did not. The computer-assisted watershed delineations based on 1:24,000-scale level-2 DEMs were visually and statistically compared to manual delineations of the same watersheds. The computer-generated delineation compared very well to the manual delineations, generally following ridges and drainage divides; however, some computer-generated subwatershed boundaries required editing in small, low-relief areas such as stream confluence floodplains. Statistically, the areas of 29 14-digit DEM/computer-generated and manually derived subwatershed delineations differed between 0.04 to 8.16 percent. The average area difference was about 1.5 percent. Labor costs (including data acquisition, pre-, and post-processing) were reduced by about 30 percent by using the DEM computer-assisted delineating method. Additional labor savings are possible as available tools and data are enhanced. The computer-assisted delineation method has since been used by the USGS on adjacent watersheds in Arkansas with cooperation and quality control by NRCS.

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A-0530

Global Climate Change: Implications of Extreme Events for Soil Conservation Strategies and Crop Production in the Midwestern United States. Otto Doering, Mike Habeck, Jess Lowenberg-Deboer - Agricultural Economics, Purdue University; Rebecca Pfeifer, Consultant; J.C. Randolph, Jane Southworth - School for Public and Environmental Affairs, Indiana University; Mike Mazzocco - Agricultural Economics, University of Illinois; Mark Nearing, USDA-ARS-NSERL, West Lafayette, Indiana

Climate models indicate that by the year 2050 average annual temperatures in the Midwestern U.S. may increase around 8 degrees F and average annual rainfall may increase, resulting in warmer, wetter conditions. Perhaps more importantly, less predictable weather patterns will emerge, increasing the frequency of extreme weather events such as heavy downpours of precipitation, late season frosts, and droughts. For example, July rainfall may increase 20% and might come in just two rainfall events. This study combines expertise from several disciplinary areas with modeling strategies to assess the impact of global climate change on Midwestern agriculture. Predictions of warmer summers, wetter springs, and more extreme events indicate that the cropping system may need to be adjusted to effectively conserve soil, maintain timely planting, avoid early season frost damage, and take advantage of warmer growing conditions. Climate projections (HADCM2), crop growth models (DSSAT), expert panel discussions, and farm level decision models (PCLP) are used to study some of the choices farmers will have. Some options to be evaluated include altering the crop mix, changing time of planting, and planting genetically improved seed. Planting of cover crops and reducing the amount of tillage performed may also be viable alternatives to reduce the amount soil loss resulting from more intense storm events. This paper will address some of the key findings from the project , and emphasize the extent to which extreme events under climate change raise special concerns about soil erosion. It will offer insights into the conditions which may facing Midwestern farms and offer alternatives for preserving the quality of the soil resource and remaining competitive in the world market

Otto Doering

A-0531

Drought, Grazing, and Burning Influences on Rangeland Ecosystem Sustainability. Rodney K. Heitschmidt, USDA-ARS, Fort Keogh Livestock & Range Research Laboratory, Miles City, MT USA

Drought, grazing, and burning all decrease standing biomass with the potential to influence rangeland productivity and sustainability through changes in surface runoff, erosion, and nutrient loss. Small increases in runoff, erosion, and nutrient loss for long time periods can potentially lower productivity of the site. The purpose of this work was to evaluate increases in runoff, erosion, and nutrient loss from drought, grazing, and burning and calculate long term changes in nutrient status to address the issue of rangeland ecosystem sustainability. Drought and grazing were evaluated on the northern Great Plains under natural precipitation with non-weighing lysimeters, while prescribed burning was evaluated with a rainfall simulator on southwestern semiarid rangelands for changes in runoff, erosion, and ecosystem nutrient loss. All the treatments increased runoff, erosion, and nutrient loss. The soil contained most of the nutrient and most of the lost nutrient was attached to the eroded soil. Even at the accelerated soil loss rates, it would require many years of nutrient loss before it would effect ecosystem processes. Precipitation was found to replace some of the lost nutrient to maintain the systems.

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A-0532

The European Soil Erosion Model: Peformance In Practice. R P C Morgan, Department of Natural Resources Management, Cranfield University at Silsoe, Silsoe, Bedford, UK

The European Soil Erosion Model (EUROSEM) is a dynamic distributed event-based model for simulating soil erosion by water at field and small catchment scales. The success of models is conventionally evaluated by comparing model outputs with measured data for either individual storms or specific time periods. EUROSEM gives mixed results when validated in this way but can perform well with careful calibration. In practice, most users will not have access to suitable data for validation and, for making management decisions, do not require high levels of accuracy. It is sufficient if the model yields predictions which broadly correspond with reality and behaves in a plausible manner. Against this background, EUROSEM was applied to hillslopes under arable farming in southeast England and upland pastures in mid-Wales. In both cases, synthetic rainfall data sets were produced for one-hour storms of return periods ranging from 0.5 to 1,000 years. Outputs from the model were soil losses for individual storms and, by integrating the results over tine, estimates of mean annual soil loss. Values of the most sensitive input parameters were allowed to vary enabling means and standard deviations to be determined for the losses from each storm and 95 per cent confidence limits for the mean annual soil losses. For south-east England, EUROSEM simulated storm soil losses under bare soil conditions and a conventional arable rotation which were realistic for individual storms of the given return periods; estimates of mean annual soil loss were close to measured short-period means. The model simulated well the changes in erosion and deposition along a convexo-concave hillslope. For mid-Wales, EUROSEM simulated storm soil losses and mean annual erosion rates which approximated measured values for the mineral soils under both well-vegetated and overgrazed conditions but the predictions were too low for the upland peat soils. Different results were obtained for individual slope segments when they were considered in isolation to when they were linked in a catenary sequence. EUROSEM can perform well if the user takes care in representing the landscape as a cascading sequence of slope planes and in choosing appropriate input parameter values. This requires understanding of both the model and the erosion processes operating in the study area. Misleading results can arise from simulations of individual slope planes evaluated in isolation of their position in the landscape. Users will have to accept high levels of uncertainty in model predictions; these reflect natural variability in the landscape.

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A-0533

Updating Slope Topography During Erosion Simulations with the Water Erosion Prediction Project Model. Jingcai Zhu, Seth M. Dabney, USDA-ARS, National Sedimentation Laboratory, Oxford, MS USA, Dennis C. Flanagan, USDA-ARS, National Soil Erosion Research Laboratory, West Lafayette, IN USA.

The Water Erosion Prediction Project (WEPP) is a process-based continuous simulation erosion prediction model. Major input data files for the hillslope application include climate, plant and management, slope, and soil. Continuous simulation means that the computer program can simulate a number of years with climatic data, soil moisture, soil roughness, surface residue cover, canopy height, and canopy cover updated on a daily basis. However, WEPP currently assumes a fixed soil surface topography, which does not change due to predicted detachment and/or deposition through a simulation period. This approach is satisfactory for uniform slopes with single management, but it is a major limitation for profiles having non-uniform slope, soil, and management. In particular, slopes on which grass buffer strips induce significant deposition (in and above the strips) and have large amounts of detachment (below the strips) are impossible to adequately represent with the current WEPP hillslope model. Since slope steepness is a sensitive and important factor for erosion prediction, updating of a profile's slope data during a simulation should improve the erosion prediction for these kind of situations. In this study, a computer program was written to update the input slope file for WEPP on a selected time interval. After having simulated soil detachment and deposition for a given time period, WEPP outputs a soil loss summary file which contains horizontal distance, elevation, and erosion and deposition along a profile. The slope updating uses this output file as input. Sediment is redistributed above and in the grass hedges according to actual deposition patterns obtained by flume simulation and field survey observation. A new slope profile is then calculated based on the new elevations and exported to a file in a format which can be used directly by the WEPP model in subsequent erosion simulations. Simple uniform slope and non-uniform slopes with grass hedges will be demonstrated and compared in this presentation.

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A-0534

Soil management influencing ratio between water intake rates as determined using sprinkler infiltrometer and cylinder infiltrometer. Q. de Jong van Lier, Universidade de São Paulo, Piracicaba (SP), Brazil , R. Levien, Universidade Federal do Rio Grande do Sul, Porto Alegre (RS), Brazil & A.G.C. Alves, Universidade Federal de Pernambuco, Recife (PE), Brazil

Together with rainfall rates, soil water intake rate determines runoff, making it a very important soil parameter for all erosion and soil conservation studies. Measurement of intake rates can be done using a cylinder infiltrometer (CI) or a sprinkler infiltrometer (SI), among others. The use of CI is less labor requiring, but its results often don't agree with rates occurring in real rainfall situations, because surface crust may form. Crust formation depends both on factors that do not depend on soil management, like rainfall intensity and soil texture, and on factors that do depend on management, mainly soil structure, aggregate stability and residue cover. In situations where crust formation is likely to occur, intake rates measured by CI will probably overestimate real intake rates occurring during rainfall events. To verify if correlation exists between soil management and ratio between intake rates determined using SI and CI, intake rates were measured by both methods on an Ultisol from southern Brazil. Plot treatments differed in residue cover, surface roughness and removal or not of preexisting crust. SI measurements were done using a rainfall simulator with a Veejet 80100 nozzle over 3.5 x 11.0 m plots, generating rainfall intensities of about 64 $mm.h^{-1}$ during 120 minutes. Plots were bordered by steel plates, and runoff was collected at the lower border for 3 or 5 seconds every 3 minutes. The CI was composed of an inner cylinder (diameter 0.30 m) and an outer cylinder (0.50 m), driven into the soil to a depth of 0.10 m shortly before SI determinations. The area inside the cylinders was flooded and infiltration rates within the inner cylinder were registered at regular time intervals for 120 minutes. All CI measurements were replicated three times per plot. Results show a five to tenfold overestimation of final intake rates by CI. Overestimation is less when more soil cover is present. Instant infiltration rates are not or less overestimated when no preexisting surface crust exists. These results show that intake rates determined by CI cannot be used without correction in soil conservation studies, and that correction factors should consider management conditions, especially those related to soil crust existence and formation and presence of residue cover.

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A-0537

Spatial Patterns in Water use Efficiency Created by Intensive Cultivation on Semi-arid Hillslopes. Bas van Wesemael, Flood Hazard Research Centre, Middlesex University, Queensway, Enfield, United Kingdom, Mark Mulligan, Geography Department, King's College, Strand, London, United Kingdom and Jean Poesen, Laboratory for Experimental Geomorphology, Catholic University Leuven, Leuven, Belgium,

The rocky expansion of almond monocultures in southeast Spain has forced farmers to cultivate steep and rocky soils. The intensive cultivation of entire hillslopes from the crest to the valley bottom results in a redistribution of soil, leaving very thin soils on the convexities and thick soils in the valley bottoms. Previous research has indicated that apart from the soil redistribution, tillage of stony soils also creates a lateral and vertical movement of rock fragments leading to a rock fragment armouring both on the convexities and in the valley bottoms. Furthermore, the heterogeneous hydrological behavior of soils under shrub vegetation, common to semi-arid rangelands, is erased by tillage. Frequent tillage of entire hillslopes has therefore resulted in a spatial pattern of soil properties such as soil thickness, rock fragment cover, rock fragment content and porosity of the fine earth. These are key parameters in the water balance of marginal soils. A systematic sampling of soil depth, stoniness, fine earth bulk density and soil texture along cultivated hillslopes was carried out and the establishment of almond trees in plant pits with known soil depth was monitored. The water balance of selected pits along a transect was simulated for the hydrological year 1996/97 using the PATTERN eco-hydrological model. Overall the stoniness and frequent tillage result in a low runoff coefficient and a very high infiltration capacity and Ksat. The model results indicate that the hydrological response of the thin, stony soils is more dynamic than that of the deeper soils in the valley bottoms. This spatial pattern is reflected by the poor establishment and small stem diameter of young almond trees on thin soils. This approach is a first step towards the understanding of the implications of land use change in dryland farming on crop yield, runoff, excess soil water ending up as groundwater recharge or river discharge.

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A-0538

Soil aggregate stabilization by a basidiomycete. TheCan Caesar-TonThat and Verlan Cochran, USDA-ARS, Northern Plains Agricultural Research Center, Sidney, MT USA

Dryland soils of the North Great Plains have lost an estimated of 50% of organic matter. The decline of organic matters has been accompanied by a loss of water stable aggregates and a greater propensity to erode. Fungal hyphae are known to bind soil particles and micro-aggregates into macro-aggregates that are stabilized by amorphous materials. The objectives of this study were: 1) compare fungal biomass between tilled soil and undisturbed grass row barriers that has been in place for 30 years, 2) investigate whether or not Basidiomycetes are more prominent in undisturbed soils than tilled soil, and 3) determine what class of fungi are more efficient for stabilizing soil aggregates. Fungal biomass was determined in undisturbed and cultivated soils using confocal scanning laser microscopy combined to image processing techniques. Results showed that undisturbed soils contain more fungal biomass than cultivated soils. Moreover, more water stable macro-aggregates were found in undisturbed soils. Rabbit (polyclonal) antiserum raised against Basidiomycete mycelia was utilized to develop an enzyme-linked immunosorbent assay (ELISA) to assess the presence and the volume of Basidiomycetes in both soils. Results showed that Basidiomycetes were predominant in undisturbed soils. A corticioid basidiomycete isolated in Eastern Montana was found to stabilize sandy soil into persistent, water stable aggregates. This fungus secretes water insoluble mucilage that acts as a binding agent. The fungal mucilage is not destroyed by heat and is stable at –20C. This mucilage can be easily produced in large quantities using batch culture technique.

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A-0539

Information, Visualization and Modeling Technology for Land and Water Conservation. Douglas M. Johnston, Helena Mitasova, Diane Szafoni,William M. Brown, Avinash Srivastava, Wes Reez, Geographic Modeling Systems Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL USA

The Geographic Modeling Systems (GMS) Laboratory is an interdisciplinary association of academic and research organizations involved in the design, development and application of advance tools for geographical modeling in a variety of environmental systems. A significant portion of GMSLab research activity focuses on methods and technology supporting sustainable land use management and protection of water and soil resources. The exhibit will include the following main areas of research and development: Information systems: ISIS, The Illinois Streams Information System (ISIS) is a geographic information system containing descriptive information relevant to Illinois stream reaches with drainage areas greater than 10 square miles. The geographical component is a series of digital data, which provide an accurate graphical representation of the hydrologic system and a visual/locational approach to reviewing and retrieving stream information. The narrative component contains biological, physical, cultural, recreational, and developmental information for each stream. The main goal of this project is to identify and demonstrate ways that the ISIS geographical data can be viewed, queried and linked to the other tabular data sets for use by streams biologists and others. ESRI's Arc View software is the interface used, modified with the

Avenue programming language to provide customized applications and user interfaces. MARIS, The Multistate Aquatic Resources Information System (MARIS) is a six state cooperative pilot project to make accessible, via a common, internet-based application, selected fish population survey data from each of the cooperating states. MARIS states include Illinois, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. These states have developed a statewide fisheries survey database containing information on relative or absolute abundance of fish species, morphometry, location, and water chemistry in selected lakes. Each state will maintain authority and responsibility for its own database, but will support internet access through a defined set of summary queries and reports. GRASS, The new release of Geographic Resources Analysis Support System GRASS5.0 (Baylor University, Texas; University of Illinois at C-U) includes floating point raster support, multidimensional site format and numerous enhancements to existing programs. Pre-configured "toolbox" GRASS installations for specific applications including hydrologic modeling are under preparation. Visualization: Nviz, a 3D dynamic visualization for GRASS5.0, ported to OPEN GL, opens the possibilities for its implementation on various systems. Its capabilities are demonstrated by applications to hydrologic and erosion modeling and soil properties analysis. Virtual Reality: CAVE. The objective of this project is to develop tools to access and display geographic data and update an overland flow simulation in real time as it is produced by a hydrologic model. The data will be displayed in a three dimensional virtual environment using the CAVE Automatic Virtual Environment. Virtual environments allow the viewer to be immersed in the data, therefore increasing perception and realism. The CAVE virtual environment was chosen because unlike head mounted displays, it allows several people to share in the same experience. Digital elevation model and spatial analysis. Enhanced versions of spatial interpolation and topographic analysis tools provide options for surface interpolation from scattered data with spatially variable smoothing and estimation of surface accuracy, as well as computation of slope, aspect, curvatures and partial derivatives for use in hydrologic and erosion models. Modeling and simulation of landscape processes. GIS-based methodology and tools support erosion modeling at various levels of complexity from modifications of the USLE/RUSLE, the Unit Stream Power-based Erosion/Deposition model USPED, to fully distributed, multiscale, process-based simulation tool SIMWE (Simulated Water Erosion). Pflow2d is a parallel implementation of a physically-based, distributed, raster hydrologic model which stimulates the hydrologic response of a watershed subject to a given rainfall field.pflow2d calculates large scale surface runoff by integrating interception, infiltration, overland flow, and subsurface storage detention. Decision Support Systems: HydroPEDDS (Hydrologic Performance Evaluation and Design Decision Support System) is a prototype application for land planners. It is a decision support tool which allows planners to generate alternative land-use scenarios and then compare their hydrological impacts. It is developed from the same ideas as the HydroPEDDS (Hydrological Performance Evaluation and Design Decision Support System) but uses USGS's HSPF modeling software.

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A-0540

Locally Led Conservation Activities: Developing a Soil Quality Assessment Tool. A. J. TUGEL, USDA-NRCS Soil Quality Institute, Department of Agronomy and Horticulture, Las Cruces, NM, USA, S. SEITER, D. FRIEDMAN, J. DAVIS, R. DICK, D. McGRATH, R. WEIL, USDA-NRCS Soil Quality Institute, Oregon State Univ., Univ. of Maryland, USA

Local groups of farmers have developed Soil Quality Assessment Cards according to guidelines for a facilitated farmer meeting. Facilitators follow a nine- step meeting procedure to guide farmers to identify locally important soil quality indicators, develop descriptive terms for soil quality assessments, and design the format of their soil quality card. The procedure is described in the Soil Quality Card Design Guide prepared by the USDA- NRCS Soil Quality Institute, and University research and extension partners in Oregon and Maryland. The farmer meeting provides an opportunity for the Natural Resources Conservation Service, Soil and Water Conservation Districts, Cooperative Extension, producers and others to join together to create do-it-yourself soil quality cards for farmers for each unique cropping region of the country. The field-tested collaborative process used to create the cards offers locally led conservation opportunities for dialogue and idea sharing, thus blending the scientific knowledge of professional conservationists and soil scientists with the common-sense experience of producers. Farmers can use soil quality cards to assess and review changes in soil quality resulting from different management systems or to track changes from year to year. Agricultural professionals, educators, students and others with an interest in soil quality and the impact of management practices on soil can use the cards to enhance communication and learning.

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A-0545

The Effect of Deep Rooted Plant Growth on the Qualities of Overcompacted Soils. Jaan Kuht an Endla Reintam, Estonian Agricultural University, Department of Field Crop Husbandry and Department of Soil Science and Agrochemistry, Eerika, Tartu, Estonia

Deterioration of properties in arable soils having being caused by use of heavy agricultural machinery, improper cultivation and crop rotations is one of the main factors damaging soil environment and yields. Deep compaction caused by trampling does not rehabilitate by itself and the methods having being used up to now help to improve the situation, but only with great difficulties. As in Estonia the share of compacted soil is very big and deep loosening (up to 80 cm) is expensive and requires lot of energy, it can not be applied to large areas. Data are collected in field experiments carried out at Eerika (Tartu county, Estonia) on sandy clay soil (Stagnic Luvisol) and during expeditions carried out different part of Estonia. The purpose of the research was establishment of suitability of various plants of different root types to improve soil qualities and studies to establish the impact of cultivation such plants and its durability on physical and biological properties on the degraded soils. The method was based on biopores, formed in soil by plants, thus creating a loosening effect. Porosity established as the result of biological action is usually more durable than loosening brought along by mechanical action. The soil properties in ploughed layer improved significantly, biopores, formed by plant roots also helped to loosen up deep compaction. The measurements showed great capacity of creeping roots of *Cirsium arvense* to penetrate deep compaction caused by trampling. Creeping roots spreading horizontally in deep soil had also loosening effect. The deep and expanse root system of *Cirsium arevense* make possible the amelioration of soil properties – increasing stable soil porosity and structure.

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A-0547

Intensive Rotational Grazing Effects on Soil Physical Properties. T.E. Schumacher, G.D. Lemme, M.J. Lindstrom, D. G. Johnson, and G.J. Cuomo, Department of Plant Science, South Dakota State University, Brookings, SD USA, West Central Experiment Station, University of Minnesota, Morris, MN USA, USDA-ARS, N.C. Soil Conservation Research Laboratory, Morris, MN USA.

Intensive grazing systems are a viable option for dairy operations especially for operators who wish to substitute off-farm inputs with increased management expertise. Many consider these systems to be more environmentally sensitive and sustainable. A multi-disciplinary study was started in the fall of 1994 to evaluate the use of rotational grazing systems in dairy operations. The soil study compared a non-grazed grass check with two levels of grazing intensity. Plant composition on the measured treatments consisted primarily of a mixture of Kentucky bluegrass (Poa pratensis L.) and smooth bromegrass (Bromus inermis Leyss). The soils on the site are a calcareous loam formed in glacial till with 6 to 12% slopes. Three replications were measured in a strip plot design. Grazed treatments were intensively grazed (56,000 kg of cow/ha) 4 to 6 times per 5 month grazing season by lactating Holstein cows when forage reached 25 cm height. Cows were removed from the plots on the low and high intensively grazed plots when average forage height was reduced to 15-20 cm and 5-15 cm respectively. The grazed treatments were uniformly grazed one time in the fall of 1994. The grazing protocol was applied during the 1995 and 1996 seasons. Soil measurements were repeated in the spring and fall of 1995 and 1996. Soil measurements included bulk density, soil strength, and in-situ measurements of unsaturated hydraulic conductivity using a tension infiltrometer. Bulk density and soil strength measurements were also made on two pasture renovation treatments included in the study, alfalfa (Medicago sativa L.), and a "graziers mix" (a mixture of legume and grass seeds). An initial survey of the site measured topsoil depth for possible use as a covariate in data analysis. Data will be presented illustrating changes that have occurred between treatments during the course of the study.

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A-0548

Application of the ceres-wheat simulation model to durum wheat to simulate the impact of tillage management and nitrogen fertilization on crop response. Castrignanò, A., De Giorgio, D. and Fornaro, F. Istituto Sperimentale Agronomico, Bari (Italy).

This paper is aimed at the study of the ability of CERES-wheat model to be used as a decision-making tool to analyse the impact of tillage management and nitrogen fertilization on crop response. CERES-Wheat is a simulation model widely tested in many regions of the world, but at present there are not still many applications to studies of wheat response to drought. This paper describes the model validation in a semi-arid Mediterranean environment using the data from a tillage management x nitrogen fertilization trial carried out on a silty clay soil in south Italy during two crop seasons. The two compared tillage treatments were traditional mouldboard ploughing and minimum tillage with rotary hoeing in combination with three doses of N fertilization (0, 50 and 100 Kg ha^{-1}) on continuous durum wheat, according to a split-plot experimental design with 3 replications. The results of statistical testing showed that CERES-Wheat crop model could be applicable with sufficient reliability under Mediterranean conditions, generally providing realistic enough information within the growing seasons. It appears, however, that the CERES-Wheat model, developed for more favourable conditions, should be modified or calibrated for the Mediterranean area under moisture-limiting conditions. The model proved useful in investigating the effect of water stress in setting grain number and grain yield. The analysis showed that the influence of stress on

partitioning of biomass to the ear during pre-anthesis ear growth was much more important in determining grain number than was the effect on biomass accumulation during the same phase. The results from the study also indicated that minimum tillage combined with the medium dose of N fertilizer could be recommended in a semi-arid Mediterranean area, because it allows greater saving in time, costs, energy and human work, without causing appreciable losses in yield and reducing the impact of farm management on environment.

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A-0549

Map of soil vulnerability and degradation in Estonia. Loit Reintam, Institute of Soil Science & Agrochemistry, Estonian Agricultural University, Eerika, Tartu, Estonia;, Igna Rooma and Ain Kull, Institute of Geography, Tartu University, Tartu, Estonia

The soil cover of Estonia was mapped at the scale of 1: 10,000 for 1992. On the basis of this large-scale survey generalized maps (1: 50,000) for all counties and some natural regions were compiled. Soil maps at scales 1:200,000; 1:500,000 and 1:1,500,000 represent the product of step-by-step generalization of these large- and middle-scale maps. After the European Soil Bureau activity in 1995, the document to be produced by I. Rooma and L. Reintam was a digitised (digitalisation by A. Kull) "Soil Map of Estonia, 1:1,000,000" compiled on topographic base with FAO–1990 nomenclature used in the Legend. It was edited and published by INRA (France) in "Soil Geographical Data Base of Europe at Scale 1:1,000,000", and demonstrated in the 16. World Congress of Soil Science in Montpellier, France, in 1998. For the SOVEUR Project, advised by ISRIC, a soil map 1:2,500,000 was produced by I. Rooma and L. Reintam whereas this represented a basis for the "Soil Degradation Map of Estonia" compiled by us after the ISRIC methodology. This map with complementary materials will be demonstrated and discussed in our presentation. Taking the percentage of natural stable situation (0–100%) as basic, 13 generalized taxa were distinguished in the map of soil vulnerability and degradation. Most of Histosol and Gleysol expanses as well as large forested areas on different soil complexes are entirely natural stable. Neglected drainage systems have often led to the continuation of gleyization and restoration of waterlogging of formerly drained areas. This kind of physical degradation tends to be actual even for the neighbouring forested and arable lands. At the same time, owing to the land privatization and changes in the types of machinery in use today, a decrease in soil compaction and accompanied surface reductomorphic processes can be observed. As the great majority of the Estonian territory is plain and soil texture is loamy, the water and wind erosion are not natural hazard. Changes in the land use have resulted in the decrease in erosion even on the endmorainic hills of Southeastern Estonia. Acidification is occurred in some sandy Podzols, alkalinization and contamination with heavy metals is relatively high in the region of oil-shale industry and energy production in Northeastern Estonia. Chemicals used in agriculture in predominant cases do not behave as pollutants for soils. An increase in urban land conversion is characteristic of Northern Estonia, but can also be mentioned in other localities. Some local points of industry as well as former Soviet military objects have an importance of soil contamination and pollution. Changes in economic situation in Estonia have positively influenced on soil status and modern soil processes.

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A-0550

Testing and Evaluating the Ephemeral Gully Erosion Model (EGEM) in Mediterranean environments. Nachtergaele, J., Poesen, J., Oostwoud Wijdenes, D., Vandekerckhove, Laboratory for Experimental Geomorphology, K.U.Leuven, Leuven, Belgium, L., Roxo, Departamento de Geografia e Planeamento Regional, Universidade Nova de Lisboa, Lisboa, Portugal.

Recent studies have shown the relevance and importance of ephemeral gully erosion. On the other hand many studies overlook the contribution of ephemeral gullying to total soil loss at the watershed scale.. There are only a few models that can deal with ephemeral gully erosion (e.g. CREAMS, WEPP, EGEM). The EGEM model was specifically developed to estimate soil loss by ephemeral gully erosion. The model has two major components, of which the hydrology component is a physical process model, based on the runoff curve number. The erosion component uses the hydrology outputs to solve a combination of empirical relationships and physical process equations in order to compute the final width and depth of the ephemeral gully (Merkel, W.H., et al., 1988). Although EGEM pretends to have a great potential in predicting soil losses by ephemeral gully erosion, it has never been thoroughly tested. An EGEM-input data set for 86 ephemeral gullies was collected: 46 ephemeral gullies were measured in intensively cultivated land in South-Spain and another 40 ephemeral gullies were measured in both intensively cultivated land and in abandoned land in the Alentejo (South-Portugal). The abandoned fields are part of a system which combines the growth of oak trees (Montado), with a rotation of fallow and cereal. Together with the EGEM-input parameters, the eroded volume per gully was determined, so that the EGEM performance in predicting ephemeral gully erosion could be tested. Besides a simple plot of the predicted erosion volumes versus the measured volumes, a critical analysis of the results and how to interpret them was made. Furthermore, the results of the predicted ephemeral gully erosion could be refined. As the data set for South Spain contains ephemeral gullies that are formed in top soils with a very high rock fragment content., the "channel erodibility factor" and the "Manning's n", which are EGEM-input parameters, can be adjusted for this rock fragment content of the top soil. Another possible refinement concerns the introduction of a distinction between the (sub-)surface characteristics of the watershed and those of the concentrated flow zone. By doing this, concentrated flow zones with conservation measures (e.g. grassed waterways) can be discerned from zones without any protection.

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A-0551

Reduced Tillage Problem in the New Conditions of Romanian Agriculture. Dr. Eng. Vergil GÂNGU, Eng. Florian NEACSU, Eng. Iosif COJOCARU, National Research-Development Institute for Machines and INMA, Department Soil Tillage and Crop Establishment, Romania Bucharest

Situated in the Central-South-Eastern part of Europe, in a temperate-continental climate and having large fertile plains, Romania was considered between the two world wars the granary of Europe, but in the period of the Communist regime Romania lost its top position because of many reasons. Even in this situation, research on Minimum or No Tillage has been carried out in Romania for more than 30 years either on flat or slope fields. Nevertheless these techniques are not large scale extended in our country because of several reasons (lack of appropriate implements, not enough publicity between the farmers, the rules of centralized economy in the former regime a.s.o.). For similar reasons, in the past, ecological aspects and soil protection and conservation were almost neglected . After the 1989 political changes, a lot of changes occurred also in the features of the agriculture in Romania. As a consequence, the main task is to reduce as much as possible the working time and in the same time to reduce fuel consumption, spare parts and time for technical maintenance, but also the damages to the soil that could be obtained by using Reduced or No-Tillage technologies. This paper wants to present some of the Romanian researchers' preoccupation and the results of the experiments carried out in the last years in the field of reduced tillage. Several experimental models have been achieved and experimented in order to solve these problems and to set up sustainable alternatives for soil tillage and crop production according to the agricultural practice, crop diversity, soil and climate characteristics of different regions of Romania. Despite a great number of farmers who do not conceive yet agriculture without moldboard ploughing, it is an almost general practice after late preceding crops, the winter wheat crop establishment after disking because of shortage of time for conventional tillage and seed bed preparation. Good results have been also obtained with a non-inversion chisel ploughing and sowing with a classical grain drill with double-disc openers both designed to the 65 HP tractors, that represent more than 75% of the energy source in Romanian agriculture. The fuel consumption was reduced to 61% and the working time to 52% of the consumption in the conventional technology. On the other hand, in spring there is also a short optimal period for crop establishment. For solving this problem and also for the other reasons presented above, we tried to apply to Romanian agriculture American experience in reduced tillage and we have achieved for the same 65 HP tractors a 4-6 row direct planter, a ridger cultivator and a machine for planting on ridges. The fuel consumption when direct planted was 45-49% of the conventional technology and 35-48% when planted on ridges and the working time was reduced to 28-39% of the conventional one. The soil compaction was reduced either as a consequence of limited traffic and low tire pressure or of natural phenomena and much more present and active fauna. There was not significant difference of yield as compared to conventional technology when weeds have been correctly controlled. An important constraint for extending these technologies, excepted the lack of the machines, is the weed control due to the limited efficiency and high price of herbicides and the safety problems involved by their manipulation and application and their influence on the soil and plants from ecological point of view. There is not yet sufficient data available concerning the soil infestation by leaching of pesticides. Crop rotation and a mix tillage practice with soil loosening and moldboard ploughing every 4-5 years and then reduced or no tillage seems to be also a good way to go on and further research and experience is necessary for finding out the best choice. From technical point of view the straw and other vegetal residues cause many problems for the tillage and sowing implements, whose working bodies have to be optimized. Reduced tillage is therefore a complex problem . Of a great importance for the farmer is an extensive know how to be able to switch from one to another technology according to the specific situation of each year and parcel. A comprehensive range of technical, economic and ecological data is available in Romania concerning where the reduced tillage can be developed, how and in which conditions, with what kind of implements, the potential profit margins, crop rotation etc. It is still to search more ecological aspects and to find an efficient and cheaper way for weed control, to improve the working bodies of the implements for better results even on the fields with high quantity of crop residues and on medium and heavy soils. Of great importance is to transfer information to the farmers and to convince them to overtake the psychological, technical and financial barriers.

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A-0557

Water erosion measurement and mapping on the Balaton Upland in Hungary. Centeri, Cs., Barczi, A., Gentischer, P., Ritter, D., GATE-Talajtani es Agrokemiai Tanszek,

The scientific works in connection with erosion problems began after World War II in Hungary. The well-known erosion prediction projects - like WEPP, CREAMS, etc. models - require too much data that we are not capable to collect since those are not available and have never been collected in Hungary. That's why we chose the USLE model (Wischmeier-Smith). At the University of Agricultural Sciences in Gödöllő, at the Department of Soil Science and Agricultural Chemistry we started a new project. In Hungary we have a brand new national park called the Balaton Upland. Our team has been working on part of this national park for 5 years. With the help of sponsors such as the Ministry of Agriculture we started our research.Our working map was made by the Hungarian Army in 1988 (1:50 000). We used the digital maps of the area (DTA 50, Version 1.0) as well. In addition we used the 1:100 000 Agrotopography Map of Hungary that contains data on erosion, too. After examining books, newspapers, maps and air photos we went to a field trip and chose the job sites for sampling. We wanted to study forests, arable lands, vine-yards and pastures in four slope angles and in three replicates. Since erosion protection is good under forests, we chose them from the second, third and fourth categories. It is almost impossible and not wide-spread to farm on the fourth category so we chose the arable lands, vine-yards and pastures from the first three category. One of our job-site described 5-20 ha (1 acre = 0.4 ha). Inside this site we chose a 50-200 sq. m. (1 sq. yard = 0.836 sq. m.) sample-taking area. On every sample taking area we opened a soil horizon once in 1997. We took four Pürckhauer-samples at the corners of a rectangle about 50-150 meters far from the horizon at upper and lower third of the chosen slopes four times in 1997. We used the GPS (Global Positioning System, Sony Pyxis IPS-760) to record the sample taking points. To build data base, bring them to the map and make it ready to print we used the GIS system, the PC ARC/INFO and ARCVIEW software. To measure the soil loss and to show it on the map we chose the USLE model (Wischmeier-Smith). We used other scientists results to correct the factors - like C-factor - of USLE. According to the results of the soil horizons and the Pürckhauer samples we described the land use categories with special regards to land slopes. We found the soils under the forests well protected. Still - since there is no undisturbed forest in Hungary, every one of them was cut way down at least once in the last 1000 years - there are signs of huge soil losses under the forest. On our area the arable lands had the highest soil losses with no sign of soil protection. The wheat and corn covered the most of the arable lands and there was no sign of using plants that have good erosion protection ability (e. g. alfalfa). In the most part of the year the plant cover was small on the area. We found high erosion sensibility in vine-yards with no sign of soil protection. Since there is a high amount of K and N fertilizer needed on these areas it is important to use some kind of erosion protection. On the pastures it was hard to measure erosion. The natural pastures were on thin soils and/or under antropogenic or disturbed areas. We made maps of the area. You can read the estimated soil loss every 25 meters on our maps. We used the scale of the red color to show the amount of soil loss. The first map shows the soil loss on arable lands. The second map shows the soil loss on forest lands. The analization of these maps shows clearly that the forest is protecting the soil much better than the arable land. The difference comes much better on our next maps, where we gave the C-factor of arable land for the whole area on the third map and the C-factor of the forest for the whole area on the fourth map. This way these two maps are estimating the soil loss. The third says, what if we clear all the lands and use as arable land, the fourth shows what if we plant trees on the whole area. We don't need to analyze these maps to say the differences between the protection sensitivity of the two land use. The soil loss is much higher on the arable lands. Our fifth map has three colors. The USLE says that the acceptable soil loss is 15 tons/ha/year. Meanwhile the soil development is 2 tons/ha/year. The red color shows the areas on the map where the soil loss is higher, than 15 tons/ha/year. The green colors shows where the soil loss is between 2 and 15 tons/ha/year. The USLE allows arable farming with no soil protection on these areas. We say that farmers need to protect the land somehow on these areas. The white color shows the areas where the soil loss is under 2 tons/ha/year. If we want to protect the rich upper layer of the soil we need to farm much carefully and with laying more emphasis on soil protection on huge areas where we disregarded the protection of soil so far. The problem is going further than loosing of soil since the washed soil is going directly to Lake Balaton and provide nutrition for algae and decreases the water quality of the lake. We offer our maps for environmental protection management, farmers, regional planning, measure buffer zones and erosion monitoring. We wish to continue this project in the future. We would like to make it easier to plan protection against erosion for farmers and all the scientists who work on these areas around the Lake Balaton.

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A-0558

The Calculation and Distribution of Rainfall Erosivity in China. Wanzhong Wang, Juying Jiao and Xiaopin Hao, Institute of Soil and Water Conservation, Chinese Academy of Sciences, Yangling, Shannxi Province, P.R.China

A lot of efforts have been made on rainfall erosivity factor (R) which used in the Universal Soil Loss Equation (USLE) in many countries. Several methods or equations were suggested for rainfall erosivity calculation in different regions and countries, and thereby the isoerodent map is obtained. In China, most studies of rainfall erosivity are limited in some local areas. So this paper will: (1) select the appropriate rainfall erosion index applied in all over the China; (2) give the simple calculation method for R values using precipitation instead of rainfall energy; and (3) make the isoerodent map of annual rainfall erosivity of China. Natural rainfall soil loss data of 10 plots from 8 sites was used in this rainfall erosivity index study. These sites include southern red soil region, northeastern black soil region and northwestern loss region. Raingage records in 12 climate stations are used to find a method of simple calculation of soil erosivity (PI30). In order to compare with the USLE easily, PI30 was converted to EI30 by a regression equation. For some locations, event by event rainfall may be not available, a regression equation was fitted for annual rainfall erosivity computation using a total annual rainfall amount. 24 climate stations were used in this calculation. Finally, the rainfall data in 125 stations is used to compute the annual R values. The plot data analysis shows that the appropriate soil erosion indices are the product of total storm energy (E) times the maximum 30-min rainfall intensity (I30) in Northeastern China, EI10 in Northwestern China, and EI60 in Southern China. According to the soil loss data of the 10 plots used in this study, the correlation coefficient between EI30 and PI30 (rainfall amount times I30) was very high by the equations EI30=1.7(P*I30)**-0.136 (I30<10mm/h) and EI30=2.35(P*I30)**-0.523 (I30¡Ý10mm/h). For the annual rainfall erosivity index, equation Ra=0.27(Pa*I60)**1.205 gives reasonable results also, where Ra is annual rainfall erosivity index, Pa is annual rainfall amount, and I60 is the maximum 60-min rainfall intensity in that year. The coefficient of determination(r2) between PI30 and Ra is 0.96. The distribution of annual soil erosivity in China is the decrease from southeast to northwest. The highest center is located in the southeastern coast areas, where the value of soil erosivity is about 1000 hundreds of m¡¤tonf¡¤cm¡¤(ha¡¤h¡¤ yr)-1(579.6 hundreds of feet¡¤tonf¡¤inch¡¤(ha¡¤h¡¤ yr)-1.in U.S. customary units). The lowest center is located inner continent city of Hami, Xinjiang provinces, where Ra is only 1.1. The four regions are divided by the values of R. They are the southeastern region, where the value of R is greater than 400; the middle region, where Ra is 100-400; the transact region, where Ra is 25-100; and the western region, where Ra is less than 25. The correlation coefficients of soil loss to rainfall erosivity indices EI30 and PI30 are almost the same, so the PI30 can be used for where the detail rainfall data is not available. But EI30 can explain the soil erosion dynamic process better. Therefor converting PI30 to EI30 with a local relationship is helpful for comparison between countries in the world.

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A-0560

Predicting hillslope scale erosion on disturbed landscapes from laboratory scale measurements. G.J. Sheridan; H.B. So and C.P. Horn, Centre for Mined Land Rehabilitation, School of Land and Food, The University of Queensland, St Lucia, Qld, Australia.

Open-cut coal mining and associated activities in Queensland have resulted in the disturbance of an estimated 50,000 ha of land. The cost of rehabilitation range from an estimated $5000 to $35,000 per hectare, most of which is associated with earthworks to lower the slopes of the steep spoil-piles produced by dragline operations. The extent and cost of earthworks may be minimised, and failures avoided, if erosion from design landforms can be predicted prior to construction. Recognizing the high costs and inconvenience associated with field based erosion studies, a method was developed and tested for predicting hillslope scale soil erosion from laboratory scale measurements of erodibility. A laboratory tilting flume and rainfall simulator was used to determine rill and inter-rill erodibility coefficients for 32 soil and overburdens from Central Queensland open-cut coal mines. A simple event based model, called MINErosion, was developed based on fundamental erosion processes incorporating functions developed from this research. The model was developed as a user-friendly Windows 95 program to provide a simple method for the rapid assessment of potential erosion from unvegetated post-mining landscapes. Predicted sediment delivery rates based on the MINErosion model were tested against field observations of erosion from 113 simulated rainfall events on 12 m long plots at slopes ranging from 5 to 30 %. Regression analysis showed a good agreement (R2=0.70) between predicted and measured sediment delivery rates. Extrapolation of MINErosion to large field erosion plots established on the outer slopes of waste rock dumps at slopes of 44 % and 75 % shows good agreements with observed erosion rates.

G.J. Sheridan

A-0561

Long-term field experiments - an inevitable basis for the experimental proof of sustainable land use. MARTIN KÖRSCHENS, Centre for Environmental

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The soil is a vital basis for mankind, not only with regard to food production but also to space for living, environment and purity of air and water. Ninety eight percent of human foodstuff are produced via soil. Feeding the steadily incresing world population on the one hand and preserving the environment, especially by avoiding trace gas emissions to reduce the greenhouse effect on the other, call for globally acknowledged measures to safeguard the existence of mankind. Changes of soil properties runs very slowly and it is very difficult to quantify these changes. In case of carbon and nitrogen content in the soil, for example, up to 70 years are necessary to reach a new steady state after changing management system. Investigations of sustainable soil use call for long term experiments which have reached steady state after correspodingly long experimental duration and of which the development of yield and soil properties can be obseved. As criterions for sustainable land use are used: Yield development : safeguarding sustainable soil use demands for high and steadily increasing yields; Carbon and nitrogen balances: for the evaluation of sustainability of various land use systems nutrient balances and organic matter fluxes are an indispensable tool. Nitrogen balances are of special importance, because the effect on yield and the risk of pollution are closely related. Improper, excessive use of nitrogen has led in recent decades to high N losses. Carbon balances, on the one hand, are of growing interest for the estimation of the sink potential of soils for atmospheric CO_2 , and the role of agriculture systems in the global carbon cycle. The results of selected long-term experiments from different countries all over the world are represented to evaluate different fertilization systems for various soil and climatic conditions with view to sustainability.

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A-0562

Effect Of Up-Slope Runoff On Shallow Gully Erosion Process At Down-Slope Section. ZHENG Fen-Li, Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resourses, Yangling, Shaanxi, P.R.China and GAO Xue-Tian College of Water Conservancy and Construction Engineering, Northwestern Agriculture University, Yangling, Shaanxi, P.R.China

Soil erosion on the loess hillslope has an obvious vertical zonation, i.e. sheet erosion zone, rill erosion zone and shallow gully erosion zone. Shallow gully erosion is a special erosion type and a severe erosion process in the Loess Plateau of China. Its area occupies 60% of the total area of hillslope and its erosion amount takes up above 70% of total hillslope erosion amount. Field investigation shows that shallow gully erosion process is closely related to up-slope runoff, but the experimental research is rarely conducted, especially its erosion mechanism is rarely studied. A dual-box system experiment with a 1.5m wide by 2m long feeder box and a 1.5m wide by 3m long test box is conducted to study effect of feeding runoff on shallow gully erosion process at down-slope section under 20 degrees gradient and 50mm/h, 70mm/h and 90mm/h rainfall intensity. Experimental soil is clay loess. The researched results demonstrate that when down-slope accepts up-slope runoff, shallow gully erosion amount at down slope section increases by more than one time. At designed condition, runoff from feeder box flowing into text box is the key reason that shallow gully erosion occurs and develops. In a rainfall event, the erosion amount at the down-slope is dominated by erosion amount of shallow gully channel where single shallow gully rapidly develops. Deep cutting of shallow gully channel and head extension dominate erosion processes of shallow gully erosion. When feeding runoff flows into down-slope section, sediment content in shallow gully channel will increase, increasing amount is controlled by gully channel deep cutting and gully head extension. Runoff velocity in shallow gully channel is three times to the velocity of sheet runoff. When down-slope accepts feeding runoff, runoff velocity in shallow gully channel will increase by about 50%.

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A-0563

Erosion intensity evaluated from microtopographic soil erosion features, and its correlation with conservation practice, slope steepness, presence of fertiliser and the erosion development between alley cropping hedges. Data of Doi Thung and Nan, northern Thailand. Ir.Eelko Bergsma, Soil Science Division, ITC, International Institute for Aerospace Survey and Earth Sciences.

Microtopographic features caused by erosion during the period since the last weeding were recorded as evidence of the accumulated effect of the erosion hazard during that period. The relative intensity of the features allowed a ranking of the investigated plots in the order of their erosion hazard. The microtopographic erosion features used for comparing the erosion intensity of the various erosion plots are the following: - ORIGINAL / RESISTANT clods, original forms that were created by tillage, - ERODED parts, formed by splash and desaggregation (wetting, drying, etc.), - FLOW surfaces, formed by shallow unconcentrated flow, - PRERILLS, micro-channels up to 3-5 cm deep, formed by shallow concentrations of flow, - RILLS, micro-channels, deeper than prerills, - DEPRESSIONS, places between clods where eroded material can accumulate, - VEGETAL MATTER: the basal cover of plants and residues. The ranking of the plots in the order of their erosion intensity, which is derived from microtopographic erosion features, showed a strong correlation with application of fertiliser on the plots, it showed a strong correlation with steepness of slope and it showed how the intensity of erosion in an interval of alley cropping increases within the interval. For cultivation systems as a whole, including all replication plots, a high correlation existed between the erosion intensity derived from surface features and measured soil loss. This had been found before for an hilly area on loess in Holland and for an area on schist substratum in central Thailand. Applications of the method are considered for erosion hazard mapping, for comparing the effect of soil conservation practices and for arriving at criteria for the length between hedges of an alley cropping system in relation to slope steepenss, without having to repeat measurements of soil loss for various situations. The Doi Thung experimental station station is located in the Mae Sai district of Chiang Rai, at 920-960 meters altitude, with an annual rainfall of 1726 mm. The general description of the soil is Haplic Acrisol. Soil loss figures are high, a median value is 140 t/ha/y on traditional fields, on the bare plots it is 330 t/ha/y. The conservation treatments are: Traditional farmer practice, Alley cropping, Bahia grass strips, Hillside ditch, Agro-forestry, Thrash lines. A stated acceptable erosion intensity, for instance expressed by a percentage occurrence of prerills and flow surfaces, could be used as a reference to determine the downslope interval which would avoid higher erosion intensities. In a landscape with various lengths of intervals and steepnesses, the needed relationships may be found without a need for more experimental fields.

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A-0564

Re-interpretation of data from USLE-type of experiments to drive physically-based erosion models with examples from southern China and northern Thailand. B. Yu, C. W. Rose, Faculty of Environmental Sciences, Griffith University, Nathan, Qld, Australia, D. Yin, Guizhou Academy of Agricultural Sciences, Guiyang, P. R. China, and C. Anecksamphant, Department of Land Development, Bangkok, Thailand

The USLE/RUSLE has a profound influence on the way in which soil conservation research is conducted around the world. Typically, standard or nearly standard USLE runoff plots are set up on different slopes, and rainfall, runoff and soil loss are measured for individual storm events for various treatments representing different conservation technologies to be tested. What is missing from this type of experiments is data on the runoff rate. Runoff rate is one of the most important determinants of the rate of soil erosion, especially on sloping lands. Data on runoff rate are explicitly required to drive process-oriented soil erosion models such as WEPP and GUEST. In WEPP, for instance, the rate of soil erosion is related to the peak runoff rate. In GUEST, the sediment concentration at the transport limit is related to a weighted average runoff rate, known also as the effective runoff rate. Analysis of 1-min rainfall and runoff rates from several sites in Australia and South-east Asia has shown that a one-parameter infiltration model is adequate to generate storm hydrographs given rainfall intensity and runoff total. One of the distinct advantages of using this simple infiltration model is that there is no need to select model parameter values for individual storm events. In this paper, we use this methodology to generate hydrographs for two sites in southern China and northern Thailand, respectively, and show how to apply the physically-based model GUEST to these sites. In addition, we compare USLE/RUSLE and GUEST erodibility parameters using an identical set of rainfall, runoff and soil loss data for the two sites.

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A-0567

Research and practical experiences with vegetative barriers for water erosion control in Venezuela. Oscar S. Rodríguez P., Conservación de Suelos y Agua, Instituto de Agronomía, Onelia Andrade, Universidad Central de Venezuela. Instituto de Edafología, Maracay, Estado Aragua, Venezuela

Data obtained from erosion plots under natural and simulated rainfall through different experiments within the period 1980-1998 is summarized using ¨CP¨ factor (USLE) as an indicator of water erosion control efficiency by vegetative barriers. Different plant materials, mainly grasses (*Andropogon gayanus, Cenchrus ciliaris, Cymbopogon citratus, Vetiveria zizanioides, Trixacum laxum, Nephrolepis sp. and Agapanthus africanus*) were evaluated under different experimental conditions. Variations in slope gradient, agroecological conditions, land use and soil management between barriers, as well as different lengths of slope, plants age and success of establishment influence the efficiency of vegetative barriers for water erosion control. CP values range from less than 0.001 when the barriers were associated with high levels of residue cover and permanent crops up to more than 0.53 when vegetative barriers are alone (bare soil upside the hedges) and recently established. Vetiveria zizanioides and Trixacum laxum were the most efficient in reduce water and soil losses but the other plants demonstrate good potential in particular land use systems and circumstances. Additional information related to vegetative barriers behavior and performance was collected in order to assess criteria for its selection and best management when used for water erosion control. A table is presented as a guideline to design vegetative barriers spacing considering rainfall erosivity, soil erodibility and crop- management intensity. Practical experiences using vegetative barriers within farmers fields and rehabilitation processes of degraded lands have demonstrated the high potential of this soil conservation technology to help develop sustainable land use systems.

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A-0569

Identification of Regional Soil Quality Indicators for the Central High Plains. John J. Brejda, USDA-NRCS, Soil Quality Institute, Ames, IA USA, Thomas B. Moorman and Douglas L. Karlen, USDA-ARS, National Soil Tilth Lab, Ames, IA USA

Soil quality monitoring is hindered by our inability to measure soil directly, and the high correlation between soil properties that serve as indicators. The objectives of this study were to: 1) identify sets of soil quality indicators for use in the Central High Plains region, and 2) evaluate how these indicators vary with land-use, landscape position, and slope aspect. A statistically representative sample of National Resource Inventory sites within the distribution of the Ascalon (Fine-loamy, mixed, superactive, mesic Aridic Argiustoll) soil were sampled and analyzed for twenty soil properties. Factor analysis was used to identify sets of correlated soil properties that could serve as soil quality indicators in this region. Five groups of soil properties were identified which explained over 76% of the total variation in the data. The first group, termed the organic matter factor, was comprised of organic C, microbial biomass C, basal respiration, total N, potentially mineralizable N, and water stable aggregates, and accounted for 23% of the total variation in the soil properties. The second group, termed the soil texture factor, was comprised of sand, silt, and clay content, and CEC, and accounted for 22% of the variation in the soil properties. The third group, termed the soil acidity factor, was comprised of soil pH and exchangeable Ca, Na, and acidity, and accounted for 14% of the variation in the soil properties. The fourth group, termed soil color, and fifth group comprised of extractable P, accounted for <10% of the variation in the soil properties. Both the organic matter factor and soil acidity factors varied significantly with land-use. None of the soil quality factors varied significantly with landscape position, and only soil color varied significantly with slope aspect. The results suggest that the soil organic matter factor may offer the greatest potential for measuring soil quality at a regional scale in the Central High Plains.

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A-0570

Influence of Irrigation Water Properties on Furrow Infiltration. Lentz, R.D. and D.L. Bjorneberg, USDA-ARS, Northwest Irrigation and Soils Research Lab., Kimberly, ID USA.

Water infiltration into soil is critical in agriculture. For surface irrigation, the rate and spatial characteristics of infiltration processes influence cropping productivity, water use efficiency, and erosion potential of stream flows. A change in infiltration rate alters furrow stream flow velocity and shear, and hence irrigation-induced erosion. Furrow irrigation models may be improved if they can account for the influence of water properties on these processes. The kinds and amount of electrolytes and suspended sediment in irrigation water affect infiltration by altering depositional seal formation in furrows. Water temperature may influence furrow infiltration by altering fluid viscosity. We conducted laboratory soil column intake (constant head), and field recirculating furrow infiltrometer experiments, to determine whether irrigation water temperature significantly altered infiltration. The soil was Portneuf silt loam (coarse-silty, mixed superactive, mesic, Durinodic Xeric Haplocalcids). Soil column intake increased by 0.8 to 2.7 percent per degree C. These values corresponded well with the smaller furrow infiltrometer database, which showed a 2.0 to 2.9 percent infiltration rate increase for each degree C increase in irrigation water temperature. More field studies are needed to clarify this water temperature effect; however, these data show that diurnal and seasonal changes in irrigation water temperature can significantly altered furrow infiltration and stream flow. These effects may help explain observed infiltration field variability. Inclusion of temperature algorithms in furrow irrigations models may increase their predictive accuracy.

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A-0572

Rocks and Rills-impact of stones on soil loss in laboratory experiments. Dirk Rieke-Zapp, Purdue University, West-Lafayette, IN USA, Dr. Jean Poesen, Laboratorium voor Experimentelle Geomorphologie, Leuven, Belgium, and Dr. Mark Nearing, USDA-ARS, National Soil Erosion Laboratory, West-Lafayette, IN USA

In recent times people become more and more interested in the role rock fragments play in soil erosion. Since considerable attention has been paid to study the effect of the finest particles the demand was rising to focus on the interaction between fine particles and rock fragments and their effects on soil loss due to some reasons. Rock fragments can have a variety of contrasting effects on the hydraulics of overland flow and soil erosion. Therefore flume experiments were conducted in which overland flow was applied to a typical Miami Silt Loam (fine-silty, mixed, mesic Typic Hapludalf) a typical soil of the Midwest of the United States. The study focused on four different treatments: slope (7 and 14%), discharge (5,7 and 11,4 L/min), rock fragment content (0; 5; 10; 20, 40 Vol.%) and time. The results show the development of an erosion pavement over time and a kind of armoring for soils containing rock fragments. The Intensity and the speed of developing this pavement depend on slope, discharge and initial rock fragment content. An increase of the rock fragment cover ontop of the erdoing surface leads to an armoring effect reducing soil loss that can be plotted in different ways for illustration. The more rock fragments are applied to the soil the less sediment yield was observed in general. It was part of the experiments to use a laser scanner and other methods to evaluate soil surface roughness and the increase of stone cover during the experiments to find a method of measuring the covering or armoring effect. Reynolds number, Froude number and Darcy-Weisbach coefficient were calculated and plotted versus time to find a relationship for the decrease of soil loss due to a rising covering effect. It was found that rills form narrower and deeper in soil material with less stones applied. For turbulent flow Darcy-Weisbach coefficient is positive correlated to Reynolds number due to the development of headcuts one can not refer from hydraulic flow data to an increase in surface armoring.

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A-0573

Assessment of wind erosion parameters using wind tunnels. Lawrence J. Hagen, USDA, ARS, Wind Erosion Research Unit, Kansas State Univ., Manhattan, KS USA

Empirical wind erosion prediction models frequently use a single factor to represent the soil loss ratio from a test surface and a defined reference surface. These ratios are often determined in wind tunnel tests, but their interpretation for a field scale is problematic. In addition, the ratios also are highly dependent on the wind speed used in the tests. Another approach, described in this paper, uses wind tunnels to obtain physically-based parameters that control the erosion processes for a range of surface conditions. These parameters include the erosion threshold friction velocity, the emission coefficient for loose soil, the abrasion coefficient for clods/crust, and the breakage coefficient of saltation/creep aggregates to suspension-size. These parameters, along with the aggregate size distributions created by various processes, determine the downwind soil discharge in the saltation/creep and suspension transport modes. The sources of the PM-10 fraction generated by wind erosion processes also can be determined using wind tunnel tests. The wind tunnel test configurations to obtain these parameters are described in the paper. In general, one needs a relatively long wind tunnel, an upwind abrader feeder, wind speed measuring transducers, various surface materials, and specialized soil catchers to obtain downwind mass and size distribution of the soil discharge.

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A-0574

A Study on Erosion Environment Harnessing in Shenfu-Dongsheng Coal Mining Area. Gao Xuetian, College of Water Conservancy and Construction Engineering, Northwestern Agricultural University, Yangling, Shaanxi, P.R. China

Shenfu-Dongsheng coal mining area, a base for high quality power coal production, locates in wind-water erosion interaction zone of the Loess Plateau, where wind erosion and water erosion are key reasons of fragile eco-environment and main restricting factors of coal mining and sustainable development of mining area. In early stage of coal exploitation, fragile environmental characteristics was rarely taken care of, so some necessary prevention and control measures were not implemented. As a result, land desertification and soil and water loss intensified; river bed deposition and flood disaster increased; groundwater level declined and surface water resource reduced, which resulted in the fact that irrigated land became dry land. All this makes original fragile environment tend to be more fragile and seriously threatens safe production sustainable development of the coal mining area itself. Coordinance of coal exploitation with environment becomes an important project of mining area's construction and sustainable development. Erosion environment control which suits the harnessing of wind erosion and desertification and soil and water loss as main characteristics is the environment control core of the mining area. Based on analysis of natural environment factors, (1) it is considered that thoroughly controlling wind erosion and desertization, and soil and water loss are impossible in Shenfu-Dongsheng coal mining area. (2)The environment harnessing should focus on the environment improvement as a whole in all mining area, but not reducing sediment only. (3) The key of the harnessing is the systematic controlling of fragile eco-environment which wind erosion and desertization, soil and water loss are mainly characterized. (4) From current conditions of erosion environment and actual situation of exploitation and construction of Shenfu-Dongsheng coal mining area, the cardinal way of environment harnessing in the mining area is that breaking through the traditional environment protection model, taking erosion environment harnessing as the center, and taking the environment harnessing as an important component of resources exploitation and economic development to form a mutually promoted mechanism of coal are environment harnessing, coal resource exploitation and regional economic development.

Gao Xuetian

A-0575

Erosion Effects on Carbon Pools in Soils within the United States. John Kimble, NRCS, Lincoln, NE, Rattan Lal, Ohio State University, Columbus, OH and M. Mausbach NRCS, Washington, DC USA

Soil organic carbon is concentrated near the pedosphere surface and therefore is very susceptible to the effects of erosion. Many areas in the United States have been effected by both wind and water erosion. Estimates from the USDA-SCS (NRI, 1992) show that up to 1038 MMT/yr soil may be lost by water erosion and 833 MMT/yr soil by wind erosion on cultivated cropland. There are also major loses on uncultivated cropland and rangeland by both water and wind erosion. The movement of topsoil through erosional processes can lead to increased atmospheric releases of carbon dioxide through accelerated oxidation of the SOC. Some of the material transported by erosional processes may lead to deep burial in the soil profile and deposition in water bodies but the positive effects of SOC in the pedosphere are lost. Loss of soil carbon stocks through erosional processes reduces aggregation and reduces the natural fertility of the soil. The loss of SOC leads to a decrease in soil quality and a reduction in the sustainability of the overall farming system. Data is presented showing the effects of soil erosion on the overall carbon stocks and the how the reduction in SOC also effects other soil properties.

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A-0577

Factors Affecting Agricultural Sustainability in the Pacific Northwest, USA. D. K. McCool, K. E. Saxton, D. R. Huggins, and A. C. Kennedy, USDA-Agricultural Research Service, Biological Systems Engineering Department, Washington State University, Pullman, WA USA

The Pacific Northwest drylands are a unique and valuable agricultural resource because of their deep loess soils and favorable climate. Soil, water, and air quality are threatened, however, by substantial resource degradation that has occurred due to agricultural practices used over the past 120 years. Inversion tillage has accelerated water erosion and tillage-induced soil translocation, and resulted in decreased rooting depth, water holding capacity, organic matter, porosity, infiltration, biological activity, and nutrient availability at eroded surfaces. Over time, depositional surfaces have received subsoil from eroded uplands with markedly poorer soil quality. Use of ammonical fertilizers has promoted soil acidification to levels that adversely impact crop yields, increase soil-borne disease pressure, and decrease nutrient cycling and use. Compaction, water-logging, and poor aeration are problematic in poorly drained lowlands. Drier areas of the region are subject to severe wind erosion and associated loss of topsoil and degraded air quality. Reduced tillage and direct seeding offer a means to promote agricultural sustainability by reversing the deterioration of soil, water, and air quality. This presentation will cover causes and effects of soil degradation in the dryland areas of the Pacific Northwest and document efforts to reverse the process.

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A-0578

Global assessment of land quality. Fred H. Beinroth, Hari Eswaran and Paul F. Reich, Dept. of Agronomy and Soils, University of Puerto Rico, Mayaguez, PR

Land quality is a measure of the ability of land to perform specific functions. In the context of this study, the function is to sustain grain production and respond to cultural practices conducive to sustainable land management. The principal determinants of land quality are soil performance and soil resilience. Two databases were critical to the global land quality assessments presented in this study. First, the 1:5,000,000 FAO-Unesco Soil Map of the world, now available in digital form, whose map units were translated into taxa of Soil Taxonomy. And, second, a global climatic database comprising records for about 25,000 stations, which allowed to compute soil moisture and temperature regimes and produce a pedoclimate map that was superimposed on the soil map. This information was used to group the units of the soil map in one of nine land quality classes, with Class I having the most favorable and Class IX the desirable attributes. A GIS based spatial analysis revealed the following global extent of soil quality classes, as a percentage of the 130,576,900 km^2 of ice-free land of the world: Class I, 2.6%; Class II, 6.8%; Class III, 3.0%; Class IV, 3.3%; Class V, 17.5%; Class VI, 7.4%; Class VII, 5.3%; Class VIII, 26.6%; and Class IX, 27.5%. Class I , II and III land occupies only a small fraction of the global land surface (16.2 million km^2, 12.4%). These lands are generally free of constraints for most agricultural uses. They are, however, spread unequally around the globe and occur predominantly in the temperate regions. Class IV, V, and VI land occupies a significant part of the earth's land surface (36.6 million km^2, 36.6%). The soils of these areas require considerable management inputs and conservation practices. The large area of land in Class VII, VIII and IX (77.6 km^2, 59.6%), which includes the desert and the tundra regions, is either too dry, too wet, too cold or too steep and thus unsuited for sustainable grain production. Although the above land quality estimates inevitably lack precision, they are nevertheless considered an improvement over previous efforts as they are based on solid soil and climate data, which were processed with GIS technology. The analysis shows the relative scarcity of prime agricultural land and the resulting imperative to preserve these areas for food production and optimize the land use of the remaining areas.

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A-0581

A Large-Scale Soil Information System for Land Management Decisions in Flanders (Belgium). Johan DESMET, Senior Research Officer, Agricultural Research Centre–Gent Research Group: Land Management, Merelbeke, Belgium

Geoinformation technology has become an essential tool for sustainable development of natural resources and for land management in general. The collection of data and their incorporation into Geographical Information Systems (GIS) forms the basis for the spatial analysis of the many land use aspects of development and management of land. With these new techniques it is possible to visualise on a map the changes occurring with land, the land readjustment programmes and the environmental issues as well as the economic aspects of land management. Belgium is the only country in the European Union that has surveyed its soils on a scale of 1/5000 and has published those maps on a scale of 1/20 000. Geographical Information Systems (GIS) have made it possible to realize a large scale Soil Information System (SIS) based on those digital soil maps and on a detailed, metrically corrected cadastral map (scale 1/2000). From the suitability maps for various cultivation groups, the inclusion of socio-economic data of the individual agricultural production facilities in the SIS and through thematic processing an agricultural map is obtained, which can serve as a basis to balance agricultural and environmental interests. A typical application of such a SIS at local and regional level is the study of the influence of the Regulations for Environmental Licensing for pig houses and poultry houses.

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A-0582

Methods and Practices of Soil and Water Conservation in South China. Li, Huaxing. Professor, College of Resources and Environmental Sciences, South China Agricultural University, Guangzhou, P.R.China

The red, yellow soil areas in South China stretches over tropical and subtropical regions, covering an area of 2.20 million km2 and spreading over 13 provinces---Zhejiang, Jiangxi, Hunan, Yunnan, Guizhou and parts of Sichuan, Hubei and Anhui. There are about 410 million of agricultural population and 26 million ha of arable land in this region. This area is China's important production base of grain crops and is regarded as having great potential productivity for tropical and subtropical cash-crop production and animal husbandry development because the warm, wet season favors crop production and rapid biological cycling. However, owing to mismanagement and inappropriate land uses, the area of soil erosion increased from 600,000 km2 in 1950s to 740,000 km2 in the early of 1990s. With 0.06 ha of arable land per capita, loss of productive land is serious problem in South China today. A variety of approaches have been developed by Chinese scientists to restore degraded lands and to conserve the soil and water including engineering measures and biological measures, steroagriculture and other agricultural measures. Engineering measures to reduce soil erosion in hilly region focus on check dams, hillside catchments, hillside diversion channels and terraces. Check dams placed at the gully opening slow floodwater and trap sediments, ultimately raising the mouth of gully and creating the proper conditions for growing plants. Biological measures, on the other hand, can provide permanent soil erosion control, and reduce nutrient and water loss. Plant measures concentrate on planting fast growing trees and herbs. Trees, bushes and herbs were grown together in a certain proportion when carrying out revegetation. The combination of plants contributes beneficially to revegetation and can help to form a multilayer canopy; such vegetative canopies provide higher benefits erosion control and soil fertility enhancement. For example, in Meixian County of Guangdong Provinces, the rapid plant cover technique shows that the vegetation cover reached 80-100% in the same year during which the plants were grown, and made a pronounced effect on controlling erosion by stabilizing gully walls and reduced runoff value by 40-100%. Steroagriculture is an important form of ecological agriculture that is practiced in hilly areas of South China. This form of agriculture is designed to generate a variety of products from a topographically varied side. The benefits of steroagriculture include improvements in environment quality and reduced economic risks for farmers. By taking a certain policy action, such as prohibiting slash-and-burn cultivation, and adopting other agricultural measures, the soil fertility and soil moisture retention can be improved more quickly and effectively.

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A-0583

Evaluating the potential of integrated crop management, AgCover systems, and participatory approaches to improving food security of small holders in the tropics. K. Schlather, R. Puentes, B. Triomphe, M. Meilitta, M. Flores, J. Mureithi, and S. Swink, Cornell University, Ithaca, NY USA

Several organizations from around the world are collaborating on an examination of the current and potential value of three approaches to increasing food security for rural poor in developing countries. The three approaches include 1) participatory approaches to the generation and dissemination of innovation (PA), 2) the use of integrated crop management with an emphasis on integrated nutrient management (INM), and 3) the use of any of a group of technologies including green manures, cover crops, managed

fallows, and reduced tillage (systems using any of these technologies are hereafter referred to as AgCover systems). The evaluation relies on information drawn from 4 main components. They are: 1) analyses of cases of AgCover and PA, 2) surveys of institutions and interviews of individuals involved in any of the three approaches, 3) literature (from both refereed journals literature sources reviews, and 4) field trials and other forms of research carried out small focus groups and working groups in collaboration with any or all of the participating organizations. The collection and analysis of the information is being facilitated by more than 100 individuals who have extensive experience with at least one of the approaches. Outputs will include: A summary of the critical issues facing each of the three approaches to increasing food security;. a summary of current INM strategies and knowledge related to INM; conclusions about the current and potential contribution of AgCover systems towards increasing access to food and other resources on the part of the rural poor in developing countries; potential agroecological and scioeconomic niches for AgCover systems; an analysis of knowledge gaps and research opportunities in INM and AgCover systems (a draft research agenda); and a summary of the current status of participatory approaches to generation and diffusion of innovation, including methodological aspects, training requirements, and its integration into formal research and extension systems. Selected outputs from the evaluation will be presented, and discussed in terms of sustainable land use in marginal areas of tropical countries.

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A-0585

Wind Speed Effects on Rain Erosivity. Katharina Helming, ZALF, Dept. of Soil Landscape Research, Muencheberg, Germany

The kinetic energy of rainstorms plays a paramount role in surface sealing, runoff, and erosion processes. Typically, the kinetic energy rate is calculated based on terminal velocity of vertically falling raindrops. Yet, few studies have investigated the effect of wind on the rainfall energy and on the inclination angle of raindrops. This paper reports a first attempt to study (i) the effect of wind speed on the kinetic energy of rainstorms, (ii) the relationships between rainstorm intensity and wind speed, and (iii) to determine the frequency distribution of raindrop impact angles with respect to soil gradient, aspect, and surface microrelief. High resolution rainfall intensity and wind speed measurements were carried out during two 6 month summer periods at an investigation site in northeastern Germany. The kinetic energy and the inclination angle of the wind-driven rain was determined through application of a simple equation which combines the horizontal wind speed with the vertical drop velocity for a given drop size. For simplicity, drop size was held constant at 2 mm. The frequency distribution of raindrop impact angles with repect to slope, aspect, and surface microrelief was determined for three plots located on three adjacent slopes with varying aspect. The surface microrelief of the three plots was determined using a laser scanner with 2 mm grid spacing. The results showed: 1) the rainstorm kinetic energy, determined with respect to the wind speed, reached a maximum of two times the value of the calculated kinetic energy without the windspeed factor; 2) there was no association between rainstorm intensity and wind speed for different storms; 3) although the temporal variation of the wind speed during storms was high, it was not associated with the temporal variation of the rainstorm intensity; 4) the effect of wind speed on the raindrop impact angles differed with the aspect of the plot. The results suggest that wind speed has considerable affect on rainstorm kinetic energy and the raindrop impact angles, and therefore influences the sealing and runoff generation processes. However, further investigation is needed to quantify the interrelating effects between rainstorm intensity, wind speed, drop size distribution, and rainstorm kinetic energy.

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A-0586

Soil cover on slopes and subsurface shallow lateral water flow**.** P.Novak, S.ZlatuskovaResearch Institut for Soil and Water Conservation Prag, Praha – Zbraslav, Czech Republik

The structure of soil cover on the slopes is not only the result of soil evolution and erosion but also the result of shallow water flow through the soil laterally down the slope. Relations among complicated soil cover on the one side and different depth of water impervious layers, transport of many substances with flowing water, occurrence of the slopes springs on the other side are the subject of this paper. Directions of subsurface shallow lateral flow were constructed and redistribution of substances as a result of subsurface water flow was found out. Complicated but inevitable conditions, mosaic soil cover and redistribution of some substances should be taken into account in investigation efforts, land protection and reclamation.

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A-0589

Evaluation of cropland resources - an integrated approach. Gergely Toth, Department of Soil Science, Pannon Agricultural University, Keszthely Deak, Hungary

One of the issues in sustainable land use planning is the expression of land quality - land productivity relationship. The fine expression of this relation, however, is only possible with the understanding of the original crop growing potential of different soil types and their sensitivity to soil degradation. Agricultural land evaluation (crop productivity rating) - based on the natural and inherent characteristics of the land - categorize lands according to their suitability for crop production and the nature of limitation (if any) in production. The main goal of a land evaluation system is to express the relative production potential of different soil (and land) types. Using large scale soil maps - with detailed land and soil unit characterization as a basis of the rating process - it is possible to make territorial differentiation of crop productivity of a given area. First step in establishing an evaluation system is to set up productivity „limits" for different soil types. Low and high values of long term crop yields harvested on the same soil type indicate these „limits". The rating process then includes evaluation of the individual and combined (conditional) effects of soil characteristics on the productivity. The magnitude of the influence of the soil characteristics are different in the cases of different soil types and can be expressed numerically. The product of the analysis is a crop productivity rating system, which evaluates the lands' production potential and the role of the soil and land characteristics in this potential. On the top of the crop productivity measurements, the soil type based land evaluation system can also express soil quality related measurements. In this context soil quality means the level of degradation or the risk of degradation. The degree of loss in soil productivity after soil degradation (of different kinds), is an interim characteristic of different soil types. On the basis of the land evaluation - the quantitative expression of the land's relative production potential - and different kind of soil degradation (erosion, acidification, compaction etc.) measurement an integrated method becomes available to express land quality - land productivity relation. A new method is introduced to categorize lands according to their crop productivity, based on genetic soil classification. An attempt is made to integrate soil quality measurements into the rating system.

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A-0590

Influence of Soil Pollution with Heavy Metals on Lands` Quality and Plant Production and Regimes of Land Use in Bulgaria. Dr. P. Bojinova, L. Stanislavova, Institute of Soil Science and Agroecology, Sofia, Bulgaria

Heavy metals are a natural constituent part of soils. Along with geogenic content an anthropogenic pollution exists. The last one bring about to a soil enrichment with heavy metals and various ecological problems. In spite of the small territory of Bulgaria (111 000 km^2) a relatively large number of metallurgical plants (ferrous and non-ferrous) have been built. The basic pollutants of their activity are Cd, Cu, Pb, Zn and As. Because of the ecological significance of this pollution - accumulation in plants, heavy metal deposition on the surface soil horizons or in ground water and their toxic influence causing damages and losses for agriculture and some serious health problems a huge investigation in large scale (1:10 000 and 1:5000) was carried out in all regions of the country touched by industrial activity during 1989-1994. This action was imposed by the fact that a land reform connected to arable land restitution is going on. On the base of available data from all investigations, carried out from different organisations a method, an instruction and a decree for an assessment of polluted lands and recommendations of restrictive regimes of their use according to the levels of soil pollution were developed. The pollution was classified in three zones - "A", "B" (subdivided to B I, B II and B III) and "C". Zone "A" was determined as a multifunctional without any limitations. Subzone BI has 1 to 2-fold permissible concentration levels (PCL) and it is determined as a slightly polluted, BII (2-3-fold PCL) - middle and BIII (3-5-fold PCL) - strongly polluted. Zone C has >5-fold PCL and such soils are determined as dangerous polluted or irrevocable. Till now there is no any other alternatives created for the making of agronomic solutions under the existing conditions except restrictive regimes of land use. A large number of soil and plant samples were analysed in order to get real picture about sensitivity of crops to heavy metal impact express like phytotoxicity, metal accumulation, possible risk for consumers (human and animals) and the lest recommendations for each zone. Some of the regions allow the cultivation of 145 kinds of crops, that's why experimental plots with known heavy metal content were used, as well in order to determine transfer facilities of different plant species and the influence on their quality. A detail scheme concerning all zones, except A, considers recommendable and uncommendable species belonging to groups of crops (vegetables, cereals, fruits, forages) but for every kind of them separately.

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A-0591

Participatory land and water management: Silsoe Research Institutes' Experiences from Latin America and sub-Saharan Africa. Brian G. Sims, Steve J. Twomlow and Jim Ellis-Jones, International Development Group, Silsoe Research Institute, Wrest Park, Silsoe, Bedford, UK

Soil conservation has been strongly promoted in almost every country of the developing world over the last 50 years and a large number of, often technically sound, conservation technologies have been developed. As a consequence there have been many soil conservation projects and programs implemented. Despite this, the extent of land degradation resulting from water and wind erosion is greater than ever before. Historically, projects have concentrated on the introduction of technologies designed elsewhere, but the high failure rates of such projects and the low adoption of the

introduced technologies is an indication that this approach is flawed. Consequently the International Development Group at Silsoe Research Institute in the UK has, over the past decade been working with small-scale farmers in Latin America and sub-Saharan Africa to develop participatory methodologies that provide opportunities to build upon: Traditional farming methods in Zimbabwe (eg: using ripper tines attached to the existing draft animal plow for timely planting followed by weeding with the plow, rather than manually). Indigenous soil and water conservation systems (ISWC) in Kenya, Tanzania and Uganda, including the use of trash and stone lines, pits and ridges and banana mulching. Leguminous cover-crop and live-barrier species for a wide range of agro-ecological and social environments in Bolivia and Honduras. Our work has endeavoured to establish a more enlightened approach to land stewardship, the principle of which is that development should be promoted by building on what farmers are already doing through indigenous practices and local knowledge. We focus on farmers' concerns such as moisture conservation and fertility enhancement for crop production and we are partners with farmers throughout the whole process of research identification, planning, implementation, monitoring, evaluation and dissemination of results. Work focuses on the quantitative assessment of the technical appropriateness, economic viability, social acceptability and adoption practices of the various conservation technologies. Evaluations have included their ability to reduce runoff, slow the rate of soil erosion, increase soil moisture availability and enhance soil fertility. The work has broadened the understanding of the technical and economic performance of these technologies, as well as providing greater insight to farmer selection and decision making criteria. We have prepared training courses on Sustainable Hillside Agriculture for the University of Pinar del Rio in Cuba and CIAT, Bolivia for further dissemination to NGOs working in hillside areas and resource materials for Zimbabwe's smallholder farmers to assist them in making informed choices for conservation technologies and improved land management.

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A-0593

The West African Rural Foundation**.** Abdou Fall Head of Participatory Research Unit of WARF, Dakar Senegal

The southern area of Senegal and The Gambia are the most appropriate zones of the traditional rice growing of these two countries of West Africa. The growing rice potential of this area is due to the agro-climatic condition favorable at one time and the place rice occupies in the culture of Diolas, Mandingues and Balantes which populate these areas. In these communities rice growing is an activity of the women which makes it possible those to contribute to the food security of the household. Since large drought of the Seventies, the populations of these two areas are facing with salt intrusion as well as acidification of their lowlands devoted to rice production. These communities with the support of their respective State through soil and water management services and projects tried various technical solutions to restore the production capacities of their soil . The limited success of those interventions led on the lack of community participation on decision making as well as program designing and implementation. The West Africa Rural Foundation (WARF) tested with village communities of these two areas a participatory approach and organizational mechanisms. This WARF support strategy based on the responsabilisation of the local communities, the progressiveness of the actions and a partnership between the actors based on a clear definition of the roles and responsibility, made it possible to recover significant land surfaces initially affected by salt, to test the adaptability of the varieties of rice and to reinforce the organizational and negotiation capacities of the communities through their organizations. These various measures made it possible the communities with the support of their partners : NGOs, public agencies (Extension and Research services) to improve to a significant degree the farming system , to increase the incomes of households while preserving equity in the access and the control of the natural resources for the women.

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A-0594

Adoption and Maintenance of Soil Conservation Practices in the Dominican Republic Highlands. Bénédicte de la Brière, International Food Policy Research Institute, Washington, D.C. USA

The paper formalizes the determinants of adoption and maintenance of soil conservation practices on peasant households' food plots in northern Dominican Republic highlands. We model this decision as a two-step labor allocation choice, in the context of imperfect food markets. In the first period, households may decide to adopt soil conservation as the result of allocating labor between farming, conservation activities and casual off-farm wage labor. Conditional of this decision, in the second period, households decide to maintain or abandon the conservation practices. Households may receive training and technical assistance from a local rural development program. A household survey took place in collaboration with Plan Sierra, a local rural development program during summer 1994 in two watersheds of the Dominican Sierra. Complete information is available for 334 households of which 190 had participated in Plan Sierra's soil conservation program which included training, tools, labor in the form of work groups for setting-up conservation devices (terraces, barriers, drainage ditches, canals) and food-for-work subsidies for two years after adoption. Apart from the devices mentioned earlier, Plan Sierra also promoted crop rotation, crop mixes, hedgerows with nitrogen-fixing trees, green mulching and contour-sowing. Adoption behavior is analyzed using probit regressions. Duration models are used to describe maintenance and abandonment behavior, as farmers choose the practices most suited to their farm environment. Subsidies in the form of food-for-work help bring marginal households into soil conservation. Results show nonetheless that very small holders tend to abandon conservation practices once the subsidy stops, because their labor yields higher returns on the labor market. For large farmers, slash-and-burn rotation of food plots is a cheaper option than soil conservation. The main adopters are thus households strongly vested in agriculture, with few exit options. The adopted soil conservation practices extend the useful life of traditional food plots from an average of three to six years.

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A-0597

Traditional Practices For Local Land And Water Conservation Under The Huza System Of Farming In Ghana. David K. Bedele, B.A (Hons) M.A. Phd., Faculty Of Social Sciences, Kwame Nkrumah University Of Science & Tech., Kumasi, Ghana

Huza is the system of farming practised by the Krobo of the Eastern Region of Ghana. Under this system, a parcel of land is required by purchase by a group of farmers with a leader. The land is then shared is strips usually across a stream according to how much one is able to pay for. Each person settles in his own holding. This forms a linear settlement along the stream. This parcel of land, together with the settlement on it, forms the Huza and the form of agricultural practice of the people is referred to as the Huza system of farming. (Hill, 1963; Field, 1943 and Bedele, 1993). The organisation of the farming system under a leader promotes community conservation of land and water. Under the system, there is a "river shrine" or the source/upper course of the river which is regarded as a fertility god. It is a prohibition to farm the land close to the river. Very severe sanctions are applied where this prohibition is flouted. This provision minimises soil water loss and land erosion near the river. It also prevents the river from drying up during the dry season. Other features of the Huza system of farming similarly promote land and water conservation. These include:-(a) The small size of the farms:- This checks soild erosion on the farm and minimises soils water loss through evaporation; (b) The use of very simple farming tools such as the cutlass, the hoe and the dibble stick. This distrubes the soils very little thus minimising soil erosion; (c) The stumps are left on the farm after clearing - This leaves the soil compact and promotes land conservation; (d) There is mix-cropping - This provides maximum leaf coverage of the land surface in the farm thus minimising soils water loss through evporation and the loss of land through soil-creep. These practices take note of the fact that the Eastern Region of Ghana is in the tropical region where high temperatures and heavy rainfalls are experienced. With increasing influence of christianity, however, the worship of the rivers is declining and marginal lands along the the rivers are being farmed leading to the drying up of many rivers in the dry season. The soil along the rivers is also being washed away in surface run-off.

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A-0598

Soil Malnutrition and Holistic Approach for Sustainable Soil Use. Tag Elsir Basheer Abdalla

Food shortages are generally blamed on either drought or excessively high rainfall accompanied by flooding and erosion. The most serious menace to future production is depletion of their fertility through plant nutrient depletion or exhaustion, with subsequent reduction of biomass, organic matter and reduced microbiological activity, particularly in arid and semi-arid areas. Soil is a natural resource non-renewable in the short term or very difficult to renew, and expensive either to reclaim or to improve following erosion or physical and chemical degradation. This natural resource is a legacy for coming generations and therefore, it is our duty to maintain it for the future. The task for all people concerned with soil must be to direct their interests not just to the physical (soil physicist), chemical (soil chemist) and biological (soil biologist) aspects but also to those environment, economic, social, legal and technical aspects that affects soil use, that is to adopt a Holistic Approach, for sustainable global farm, taking in consideration the production of hygienic foods and fodder's according to ISO criteria.

Tag Elsir Basheer Abdalla
A-0600

Silvoaquaculture for Enhancing Soil-water Productivity in the Semi-arid Tropical Environment of India. Ashok K. Patra, Central Institute of Fisheries Education, Indian Council of Agricultural Research, Mumbai, India

The climatic pattern of the semi-arid tropical region of India is characterized by high temperatures (mean 26°C) and strongly seasonal and highly variable rainfall. The mean annual precipitation in this region is less than 1000 mm, with more than 80% falling between June and October in the southwest monsoon. Typically a substantial proportion of annual rainfall in the region comes in brief irregular and intense storms that create high runoff, nutrient losses and erosion problems. In the absence of adequate soil and water conservation, productivity of this region is not stable, and in many regions it is precariously low. For sustainable production and rural employment in this fragile

ecosystem holistic approach towards the use of land and associated water and bio-resources through the strategy of watershed development and management is essential. In this context, silvoaquaculture has a great potential to enhance the quality of both ecosystem and life of rural people. In semi-arid regions of India, water reservoirs (i.e. ponds) of varying sizes, depending upon the area of watershed, are constructed at the lower elevation of the catchment where maximum run-off water is harvested for future use. Since water in these reservoirs remains from few months to whole year integration of fish farming to forestry can be much profitable. Research on silvoaquaculture is limited till now. Studies of water qualities at several watersheds in the black soils (Vertisoils) areas of Jhansi region, Central India, indicated a favorable range of environmental conditions (e.g., alkalinity, hardness, dissolved oxygen, etc.) for survival and growth of fish. Fast growing fish species (e.g., common carps, silver carps, grass carps, Tilapia, etc.) can produce on an average 2 tonnes of fish ha-1 in six months (e.g. July-December), earnings an additional Rs. 50,000 (US$ 1200) with little investment (e.g. fingerlings.) The trees in the system have demonstrated for soil restoration, moisture conservation, nutrient cycling, etc., on the watershed. When fish farming is included in the system, trees can provide fodder for harbivorous fish, decomposed leaves for pond fertilization as well as wind shelter and shade to create desirable microclimate. Experiments conducted on the nutrient contents of different tree leaves and their mineralization patterns have indicated that tree leaves such as Leucaena leucocephala content as much as 3.0% N and host of other nutrients, which get slowly released into soil at a controlled rate in comparison to urea. Controlled release of N into the soil is desirable because that is often associated with high utilization and low losses of applied N. It has been observed that resource-poor farmers in the upland rural areas in the semi-arid fragile eco-system are very keen on fish farming on farms. The main constraints they face are the lack of timely availability of newly hatched fish or fish fry of selected species at right place, and a dearth of technical advice and encouragement. Research on, and silvoaquaculture itself, are only taking off now, thus, more detailed studies are needed to identify suitable combinations of tree species and aquaculture organisms. These studies should include functional and cost benefit analyses and feeding experiments. Linking trees and fish culture can benefit the farmers tremendously and help farmers for a sustainable, low input farming system.

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A-0602

Soil losses due to rootcrop harvesting: importance and implications. Jean W.A. Poesen, Fund for Scientific Research – Flanders, Laboratory for Experimental Geomorphology, K.U.Leuven, Leuven

The impacts of landuse and landuse changes on soil erosion processes have received and still receive considerable attention, e.g. in the framework of Global Change projects. Land use changes typically affect the rates of water erosion, wind erosion and tillage erosion. Field observations point to an additional significant soil degradation process which has hitherto never been considered in assessments of soil erosion rates: i.e. soil losses due to rootcrop harvesting (SLRH). SLRH data collected from the literature and field data obtained in the loess loam belt of Western Europe indicate that significant masses of soil leave cultivated fields when rootcrops (e.g. sugarbeets, potatoes, endives, chicory) or vegetables (leek, salad) are harvested. Long-term (29 years) mean annual soil losses due to sugarbeet harvesting in central Belgium amount to 8.4 ton dry soil/ha. Significant variation in SLRH figures are found over time and in space. For instance, for sugarbeets in central Belgium, annual SLRH-figures range between 5 and 22.4 ton/ha/year. Similar figures are found for endives and chicory. The spatial variation of SLRH is attributed to spatial variation in soil type (texture and water content), topography (insofar it affects significant soil properties in a systematic way), type of root crop, weather conditions at the time of harvest and harvesting technique. Significant research efforts are still needed to assess the importance of these factors for various rootcrops in a range of environments. The soil arriving with, for instance sugarbeets in the sugarbeet factories rarely returns to the field parcel where it came from. Hence, this soil mass represents a true soil loss. These soil losses cause significant on site (e.g. soil profile truncation) and off site problems (e.g. storage and treatment costs). The importance of the SLRH figures has several implications. First of all, SLRH need to be incorporated in future assessments of soil degradation rates. If SLRH figures are incorporated in current soil loss assessments, it would mean that for intensively cropped areas soil loss tolerance levels are exceeded more frequently than was hitherto thought. This would have important consequences for taking soil conservation measures. Other implications are linked to the establishment of sediment budgets and the interpretation of soil profile truncation rates in areas where rootcrops are frequently grown. Given its importance, measures must be taken to reduce SLRH. This could be achieved by, for instance, financial incentives for rootcrop growers in order to encourage low SLRH or environmental taxes for large SLRH.

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A-0604

Rational Utilizing Water Resources For Soil Salinity Control In Irrigation Districts. Fang Sheng, Chen Xiuling, Hebei Institute of Hydrotechnics, Shijiazhuang, P.R. of China

In the arid, semi-arid and semi-humid regions in the northern part of China, the cause of soil salinization in canal irrigation districts lies in excessive irrigation water application which raise the groundwater level and intensified evaporation of phreatic water and the salt accumulated to surface soil. For soil salinity control in irrigation district should regulating irrigation water application according to the agricultural water demand, and regulating the salinity in root zone of soil not exceed the threshold of crops salt tolerance and the groundwater depth in proper dynamics. The practice in North China Plain, Henan People Victory Canal, Shaanxi Jinghuiqu Canal and Xinjiang Wujiaqu Canal irrigation districts shown that, carry out conjunctive use of surface and groundwater is the basic approach for soil salinity control and bring the benefits of water resources into full play in irrigation districts. For irrigation district should be take the development and utilization of groundwater as the basis and the surface water as the supplementary, and to use the shallow groundwater aquifer as a underground water reservoir for regulating rainfall surface water, groundwater and soil water, and controlling the groundwater depth on a proper dynamics, then promote the process of desalinization by leaching is stronger than that the process of salinization by evaporation, to achieve the comprehensive control of drought, waterlogging and salinity in irrigation district. Recommend that proper reduce the water amount of Yellow River diversion, develop pure well irrigation other than Yellow River diversion in Huang-Huai Plain south of Yellow River; Developing and utilizing groundwater actively in the canal irrigation districts; Optimized regulation and rational utilization of surface and groundwater in irrigation districts.

Fang Sheng

A-0608

Meeting the International Challenges of Land Degradation and Biodiversity Conservation. Anders Jonas Rupp-Desrosiers, NSW Department of Land and Water Conservation, Parramatta, NSW Australia

International and domestic instruments draw attention to the adverse ecological and social impacts of land degradation on diminishing biological diversity. At risk is the ability of ecosystems to purify water, regenerate soil, protect watersheds, regulate temperature, recycle nutrients and waste, produce biomass, and maintain the atmosphere. The costs of this are not purely ecological, and extend to economic, medical and agricultural losses with profound social implications. This paper identifies provisions in strategic programs that address the fundamental causes of land degrading activities i.e. those activities that have or are likely to have significant adverse impacts on, and cause declines in, biological diversity. It proposes categories of activities to effectively address land degradation and conservation, sustainable use and equitable benefit sharing of biological diversity. While the concept of "biodiversity" has only recently come into vogue, both land degradation and endangered species issues have received attention for many decades. It is useful to link this developed knowledge through the concept of biological diversity. For example, endangered species have been identified and the IUCN Red List of Threatened Animals and the IUCN Red List of Threatened Plants have been developed. Destruction of physical habitat by human intervention in Earth's ecosystem processes, accounts for 73% of IUCN Red Data Book's extinct, endangered, vulnerable and rare species (Wilson, 1995). This destruction of physical habitat, generally for agricultural and resource harvesting purposes, is a fundamental part of the processes of land degradation. Sustainable development is now arguably part of international environmental law. An examination of the substantive provisions of international instruments dealing with the broader concept of sustainable development reveals strategies adopted do not adequately address the fundamental causes of the problems of managing land degradation and biologically diverse resources. The fundamental causes of biodiversity decline, i.e. causes of proximate activities that have or are likely to have significant adverse impacts on biological diversity, were identified by UNEP (1996) as being: land tenure; population change; cost-benefit imbalances; cultural factors; and misdirected economic incentives. The proximate activities include conversion of habitat, overexploitation, pollution and the effects of introduced species. These land degrading activities deplete ecosystem resilience, remove indigenous plant and animal species, encourage soil degradation and diminish water quality. Recent global legal initiatives have treated the issues of land degradation, biological diversity and human society (and other issues related to ecologically sustainable development) in two main ways: independently, explicitly or in hard law – such as the Plan of Action to Combat Desertification which was adopted at the United Nations Conference on Desertification in 1977, the United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa in 1994 (CCD), and Convention on Biological Diversity in 1992 (CBD), and inter-dependently, implicitly and in soft law – such as the Stockholm Declaration and Action Plan for the Human Environment of 1972, and the Rio Declaration and Agenda 21 in 1992. Other instruments also contribute to addressing the issues of land degradation and biodiversity conservation within a comprehensive sustainable development framework. These include the Framework Convention on Climate Change in 1992 (FCCC), and the Non-Binding Authoritative Statement of Forest Principles in 1992 (SFP), to which one can add other initiatives such as the Global Biodiversity Strategy from 1992 and IUCN Draft International Covenant on Environment and Development released in 1995. Many nations have started to use these global instruments and strategies as a basis for revising and preparing domestic instruments. While it is realistic to start with instruments that are acceptable to all potential parties, implementation will show that there is always room for improvement and harmonisation

of strategies. Of particular importance is the need to link the fundamental causes of threats to biological diversity, including soil and other land degradation, far more closely to the proximate threats. One of the major aspects of this is an understanding of the socio-economic issues surrounding the use of biological diversity. This will aid the development of effective instruments at global national levels and to manage human activity effecting land degradation and affecting biologically diverse ecosystems and resources.

Anders Jonas Rupp-Desrosiers

A-0610

Wind erosion control practices. Gary L. Tibke, USDA, NRCS, ARS Wind Erosion Research Unit, Manhattan, KS USA

Many conservation practices are placed on the land to control or reduce wind erosion. These practices are effective in controlling wind erosion when they reduce the wind sheer stress at the soil surface or create a soil surface more resistant to wind forces. This is accomplished when the practices applied reduce field width, maintain vegetative residues on the soil surface, deflect the wind from the erodible surface, create stable soil aggregates or clods, and roughen the land surface. NRCS Field employees work with land managers to plan, design, and apply conservation practices. The erosion prediction equations are used to determine the combination of practices best suited to reach the desired levels of erosion control.

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A-0611

Development and assessment of TERI (Tillage Erosion Risk Indicator) for application in Canada's Agri-Environmental Indicators Project. David A. Lobb, Don J. King, Glenn A. Padbury, Herb W. Rees, Land Resources Branch, New Brunswick Department of Agriculture and Rural Development, Fredericton, Canada

In Canada, tillage erosion has been recognised as a serious form of soil degradation, resulting in soil losses in excess of 50 t ha^{-1} yr^{-1} on convex upper slope positions of cultivated landscapes. The Tillage Erosion Risk Indicator (TERI) was developed for inclusion in Agriculture and Agri-food Canada's Agri-Environmental Indicators Project as part of the Organisation for Economic Co-operation and Development's environmental indicators initiative. The risk indicator model expresses tillage erosion as a function of tillage erosivity and landscape erodibility. The erosivity of tillage practices is based on limited research into the relationship between soil movement by tillage and slope gradient carried out in southern Ontario. The erodibility of a landscape is based on maximum gradients of slopes and the convex lengths of slope over which soil is lost. The Agriculture Census is the source of input data on tillage practices. The National Soils Data Base is the source of input data on landscape characteristics. These data sources are meant for regional scale applications (1:1 M). In addition to providing a description of TERI and a summary of results for Canada at the regional scale, this study assesses the performance of the indicator when compared to results generated from more detailed data sources from three regions across Canada. On selected sites within these regions, tillage erosion risk was compared to water erosion risk, and both were compared to estimates of soil erosion based on resident ^{137}Cs.

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A-0613

Geographical uncertainty: the effect of watershed discretisation on the output from erosion models. J.N. Quinton, A. Folly, Cranfield University, Silsoe, Bedford, UK, D. van der Vlag, University of Utrect, Utrect, Netherlands, B.Magagna, A.Muhar, Universitaet fuer Bodenkultur, Vienna, Austria, F. Sancho, Universidad de Costa Rica, San Pedro, Costa Rica and S. Lorentz, University of Natal, Scottsville, South Africa

Distributed soil erosion models are increasingly being linked to Geographic Information Systems, for example ANSWERS, MWISED, SPIES-EUROSEM and Erosion-3d. This has led to wider use of such models in watershed situations and focused attention on how the watersheds should be sub-divided. For models, such as EUROSEM watershed subdivision has relied upon the skill of the model user to divide the watershed into units that will exhibit the same erosional response. This approach almost always leads to difficult decisions; for example whether or not the watershed element be divided to take into account subtle changes in soils or slopes. For models linked with grid based GIS systems decisions concerning grid size are paramount. Little research has been carried out to examine the effects of such decisions on erosion model output. This paper examines the effects of changes in the level of watershed discretisation for a manually divided watershed in South Africa and an automated watershed division in Costa Rica. Preliminary results suggest that the effects are significant.

J.N. Quinton

A-0614

Spatial variability of soil properties along transect of CRP and continuously cropped fields. Xuewen Huang, E.L. Skidmore and Gary Tibke

The Conservation Reserve Program (CRP), which was started in 1986, was aimed at protecting highly erodible and environmentally sensitive lands with grass or other perennial plantings. Expiration of CRP contracts and subsequent return of highly erodible and environmentally sensitive lands to continuous cropping, concerns policy-makers, conservationists, and farmers. The objective of this study was to characterize the spatial variation and correlation of soil physical and chemical properties along a transect on both CRP and adjacent field that was continuously cropped. The study site, located in Stafford County Kansas, has two mapping units, Naron fine sandy loam (Fine-loamy, mixed, thermic Udic Argiustoll) and Carwile fine sandy loam (Fine-loamy, mixed, thermic Typic argiaquoll). Soil samples were collected on a 10 meter spacing along a 400 meter transect which crossed CRP land that has been grassed for 10 years and a field that has been continuously cropped during the same 10 year period. The physical properties of bulk density, water retention characteristic, and aggregate stability were measured on soil samples taken at 0-10, 10-20, and 20-30 cm depths. The chemical properties of pH, concentration of P, K, Ca, Mg, Na, and total N and C were measured on samples taken at 0-5 and 5-10 cm depths. The statistical parameters of mean, variance, covariance, and correlation were determined for each of the variables. Statistical comparison of soil properties between CRP and continuously cropped land are being made and will be reported at the conference.

Xuewen Huang

A-0615

Soil Properties Relevant to Wind Erosion. E. L. Skidmore, John Tatarko, and L. J. Hagen

Because soil erosion by wind is influenced greatly by aggregate status and/or nature of consolidation of the surface soil layer (crust), wind erosion modeling requires knowledge of soil surface properties and how they change in time and space. The main properties of dry soil aggregates affecting their susceptibility to wind erosion are stability and size distribution. Soil aggregate stability and size distribution vary widely in time and space . Aggregate density affects soil erodibility to a lesser extent but is much less variable than stability and size distribution. Crust thickness, extent, stability, and amount of loose material resting on the surface all affect the soils susceptibility to wind erosion. These surface aggregate/crust conditions influence greatly emissions, abrasion, breakage, and threshold wind speeds. The aggregate/crust status of the soil at any instant in time is the result of intrinsic soil properties and constituents and many aggregate/crust forming and degrading processes. Those properties and processes comprise a complex interrelationship of physical, chemical, and biological reactions. Soil properties affecting its aggregation/crust include: primary partical-size distribution, concentration of calcium carbonate, concentration and degree of decomposition of organic matter, composition of adsorbed ions, and type of clay. Freezing-thawing, freeze-drying, and wetting-drying, and precipitation times energy (EI) are weather driven processes affecting aggregate/crust status. Agronomic systems including cropping history and tillage affect aggregation pronouncedly but interpreting controlling mechanisms is complicated, predication of soil behavior requires not only an understanding of the effect of basic soil properties and constituents but also prediction of the duration, intensity, and extent of those soil-influencing processes.

E. L. Skidmore

A-0616

Nutrient Loss by Surface Runoff from Slope Land. Cai Chongfa, Huazhong Agricultural University, Wuhan, P.R.China, Tel 86-27-87393766, Fax 86-27-87396057

Slope is commonly used for cultivation in the Three Gorges area of upper-middle Yangtze River watershed, southwest China, due to the high density of population and the immigrants from the flooded area. However, slope cultivation easily causes soil erosion and nutrient losses. Experimental plots were made in the field, in which slope gradient, vegetation coverage, rainfall intensity and fertilization measures were conducted. Runoff, sediments and their nutrient contents were determined. The results showed as following. 1) Soil erosion factors, such as slope gradient, rainfall intensity, vegetation coverage, and protective measures, all influence nutrient loss. Extent varies with the factors. 2) The sediment has higher nutrient contents than topsoil it comes from. The ratio of sediment and surface soil, called enriched degree, is more than 1.00, which could be set in sequence from high to low, which is available nutrients, total nitrogen and organic matter, total potassium, and total phosphorus. 3) One of reasons is that the sediment contains higher fine-particle than topsoil. The content of silt (diameter of particle 0.02-0.002mm), clay (less than 0.002mm) and micro-aggregates (diameter of aggregate less than 0.002mm) are higher in sediment than in topsoil. 4) Fertilization can rapidly increase absorption of nutrient concentration in runoff. After applying fertilizer, the nitrogen loses easily at the first storm, since the concentration will sharply reduce in the rainfall, while potassium and phosphorus in runoff reduce slowly. 5) The nutrient losses occur mostly in the very shallow surface. The measured results show that contains of the absorbed nitrogen in 0-2cm topsoil, potassium and phosphorus in 0-1cm topsoil are significantly lower than under surface soil, and that absorbed nitrogen in all topsoil (15cm), potassium in 0-7cm and phosphorus in 0-1cm are significantly lower than

before rainfall. So the movement varies with nutrient elements, which just echoes the tendency of enriched degree.

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A-0621

Effects of Soil Strength, Texture, Slope Steepness and Rainfall Intensity on Interrill Erodibility of Some Soils in Taiwan. Jen-Chen Fan and Min-Fon Wu, Department of Agricultural Engineering, National Taiwan University, Taipei, Taiwan, R.O.C.

The relationships between slope steepness, soil strength, diameter of soil particle corresponding to 40% finer (d_{40}), rainfall intensity and interrill soil erosion rate were found and established. The rainfall simulator used in this study was a modification of the programmable rainfall simulators developed by Foster et al.(1982) and Fan and Lovell(1987). The rainfall simulator was proved more convenient and uniformity coefficient of the simulated rainfall was 93.7%. Kinetic energy per inch of the simulated rainfall was 793 foot-tons per acre-inch. Soils were collected from six sites distributed quite evenly in the Taiwan island. The samples were remolded and prepared in boxes with a width of 0.75m and a length of 0.5m. Slope steepnesses were 10,25,50 and 100%. Rainfall intensities were 30,60,90 and 120mm/hr. Test items included sieve analyses, fall cone shear tests and interrill soil erosion tests. After analyzing the test data by using 144 combinations, the slope steepness factor, soil erodibility factor and prediction equation, of interrill erosion were developed.

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A-0622

Rapid Indicator-based Soil Mapping for Regional Planning in northern Thailand. Vogel, H., Vearasilp, T., Pothinam K., and S. Wattana, Federal Institute for Geosciences and Natural Resources, Hannover, Germany

The breakneck speed of development in Thailand has led to ever mounting pressure on the natural soil resources. This essential agricultural resource is declining rapidly both in quantitiy and quality due mainly to uncontrolled urban development. An illustrate example is the city and valley of Chiang Mai in northern Thailand. The area is rapidly developing into the regional business centre of northern Thailand and neighboring countries. The interactions between the accelerated economic growth, an ever-increasing population, inadequate land-use practices, and the limited land resources present a formidable challenge for sound regional planning. Already, Chiang Mai is facing stiff competition for land and is struggling with pollution and recurrent waste disposal crises. Against this background and in order to quickly support regional planning in Chiang Mai, a rapid appraisal of the area's soil resources was carried out based on various soil indicators such as cation exchange capacity, base saturation, and *p*H among others. Within a period of less than 4 months a dozen indicator-based soil maps were developed at a scale of 1:100,000 as part of a German-Thai technical cooperation project. The required input data were compiled from earlier soil surveys files and field sheets stored in the archives of the Department of Land Development (DLD) in Bangkok. In the beginning, a soil map was digitized from the regional survey sheets. At the same time, available soil attribute data were extracted from the paper files and entered into a DOS-operated soil database programme. For mapping purposes, the results were then exported into the ARC/INFO GIS software environment. The legend developed is based on the USDA Soil Taxonomy. The resultant maps provide an adequate and easily readable overview of the distribution of essential soil properties that give the suitabilities and limitations of the soils for various agricultural and non-agricultural uses in the area.

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A-0623

Effect of sediment load on soil erosion in rills. Gustavo H. Merten, Ana O. Borges Universidade Federal do Rio Grande do Sul/Instituto de Pesquisas Hidraulicas, Porto Alegre, Rio Grande do Sul, Brazil, and Mark A. Nearing, National Soil Erosion Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, West Lafayette, IN USA

An experiment was carried out in a flume (7.6 m) under laboratory conditions to study the effect of sediment load in the flow on soil detachment and deposition. The soil used in this study was a Cecil sandy loam (clayey, kaolinitic, thermic, Typic Hapludult). A flow rate of 7.3 l/min and a bed slope 5% was used. We injected increasing amounts of sediments (0, 2.1,3.9, 6.5 and 8 g/s) consisting of the same soil that was used in the bed. The results showed that the increment of sediment injected reduced the soil detachment rate and increased the deposition rate in the flume. A linear, decreasing relationship was found (r^2= 0.98) between total soil detachment and the injected sediment. These results are consistent with deterministic erosion models such as WEPP, GUEST, and EUROSEM that consider the effect of sediment load on the soil detachment. However none of models could predict sediment deposition our experimental conditions.

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A-0624

How WEPP Model Respond to Different Cropping and Management Systems. X.C. Zhang, M.A. Nearing, and L.D. Norton, USDA-ARS-National Soil Erosion Research Lab, Purdue University, West Lafayette, IN, USA

One primary goal of developing soil erosion prediction models is to help farmers and land managers laying out the best management practices that conserve the land and water resources. Thus, a successful model must be able to accurately predict soil losses under different cropping and management systems. The objective of this study was to evaluate responses of the Water Erosion Prediction Project (WEPP) model to different cropping and management systems. In order to compare the WEPP model responses to the well known C factors established in the USLE and RUSLE models, the WEPP "C-factor" was calculated as the soil loss ratio of cropped conditions to reference fallow. This approach was considered appropriate in light of the fact that the RUSLE and USLE models represent general trends of cropping and management C factors for common cropping systems. The unit plot measurements (9% slope and 22-meter length) were used in the WEPP slope input files. Several common crops (e.g. corn, cotton, and alfalfa) and tillage systems (e.g. conventional, conservation, and no-till) were used to prepare the management input files. Two soils (Cecil sandy clay loam and Providence silt loam) were used. The climate input files were generated by the WEPP climate generator for three locations, representing three distinct climatic regions. The USLE C factors were directly obtained from Agricultural Handbook 537, and the RUSLE C factors were derived from version 1.04 of the RUSLE model. Results showed that the WEPP tended to slightly over-predict annual C-factors compared with RUSLE, while under-predict C factors relative to USLE. Overall, the WEPP model simulated the general trends of cropping and management factor reasonably well for the cropping systems used in this study.

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A-0625

OFMAT: An On-Farm Management Assistance Tool to help New England farmers to choose best management practices to protect surface and groundwater quality. Claire Baffaut and Kathy Ruhf, New England Small Farm Institute, Sunderland MA USA

OFMAT is a software designed to help farmers to determine what they can do to protect the water quality of streams, lakes and underground water on or near their farm. The goal is to give them the technical assistance they need to consider different options. The software includes: 1) a database of best management practices to solve on-farm water quality problems and help protect surface and ground water quality on or near a farm including the management practices listed in a guide to on-farm quality protection published in 1996 by NESFI. A computer program uses this database to find solutions to the problems identified by the farmers. 2) the engineering procedures to design the more complex management practices, in particular those that have a structural aspect. The designs will result in a cost estimate and the general characteristics of the solution. This software is intended to be used during visits to the farmers that have identified water quality problems on their farm and help them decide what management practices they can implement to address them. The work is interactive and interest in a given solution as well as constraints can be expressed at any time. The software interface is simple, functional and flexible so that a person that is computer-knowledgeable and knows the content can use it on a portable PC compatible computer during a visit to the farmer. The purpose of the software is to accelerate the process to address the water quality problems and to do the preliminary designs of the selected best management practices at the time of the visit, in an interactive session with the farmer. We think that work on a one to one basis with a computer program will encourage farmers to assess and address problems on their farm. Some farmers may not have the resources to do the work themselves and will like the automation of the process to obtain a plan of action quickly. By using a computer program to do preliminary designs during the visit, the farmer can consider many options without committing to any of them. This requires less time and resource than calling an agency to obtain technical assistance. The ease with which complex solutions can be considered will likely result in more solutions being considered and implemented.

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A-0628

An investigation on erodibility properties of soils which developed on different parent materials in k.maras-ayvali dam kizildere creek watershed. Assoc. Prof. Dr. Arslan OKATAN, Alaaddin Yüksel, Mahmut, Karadeniz Technical, Sütçüimam University, Trabzon/Türkye

This study was conducted in K.Maras-Ayval Dam, in Kzldere creek watershed which is located on the east part of Turkey. The purpose of this research was to determine erodibilty indexes of soils developed on different main materials and to determine the sensitivity of areas to erosion on the watershed. The erodibility indexes which were derived from this study are aimed to help other watershed studies from beginning stages through establishment. Total number of soil profiles was determined by "Factorial Trial Design". Soil samples were taken from 48 profiles which consisted of two different main rocks, three land use types, two different aspects, two different elevation and two different soil depth. The distribution of soil profile locations were randomly located using GIS (Geographic Information System). Soil profiles were dug on and samples were taken on; south and north aspects, the altitude ranges of 750-1350 and 1350-1950 meters, land use types of forest, rangelands and agricultural lands, parent materials of limestone and sandstone and slopes ranged between 20-30 %. During the sampling process of agricultural lands, a special attention was given to slopes and the lands were taken into consideration of fallowing at least 2 years. While taking samples, soil horizons were not easily separated from each other, therefore from two different steps of soil depth samples (0-20 cm and 20-50 cm) were taken. The soil erodibility indexes were determined by several laboratory analysis of air-dried and sieved (2 mm) samples and the susceptibility of soils to erosion in connection with their parent materials were determined. Results showed that the creek watershed soils mainly lied on sandstone and limestone and soil textures developed on those kind of parent materials are generally formed as sandy loam, loam and sandy clay loam. According to results of dispersion ratio, erosion ratio and colloid/moisture ratio, the soils developed on both limestone and sandstone, the creek watershed are found to be susceptible to erosion. Dispersion ratio values of soils which developed on limestone were found to be 11.55-46.05, 25.00-38.90 and 26.32-49.32 on agriculture, forests and rangelands respectively. However, dispersion ratio values of soils developed on sandstone were found to be 11.71-40.71, 7.02-30.30 and 12.25-54.80 on agriculture, forest and rangeland soils respectively. The results indicated that soils developed on parent materials of both sandstone and limestone were more susceptible to erosion on south aspects than the soils on north aspects. It is pointed out that the most important factors for this phenomena were physical and chemical decomposition and low microorganism activities. In conclusion, the soils developed on limestone were found more sensitive to erosion than the soils developed on sandstone.

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A-0629

A Study For Determining Physiographic Factors Effecting River Flows In Corum- Karhin Creek Watershed Using Arc/Info Gis. Assoc.Prof.Dr. Arslan Okatan, Mahmut RES, Karadeniz Technical University, Forestry Faculty, Department of Forest Engineering, and Alaaddin Yüksel, Sütçüimam University, Forestry Faculty, Department of Forest Engineering, Trabzon/Türkye

This study was conducted Corum-Karhn creek watershed which is located in the central part of Turkey in which every kind of active erosions are undergoing. Corum- Karhn creek watershed has mountainous and steep topographic structure. The purpose of this study was to determine the effects of physiographic factors on stream flows more reliable, more effective and much shorter time using GIS and to find out variations of stream flow that torrents and floods damages could be predicted before it become too late. In this research, the values of physiographic factors of Corum-Karhn creek watershed were evaluated utilizing ARC/INFO GIS. As physiographic factors, land use types (forests, rangeland and agricultural lands), average altitude, average slope, aspect, river frequency and drainage density were examined. According to the results of these properties, soil losses, destruction ratio of natural balance among climate-plant and soil, damages of torrents, floods and landslides would be predicted easily and precisely. With help of ARC/INFO GIS, land use type and slope coverage were intersected. According to new coverage data, research area was found to be 3193.13 ha, and 473.6 ha of which was agricultural land. Of 58.8 % the agricultural lands, 279.1 ha of lands had more than 15 percent slope. Because of high percentage of slope, agricultural lands which were not protected to erosion were exposed just after rainfalls and gully erosion occurred. The average slope of research area by using ARC/INFO GIS was found to be 30.3 %, and it could concluded that large portions of the lands had steep and mountainous. Due to these characteristics, rainfall didn't infiltrate and runoff water reached streams and caused harmful peak flows, torrents and floods for the region. The average altitude of the creek watershed was found to be 1132 m. Type, density, closure and the growth of vegetation were dependent on the relationship between rainfall and temperature, and thereby, depended on altitude. This phenomena affected directly watershed hydrology and soil losses occurred with erosion together with sediment yield. River frequency value was found to be 2.87 and drainage density value was found to be 2.33 on the "creek" coverage with GIS. Direct correlation exists between drainage density and the amount of runoff water. In general, the small drainage density values of watershed exist in the regions in which the relief is low, the land is covered by intense vegetation, and subsoil is resistant or permeable. However the great drainage density values of a watershed exist, on mountainous areas where the land covered by thin vegetation which is shallow and the permeability values are low. According to the slope map of creek watershed which created using GIS, 43.6 % (1966.36 ha.) of the watershed area accounted for north slopes, while the rest which was 56.4 % (1767.54 ha) taken place on the south slopes. Runoff water after heavy rains, especially, fall and spring season, great amount of soils were removed from agricultural lands. During the fall and spring after heavy rainfalls, stream flow increased abruptly and caused torrents and floods in the region. Before applying the measures for erosion, torrents and floods in the watershed, physiographic structure of watershed should be determined very well.

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A-0630

An Investigation On Alchemilla Species In The Eastern Blacksea Region Of Alpine Rangelands In Viewpoint Of Soil And Water Conservation. Assoc.Prof.Dr. Arslan Okatan, Karadeniz Technical University, Forestry Faculty, Department of Forest Engineering, Trabzon/Türkye

This study was conducted on alpine rangelands of northeastern part of Turkey. The region in terms of general characteristics is mountainous, approximately 64.56 % of the lands have steep topographic structure and receives heavy rains. Moreover, in addition to the unsuitable topographic structure of the rangelands of the region, heavy and early grazing destroy the vegetation cover, therefore the rangelands are subject to expose active surface erosion. Among the most important grassland-rangeland species in northeastern part of Turkey, Alchemilla species which have very dense vegetation cover on the soils play big roles effectively in preventing erosion. Alchemilla species have largely distributed ecologically and geographically in almost every slopes, elevations, land use types and aspects in the study area. It is found that these species may utilize the lands successfully and easily which are exposed to erosion. In addition, stabilizing the hillsides of nearby roads with Alchemilla species are found successful due to their resistance to the poor soil conditions. For this study alpine rangelands of Trabson-Degirmendere, Giresun-Yagldere and Rize- Ikizdere creek watershed were chosen which represent the region of northeastern part of Turkey (East Blacksea region). In order to identify the number of origins of Alchemilla species and to determine their effectiveness on preventing the soil erosion, a total of 96 of 20X50 meter plots were randomly chosen on different slope groups, paying attention to the parameters stated above. On the distribution locations of sample plots, two different altitude steps (1800-2200m and 2200-2600m), two different land use types (opened for grazing and closed), south and north aspects in which the vegetation cover consist of many different species, and as slopes the groups of 10-20 %, 21-30 %, 31-40 %, 41-50 %, 51-60 % were taken into consideration. In the process of identifying Alchemilla species and determining the other vegetation covers' quantitative properties of the watershed area "Linear Transect Method" was applied. According to the results of this study, 19 Alchemilla species were found in the region and eight of them were endemic. The most common Alchemilla species were encountered in the elevation levels of 1800 to 2200 meters were Alchemilla crinita Buser, Alchemilla pseudocartalinica Juz, Alchemilla orthotricha Rothm, Alchemilla stevenii Buser, Alchemilla sintenisii Rothm. While in the altitudes of 2200 to 2600 m, the most common Alchemilla species were encountered as Alchemilla minusculiflora Buser, Alchemilla ellenbergiana Rothm, Alchemilla barbatiflora Juz, Alchemilla ziganadagensis B.Pawl., Alchemilla retinervis Buser. Moreover, the results showed that most of the Alchemilla species developed fringe roots and rhizomes which penetrate more than 40 cm below the soil surface and this structure cause airing the soil and increase the infiltration rate. In conclusion, Alchemilla species decrease the evaporation rate due to having dense vegetative organs and by shading the soil surface. This structure was found especially important on poor and shallow soils where soil moisture content viable for the vegetation and having deep root systems, Alchemilla species were also proved of protecting the soils effectively to erosion.

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A-0631

Implications of tillage erosion for soil quality in temperate regions. G. Heckrath, Danish Institute of Agricultural Sciences, Research Centre Foulum, Tjele, T.A. Quine, University of Exeter, Rennes Drive, Exeter, Devon, UK, G. Govers, Catholic University of Leuven, Leuven and E. Sibbesen, Danish Institute of Agricultural Sciences, Research Centre Foulum, Tjele

In fields with complex topography, the variability of soil properties and crop productivity is affected by soil erosion. Recent studies suggested that tillage erosion was the dominant process of soil redistribution over much of hilly cropland implying an important adverse effect on long-term sustainability. However, the quantitative impact of tillage erosion on soil quality and crop yields has not been investigated previously. Therefore, a study was initiated with the objective to assess the effect of tillage erosion on the spatial variability of soil properties and crop yields on two hilly field sites in Western Denmark. The first results of this work are reported here. One-hundred thirty and two-hundred soil samples were collected to a depth of 75 cm on regular 15 by 15 m grids to

be analysed for texture, organic C, total P, and water holding capacity. So far, wheat yields were determined once for each grid point at one site. The total redistribution of soil, which had occurred over the past 30 years, is quantified by measuring ^{137}Cs inventories. Based on the different spatial signatures of water and tillage erosion and by assuming representative parameters for water erosion, soil movement by tillage alone is simulated with a topographic-based model for both sites. Grain yield was related to the depth of the A horizon which, in turn, was related to surface curvature. Shallow soils coincided with convexities and deep soils with concavities. This corresponded directly to the spatial pattern of tillage erosion. Although the importance of spatially variable P concentrations in the context of critical source areas for P export from agricultural catchments has been stressed, few studies investigated the impact of changes in soil P concentrations in space and time as a result of soil erosion. Therefore, a modelling exercise was undertaken to assess the potential impact of tillage and water erosion on soil redistribution and soil P status along a slope profile. Compared to water erosion, tillage erosion resulted in a large shift from an initially even P concentration along the hill-slope to a P distribution with a marked peak and trough corresponding to distinctive erosion and deposition areas. The accumulation of P-rich soil at the foot slope implies an increased vulnerability to P losses by surface runoff and stream bank erosion. These simulation results will be tested against field measurements from existing erosion and runoff experiments in some arable catchments in Denmark.

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A-0634

Sediment Transport in Irrigation Furrows. Thomas J. Trout, David Bjorneberg, Theodor Strelkoff, USDA- ARS-WMRL, Fresno, CA USA

Water flow in sloping irrigation transports sediment eroded from the head end of the furrows to the middle and tail sections and off the field with runoff water. Because flows are controlled, extend over long time periods, and decrease with distance, sediment transport and deposition can be accurately measured and related to the hydraulic parameters. Data collected in Southern Idaho irrigation furrows was used to determine how well established sediment transport relationships describe furrow conditions. The data were compared with the predicted results from three transport relationships embedded in the SRFR surface hydraulics irrigation model, and with sediment transport predicted by the WEPP model. The measured trends of rapidly increasing transport near mid-furrow, and then decreasing transport (due to deposition) follows expected relationships. However, the measured rates of sediment deposition and the wide variation in transport rate over time could not be explained by existing theory. Poor prediction of flow geometry, and thus shear, along furrows was attributed to varying furrow roughness with distance implying a change over time of transport coefficients or the non-applicability of the transport capacity concept. An alternative sediment transport theory, not based on transport capacity, fit the furrow transport data as well as the tested relationships with fewer parameters and more consistent coefficients.

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A-0637

Soil Resource Inventory Using Remote Sensing And Geographical Information System. Nayan Ahmed, Division of Soil Science and Agricultural Chemistry, Indian Agricultural Research Institute,New Delhi, Sanjay K.Gupta, All India Soil and Land Use Survey, Ministry of Agriculture, IARI Buildings, New Delhi, Jitendra Prasad and Suresh Kumar, Indian Institute of Remote Sensing, Dehradun, U.P

Soil and water are basic natural resources controlling crop production in irrigation command areas. Remote Sensing and Geographical Information System (GIS) are potential tools for assessment, monitoring and efficient land use planning of natural resources. Land information generated from soil resource mapping can be used to prepare various thematic maps which can be integrated in the GIS environment to produce various output providing specific informations. The study area, a part of Indira Gandhi Canal Command (IGNP) covering the Survey of India Toposheet 44K/7 in 1:50,000 scale falls in Hanumangarh District of Rajasthan. The command area of IGNP is characterised by a high degree of uneveness with sand dunes, both permanent and shifting in nature. Indiscriminate use of irrigation water, seepage due to poor lining of the canal and lack of natural drainage are considered to be the main reasons behind widespread salinity and waterlogging,enhancing soil degradation (Shankarnarayana&Gupta,1991).This problem has lead to failure of traditional crops like cotton and mustard. Several workers(Hooja et.al.1995; Mathur et.al.1996) have also emphasised the severity of the problem. In light of this an attempt has been made to prepare a physiographic- soil map of the study area through visual analysis of IRS(Indian Remote Sensing Satellite) IC LISS III (23.5m resolution) data in 1:50,000 scale and IRS IC panchromatic (5.8m resolution) data in 1:25,000 scale, in conjunction with digital analysis of IRS IC LISS III data and reconnaissance survey of the whole area. Soil profiles were studied upto 2m depth and classified according to USDA soil taxonomy(1996) upto series level. The soil survey data alongwith other collateral information was fed in the GIS software package (ILWIS 2.1 version, ITC,Netherlands) for generation of soil suitability maps for different land utilization types. Soil and Land productivity alongwith soil and land irrigibility maps were generated through GIS and a suggested land use map is proposed according to FAO(1976) land evaluation model.

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A-0638

Estimation on the erosion of micro-element contaminating agents in different soil types. Dr. habil Lajos Szabó, Gödöllő University of Agricultural Sciences, Gyöngyös College of Agriculture, Gyöngyös

In 1996. soil layers of 0-30, 30-60, 60-90 cm from 3 different kinds of soil were analyzed. On calciferous tsernozjom soil 72, on calciferous sandy soil 45 and on sour forest soil 63 - altogether 180 - soil samples - were analyzed separately to define the „total" contents by exploning cc HNO_3 + cc H_2O_2 as well as the contents that can be absorbed by the means of NH_4-acetate + EDTA erosion. The range of the components analyzed was between 10-20 while the number of measuring was above 5,000. The Conclusions of the Experiments: The As treatment was applied to calciferous and sour adobe soil. In both soil types contamination remained at the place of immission although ever the 30-60 cm type soil got enriched in sour adobe. The Cd treatment was used in calciferous and sour adobe soil. Lixiviation could not be proved as contamination in both national soil types remained in the area of immission. Cr (VI) load was applied in all the three soil types where the movement of the Cr (VI) ion could clearly be defined. Cu treatment was given in all the three types. The contaminating agent definitely got stuck in the immission zone everywhere. Hg treatment was made in organic and sour adobe soil. In the case of both types the data of measurement show the lack of enrichment in the lower layers. Pb treatment was applied to all the three types. There was no sign showing Pb movement in the lower layers of calciferous sandy and adobe soil. The 30-60 cm layer got slightly contaminated in sour soil. Zn treatment was applied to all the three soil types, as well. Zn got stuck in both calciferous and sour types in the 0-30 cm layers. In spite of the fact that fresh contamination can be indicated in 30-50 % in the form that can be assimilated, it is not subject to lixiviation. It can be stated that the mobilitiy of most elements accumulated in the soil is greatly modified by the pH value. To have the contaminating agents fixed in the soil as well as to avoid undesirable plant ingestion, liming of sour soil types can be an effective form of means. The getting out of some of the anion - forming elements like Cr and As from the soil cannot be reduced by this way. The enrichment of soil by organic substances can first of all improve the with holding of organophil elements (Cu, Hg). Living and suitable organic substance management can be well - founded claims with special regard to environment protection.

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A-0639

Influence of Institutional Structures on the Sustainability of Watersheds in Karnataka State, India. Kaushik Mukherjee, Karnataka Watershed Development Society, Bangalore, India

Karnataka is a State located in the southern part of India. The state is unmatched in its diversity of crops and variation of annual rainfall (starting from a desert-like 400 mm to a tropical 3000mm). It also has the unenviable challenge of managing 8.2 million ha. of dry land. Only 22% of the total cultivated area is irrigated and the potential for expansion of irrigated agriculture is severely limited and rain-fed agriculture has to sustain a large chunk of the rural population. The State of Karnataka is a pioneer in the Indian "watershed development movement" and it has treated nearly 1 million ha. of dry land on watershed principles. Various institutional structures and styles of implementation have been tried over the last one and half decades leading to a vast variety of outcomes. Among the institutional models tried out are: Line departments of government; Multi-disciplinary teams working in the watershed; Implementation by elected local government bodies; Projects managed and implemented by NGOs; Implementation by independent registered societies; Implementation by community based organisations. As is obvious, the environments created by these models are as varied as the models themselves. The set of stake-holders changed subtly (sometimes dramatically) with each model. The sustainability of treatment (measured in terms of maintenance of physical structures & preservation of improved practices) have been vastly different. The paper attempts to document these results on broad parameters and attempts to correlate them to the institutional structures. The paper examines the changing motivational pattern of the stake-holders in each of the models. The paper attempts to lay down optimised institutional models which are amenable to replication and scaling up. The author attempts to emphasize the importance of "net-working" to break through institutional barriers.

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A-0641

Entrepreneurship Development Among Rural Women for Land Stewardship. Mrs. Vijayalakshmi, K.G. & Dr. Narayana Swamy, B.K, Sericulture CollegeChintamani UAS, Hebbal, Kolar, Karnataka Bangalore, INDIA

Entrepreneurship development among rural women is an emerging concept cited in recent literature for local action to land stewardship. The study indicates that rural women need entrepreneurship development, because development economy of any nation depends primarily on the important role played by entrepreneurs. The part played

by entrepreneurs is of vital importance to land stewardship. In developing countries there are ample opportunities for using innovations to exploit the available resources. Thus more and more focus is being centered on entrepreneurship development of rural women. Entrepreneurship has now been recognized, vital for land stewardship. Entrepreneurship is a creative and innovative response to the environment. Doing new things or doing things that are already being done in a new way is also a part of entrepreneurial behavior. The entrepreneur is an economic women, who strives to maximize her profits by innovations. However, the entrepreneurs are not simply innovators, they are women with a will to act, to assume risk, and to bring about a change through organization of human efforts. Thus a different orientation is required for land stewardship. The study reported that entrepreneurship as a composite variable means that the women possessing entrepreneurial behavior has some specialized characteristics. Entrepreneurship has been therefore accepted as a function of several factors. In order to contribute to the development of entrepreneur, a scientific identification of characteristics contributing entrepreneurial personalities, designing mechanism to train such rural women on these dimension, evolving strategies to initiate and motivate them to develop entrepreneurship, testing them for their entrepreneurial prosperity and training them are urgently needed for land stewardship. To promote entrepreneurship among rural women attention so far given is limited in taking several steps to assist women. Research based literature on the characteristics of women entrepreneurs in land stewardship is also scanty. The worldwide bibliography on entrepreneurship research reports that studies on the characteristics of rural women entrepreneurs in agriculture are very limited. Since some of the characteristics that are based on researchers from different countries of the world are not cross culturally valid. Hence, the characteristics which distinguish entrepreneurship may not be uniform for its different strata. Further, the study recommended to achieve entrepreneurship among rural women there is need to train women to develop characters like decision making ability, Innovativeness, Achievement motivation, ability to co-ordinate, risk taking ability, information seeking ability and leadership ability for land stewardship during 21st century.

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A-0642

Impacts of mechanization on surface erosion and mass movements in vineyards of the Anoia-Alt Penedés Area (Catalonia-Spain). Ildefonso Pla Sentís & Silvana Nacci Sulbarán, Departament de Medi Ambient i Ciències del Sòl. Universitat de Lleida, Lleida (Spain)

The soil and cropping management practices for rainfed production of grapes for high quality wine and cava production in the Anoia-Penedés area in NE Spain, have been mostly mechanized in the last two decades. As a consequence of the new cropping pattern and changes in surface soil and effective rooting depth, associated to the smoothing of the lands and mechanization of the different operations, there has been an acceleration in the soil surface and mass erosion, and changes in the availability of soil water for the crop in different growth stages. Under these new conditions the traditional soil and water conservation practices have been abandoned or have become ineffective, and the effectiveness or applicability of some newly proposed practices has proved to be limited, or is creating further environmental problems. Based in recent studies presently carried on in the area, it is shown that with the use of a simulation model based on the integration of properly selected and measured soil and rainfall parameters, it is possible to predict soil moisture regimes for the whole year and cropping cycles for any combination of factors related with the soil, crop, management and climate in the area. Those predictions show how the application of some traditional conservation practices are not contributing to the soil and water conservation under the new land management, and by the contrary they contribute to accelerate the processes of mass movements and gullying. It is shown how the proposed hydrological model may be used for a more rational selection and application of cropping practices and of soil and water conservation practices, adapted to the new mechanized system, to improve the quantity and quality of production, and to decrease environmental damages.

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A-0643

Poultry Manure Application as a Viable Option for Land Stewardship. Dr. (Mrs) Chandrakala G.K. and Dr. Narayana Swamy, Institute of Animal Health and Veterinary Biologicals, University of agricultural Sciences, Hebbal, Bangalore, Karnataka, India

High pitch fever to increase the production braked the tradition wisdom resulted in soil degradation. Now the emphasis is focused on the land stewardship. Land stewardship is a revolutionary movement with low external input farming. Among the measures to obtain land stewardship using organic byproducts of animal husbandry and agriculture, applications of poultry manure as a viable option. One ton of cage system of poultry manure supply 16 Kg N, 47 Kg P_2O_5, 21 Kg K_2O and 12 Kg Sulphur. Similarly one ton deep litter poultry manure supply 12 Kg N, 20 Kg P_2O_5, 17 Kg K_2O and 10 Kg Sulphur. In India about 4 million tons of poultry droppings are available annually for preparing poultry manure. Thus poultry manure can have immense potential for enhancing productivity if processed in a systematic manner. It has been calculated that a manure laying hen of 2 Kg body weight produces on an average 42 liters if droppings with a wet weight of 0.036 tons a year. Experimental results to evaluate a poultry manure as a source of macro and micro nutrients have shown that the nutrients of poultry manure are more efficient than those applied through chemical fertilizers and have large beneficial effect on succeeding crops. Further poultry manure is about 3 times more efficient than cowdung. Aerobic digestion normally used for composting is practical only if material rich in carbon is added to the droppings bringing C :N ratio. The aerobic method also called composting needs addition of moisture and turning the pile regularly, preferably every week so that nitrogen in protein is not converted into ammonia and escapes to atmosphere. Although it is a preferred method but at the same time it is labor intensive or needs costly machinery to turn and pile. Monitoring of moisture is equally essential. The results of the studies indicated that poultry manure containing 1.78% N and 1.8% P when applied at the rate of 4-8 tons of N/ha produced paddy equal to that produced from 60 and 120 Kg of N/ha respectively. Further, the results showed that poultry manure application of 15 t/ha increases soil pH and available phosphorous. Further, it increases C and N ration in the soil decreases deterioration of soil structure, minimizes a dangerous change in the C.E.C for k^{++} and Na^{++}, reduces the excessive stimulation of microflora. Results of the experiments to determine the effect of poultry manure on growth and productivity reported that the production and productivity level of vegetables, fruits and field crops were higher, compared to chemical fertilizers. The findings of the paper will be useful for scientists and administrators in designing new strategies for local action to land stewardship.

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A-0644a

Impact of Severe Flooding on Soil Erosion and Conservation in Bangladesh. M.A. Sattar, Department of Soil Science, Bangladesh Agricultural University, H.S.M. Faruque, Bangladesh Water Development Board, Govt. of Bangladesh, Dhaka and Afroza Sattar, Department of Geography, Girls Cadet College, Mymensingh, Bangladesh

Bangladesh has an area of 140000 sqkm formed by the rivers the Ganges, the Brahmaputra, the Meghna and their tributaries, the Karnafulli and the Sangu. The country has 120 million people, and they live in 64493 villages and 64 district towns. About 90% people in villages. The country experiences a monsoon season from June to October and causes heavy rainfall- 80-95% of the annual. From 100 years data the country showed 2580-5530 mm rain in June, 3315-5881 mm in July 2720-4817 mm in August. The rainfall distribution increased 3-5 times in 1998 than in 1997, and created a historical flood devastation in July-September 1998. Bangladesh has been enjoying annual flooding every year since last 50 years which has minor influence of soil erosion and caused severe hazards on soil erosion, land degradation and soil conservation. Bangladesh experienced 10-12 severe floods in the 20th century but this 1998 flood has the longest active in the history which survived for 65 days. A field survey was done just after the flood where it was widely observed the dynamics of floods on soil erosion and conservation. Floodwater eroded plain lands at hundreds of places but where there was grass fields and crop fields the erosion phenomenon was minimum. Severe rainfall and floodwater eroded hundreds of bunds, city roads, ordinary soil roads at many villages. The erosion was observed at high speed and at land area near the small or large rivers. A severe siltation layer of 0.5 to 5.0 cm was noticed at various places. At some locations severe sand erosion engulfed the productive lands. The conservation methods largely helped to protect the land surface by hundreds of bunds, dikes, brick walls etc. Dhaka city is largely saved from floodwater where a surrounding of soil wall largely protected the city. The important conservation practices helped to minimize the erosion and soil loss are crops, crop residues, grass, roadside plantation, brick wall, bunds etc. Hundreds of erosion and conservation sites were identified and they are shown in maps. Again, erosion hazards were identified through numerous photographs.

M.A. Sattar

A-0646

Impact of agrochemical applications on agroecological environment. M. Jolánkai - Z. Szentpétery - T Szalai, Hungarian Academy of Sciences, Budapest

Seven years data of small plot cereal filed trials' agrochemical applications were processed and evaluated. The main effect and their interactions were calculated concerning yield losses and improvement. The results suggest, that non appropriate herbicide and fertilizer applications can be responsible concerning yield losses, while the use of fungicides and insecticides was found to be almost harmless. In yield improvement the use of fertilizers had the strongest impact, with fungicides second to that. An ecological model was introduced to estimate consequences of excess agronomic impacts (environmental pollution, phytotoxicity, alterations of cenosys, erosion and deflation, induction of resistant mutants, yield losses) as well as that of the effects of insufficient agronomic applications (soil nutrient abuse, danger of pests and diseases, alterations of cenosys, mycotoxins, and also yield losses).

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A-0647

Mangrove Structure in the Eastern Coast of Samar Island, Philippines. Antonio B. Mendoza

The mangal forest of the Eastern Coast of Samar Island located at the Western Central Pacific Ocean was studied in 1997 to determine the present condition in terms of density, basal area, canopy height and number of saplings and seedlings per hectare. This served as a basis for management planning of coastal ecosystem in the area. A 10 x 10-meter plot was used for the study. This was laid at 100 meters interval from the shoreline to the last mangrove stand in the seaward zone. A 5 x 5-meter plot was laid inside the mainplot for saplings and seedlings study. General collections of samples were undertaken for identification of species that were not sampled in the plot. There were 5 sampling sites established representing the most productive coastal area. There were 22 mangrove trees identified with Sonneratia casiolaris and Avecinnia marina dominate the fringing mangrove while Rhizophora apiculata and Avecinnia alba in the riverine mangrove. Highest canopy height of 5.39 meters in Gamay Bay is an indication of less human pressure in the mangrove area compared to Guiuan, which has only 3.19 meters. Likewise, the basal area of 22.78 m^2/ha. in Dolores is an indication of a larger individual sign of 1,780 trees/ha. Compared to Borongan with 21.49 22.78 m^2/ha. Basal area of 2,300 trees per hectare. In all the sites, the number of saplings and seedlings range from 2,532 to 19,600 per hectare and 32,500 to 84,000 per hectare respectively are sufficient to improve the mangrove structure should no cutting activities will be undertaken. The seedlings can supply reforestation projects in nearby coastal areas with degraded mangrove due to excessive cutting. The relative density and dominance of mangrove species differ from each sampling site. It was noted that in the northern portion of Samar Island Avecinnia and Sonneratia dominate while in the southern portion, Rhizophora and Xylocarpos dominate. The most notable destruction in the mangrove forest is in Gamay Bay caused by an oil spill by a Taiwanese fishing boat that run aground in nearby coral reef n 1993 until recently 40 hectares are still denuded and only two mollusk species are found in the area. It is recommended that the mangrove forest in this area be preserved due to its ecological and economic uses. This served as buffer zone that protects the mainland farm coastal erosion during stormy weather especially that it is open to the Pacific Ocean. This provides economic activities also to many fisherfolks especially that it is open to the Pacific Ocean. This provides economic activities also to many fisherfolks especially for mudcrab (cylla serrata) and paphia fishery.

A-0649

Soil Erosion Assessment with the EPIC-Erotop Model by GIS Method. Tamas Huszar, Department for Physical Geography, Geographical Research Institute, Hungarian Academy of Sciences, Budapest, Hungary

As a consequence of global climate change increasing aridity can be observed in Hungary manifested in the increase of yearly effects of climate change is the change of the erosion regime therefore it is necessary to extend the scope of soil erosion research. The main objective of the present study is mapping and modeling soil erosion processes in a typical watershed. (24 km^2) belonging to the northern subcatchment of Lake Balaton. Vulnerable cambisols developed on loess, rendzinas and vertisols are represented in the test area. The data base for soil erosion modeling was built up in ARC-INFO GIS consisting of the following data layers; (a) general data (topography, slope length and slope angle, calculated for each erotop); (b) climate data; (c) soil data; (d) agrotechnology data. The Universal Soil Loss Equation (USLE) and EPIC 5300 (Erosion Production Impact Calculator) models were applied and calculation results were compared. EPIC is applied for small topological units so called erotops (defined by Richter in: Kertesz-Richter 1995) with approximately same runoff direction, homogenous soil type and management, without water collecting linear elements Cultivated slopes and pasture steeper than 2° were only taken into consideration and the surfaces of colluvial accumulation were out of model. Results were input into a GIS, analyzed and displayed by ARC/INFO and ARC/VIEW, thus arriving at the erosion degree map of the area. Estimated soil loss averages for arable lands (located at the bottom of the basin) are much higher (22,14 t/ha/year) than averages for grassland located on steeper slopes not used for grazing (6,08 t/ha/year). The major conclusion is that the assessed soil loss values obtained by the two models do not show significant differences. Comparing the traditional field-work based data of erosion with the maps of calculated soil loss the areas of various degree of erosion correspond also very well to the soil loss values, e.g. the strongly eroded areas with the highest values of calculated soil loss. Relationships between soil erosion conditions and of slope morphometry, soils and land use types allowed conclusions about the frequency distribution of (1) various land use types in each soil erosion category; (2) various slope categories in each soil erosion category; (3) various genetic soil types in each soil erosion category and vice versa.

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A-0650

A case study of sustainable land management in the Loess Plateau, China. Fengrong Zhang, Beijing Agricultural University, Beijing,China

The hilly region of the Loess Plateau is in the northwest of China, a typical semiarid monsoon climate region. Crop production is low and unstable. People are poor and have no money to buy fertilizers. Worrying of starvation, people grow crops wherever they can, even on the very steep land. So the soil erosion is serious. A small watershed was selected for the experiment to get the five objectives of sustainable land management, that is: a) maintain or enhance production; b)reduce the level of production risk; c) protect the potential of natural resources and prevent degradation of soil and water quality; d)be economically viable and e)socially acceptable. The small watershed is located Chuanjia Village, Mizhi county, Shannxi province. To reach the five objectives of sustainable land management, the key methods are: a) Constructing prime farmland for satisfying food need; b) Controlling soil erosion. Terrace and deposition dams have better soil moisture regime and higher yield, so they are called prime farmland. In order to withdraw planting from steep farmland, certain terraces and deposition dams were built for food production. Fertilizers were applied on the prime farmland. The money used for fertilizers came from cash crops that include fruit trees and animal husbandry. Trees, shrubs and grasses are planted, not only for soil erosion protection, but also for animal husbandry. Both of the yield and crop production stability were raised, because of construction of prime farmland. Vegetation cover increased and the soil erosion reduced. People's income increased through comprehensive agriculture development. People gland to have these land management methods. Generally speaking, the practice of land management is sustainable. However, one thing may be obstacle for sustainable development, that is population growth. From the table we can see, although both of the total cereal production and yield increased, the grain per capita dropped down from 425 kg to 402 kg.

Fengrong Zhang

A-0652

Evaluating WEPP Predicted Infiltration, Runoff and Soil Erosion for Furrow Irrigation. David L. Bjorneberg, Thomas J. Trout, Robert E. Sojka, J. Kris Aase, USDA-ARS, Kimberly, ID USA

The Water Erosion Prediction Project (WEPP) model contains a furrow irrigation component to simulate hydrology and erosion in irrigation furrows. Our objective was to evaluate the WEPP model for furrow irrigation by comparing predicted infiltration, runoff and soil loss with field measurements from three southern Idaho studies on Portneuf silt loam (coarse-silty, mixed, superactive, mesic Durinodic Xeric Haplocalcids). One study tested inflow rate effects on soil erosion and the other two studies involved various tillage treatments. We used data from the upper quarter of two fields to calibrate baseline effective hydraulic conductivity, rill erodibility and critical hydraulic shear. Calibrated effective hydraulic conductivity (2.7 mm h^{-1}) was slightly less than the WEPP-defined value for Portneuf soil (3.4 mm h^{-1}). The erodibility parameters, however, were much less than the WEPP-defined values. Calibrated rill erodibility (0.0003 s m^{-1}) was almost two orders of magnitude less than the WEPP-defined value (0.02 s m^{-1}). WEPP-defined critical shear (3.5 Pa) was about 3 times greater than the calibrated value (1.2 Pa). The model can not be recommended for furrow irrigation use until critical shear and rill erodibility can be defined for irrigation furrows on other soils. Predicted infiltration correlated poorly with measured infiltration ($R^2 < 0.30$). Slopes of linear regression lines between measured and predicted infiltration ranged from -0.18 to 0.34, indicating that predicted infiltration did not vary with measured infiltration. Coefficients of determination between predicted and measured soil loss varied from 0.21 to 0.50. Annual soil loss was over-predicted by 3 to 10 times for one study. The model predicted no soil loss for another study even though 6 to 120 kg m^{-1} were measured. Predicted soil loss and runoff correlated well with measured values from the upper end of the two fields we used to calibrate erodibility parameters. At the end of these fields however, runoff was under-predicted and soil loss was over-predicted indicating that transport capacity was not accurately predicted by the mode for these conditions.

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A-0653

Effects of Erosion and Manure Applications on Corn Production. F. Arriaga and B. Lowery, Univ. of Wisconsin-Madison

Soil erosion has been a problem in agriculture since ancient times. The major impact of erosion is the loss of soil productivity due to degradation of soil biological, chemical, and physical properties. A study was started 12 years ago (1985) to investigate the effects of soil erosion on soil productivity and corn production in southwest Wisconsin. Three levels of erosion (slight, moderate, and severe) were identified based on the depth of topsoil above a red clay residuum (2Bt horizon) on a Dubuque silt-loam. Manure applications were started on 1988 on half of the plots to evaluate its effect on soil physical properties of eroded soils. Differences in corn yields due to erosion level have been small, but in general yields decrease with increasing erosion level. In addition, it appears that some of the yield differences between erosion levels are weather related. Plant heights also declined with increasing erosion level. Manure effects on corn yields are dependent on erosion level, but these effects are not consistent. To date, manure has had little effect on corn yields. Plant heights increase with manure applications. We suspect that manure applications will have a long-term effect on soil physical properties, mainly on water retention. Tensiometric data collected during the 1997 growing season revealed greater water retention at 30 cm on the manured subplots. Differences in water retention were less noticeable below 30 cm. Wetting front in the manured subplots appears to move faster than in no-manure subplots. This effect is more noticeable with increasing erosion level. However, because of this, manure applications may increase the potential of contaminant leaching.

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A-0655

Paso del Norte Sustainable Water Use Strategy. Ed Hamlyn, AICP, UTEP, The Center for Environmental Resource Management, El Paso, Texas USA

In April of 1996, the University of Texas at El Paso's Center for Environmental Resource Management undertook a process to create an economic development strategy for the Paso del Norte region based on the sustainable use of the region's water resources. The study was underwritten by the Economic Development Administration with support from the Ford Foundation and participating universities. A series of technical studies were commissioned as part of this study, and a year long public participation process was undertaken in 1997. The result of this effort is a detailed strategy statement that constitutes the study's principal product. The Paso del Norte region, as defined for the purpose of the project, consists of the five westernmost counties in Texas, two counties in southern New Mexico that lie along the Rio Grande, and four municipios in Chihuahua that border the Rio Grande down to its confluence with the Rio Conchos. The region falls within the arid Chihuahuan desert. While most of the region is sparsely populated, the Rio Grande floodplain is intensively irrigated and the El Paso / Cd. Juárez Las Cruces area is becoming a major urban agglomeration. Coordinated resource management planning is made difficult by differences in the laws of the three states and two nations. Historically, the urban areas have exploited high quality ground water while the region's farmers have relied on the surface waters of the Rio Grande, managed downstream of Elephant Butte Dam by a complex system of international treaties and interstate compacts. Over time, overdrafting has lowered the water tables of the region's aquifers, yet overall municipal and industrial water consumption is increasing in lock step with the region's rapid population growth. As ground water supplies diminish, the region's cities are planning to shift, or already have begun to shift, to using surface water. increased municipal use of surface water may come at the expense of agricultural use. This shift may disrupt that element of the region's economy and alter the physical environment unless mechanisms are put in place to promote agricultural water conservation. Additionally, a transition from agricultural to municipal use of water will require modifications to the legal system that controls water allocation. if existing water rights holders are not fairly compensated, a legal conflict may ensue that could forestall the transition to municipal use of surface water use and hasten the depletion of the region's aquifers. Inevitably, as municipalities shift to using surface water and lesser quality ground water, water rates will rise and this will have economic consequences. A series of technical studies were completed as part of the project. The pattern of existing water use was documented both for agricultural and municipal use, and municipal use was further broken down into residential and non-residential categories. The relationship of water use to the regional economy was documented in terms of both employment and payroll by economic sector. The overall population within the region was projected to the year 2050 based on the separate projections of the different jurisdictions in the region. An analysis was made of the types of water treatment technologies that may be necessary as the region becomes reliant on lower-quality water resources. A water exchange system was postulated to determine the benefits and potential negative impacts from a market-driven reallocation of surface water. Together with funding from other sources, a computer streamflow simulation model was created to facilitate an analysis of the environmental impact of altered stream flow regimes proposed to supply a year-round source of surface water to the region's municipalities. And finally, a report was prepared to document the legal mechanisms controlling the allocation and use of both surface and ground water, together with an assessment of how the existing legal mechanisms may or may not allow for development of a long-term strategy for sustainable use.

A-0657

An interdisciplinary approach to reduce nutrient losses by erosion in the agricultural hilly purple area of Sichuan Province, China. C. J. Ritsema, K. O. Trouwborst, J. Stolte, E. G.M. van den Elsen, DLO Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen, Netherlands, J. Thompson, S. Croxton, International Institute for Environment and Development, London, United Kingdom, S. Ledin, M. Fagerström, I. Messing, Swedish University of Agricultural Sciences, Uppsala, Sweden, C. Yibing, Soil and Fertilizer Institute, Sichuan Academy of Agricultural Sciences, Chengdu, P.R. of China, Li Zhanbin, Li Rui, Junliang Tian, Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, Yangling, P.R. of China, Shi Xuezheng, Zhihong Cao, Institute of Soil Science, Chinese Academy of Sciences, Nanjing, P.R. of China

Erosion is considered as a serious problem in China, which hinders a sustainable agricultural production. The present study deals with the Hilly Purple area within the Sichuan Basin, which is one of the most important agricultural areas in Western China. This area has been degraded by continuous soil erosion, and has reached yearly rates of around 3,000 t/km^2 by now. Soil erosion has direct negative effects on the productivity of the land by loss of water, soil and nutrients. This affects the farmers income, because more inputs are necessary to counteract these processes to maintain long-term food production. Another adverse effect is that the water, soil and nutrient losses are transported to the Yangtze river, upstream of the newly build Three Gorges dam. The government of the P.R. of China recognizes the problem of soil erosion and promotes a comprehensive approach to control soil erosion. The present study aims to find alternative land use and soil and water conservation strategies to reduce the losses of soil, water and nutrients in the Sichuan Basin by combined use of soil erosion modeling and participatory techniques. The 3-year project, which started at the end of 1998, is funded by the European Commission and the Netherlands Ministry of Agriculture, Nature Management and Fisheries. Project structure, methodology, and research aims will be exemplified in detail.

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A-0657a

Soil and water conservation planning on the loess plateau in Northern China. Coen J. Ritsema, Jannes Stolte, Kim O. Trouwborst, Erik G.M. van den Elsen, DLO Winand Staring Centre for Integrated Land, Soil and Water Research, Wageningen, Netherlands, Li Rui, Institute of Soil and Water Conservation, Chinese Academy of Sciences and Ministry of Water Resources, Yangling, P.R. China, Baoyuan Liu, Beijing Normal University, Beijing, P.R. China, Bojie Fu, Chen Liding, Research Centre for Eco-Environmental Science, Chinese Academy of Sciences, Beijing, P.R. China, Victor Jetten, Rudi Hessel, Steven de Jong, Utrecht University, Utrecht, Netherlands, Stig Ledin, Ingmar Messing and Minh-ha Fagerström, Swedish University of Agricultural Sciences, Uppsala, Sweden

The Loess Plateau in Northern China is faced with a continuous loss of land and productivity due to soil erosion. An increasing demand to produce food for the growing population increases the pressure on the land, resulting in an accelerated destruction of forests and grassland. Conscious of the extent and severity of this problem, the government of the P.R. of China promotes a comprehensive approach to control soil erosion, but, there is still no proper method to plan and evaluate the expected effects of the (combined) use of the available measures on forehand. The aims of the present research are to investigate the current situation, and to develop alternative land use and conservation strategies using a participatory planning method which integrates both soil erosion modeling and land evaluation techniques. Prospective alternative land use and conservation measures, resulting from the land evaluation process, will be evaluated on their effects on reducing soil and water losses using a calibrated, GIS-incorporated, physically based soil erosion model, the so-called LISEM model. Based upon model outcome, alternative land use and conservation measures will be refined and optimized in a participatory process. In this process, land users, local authorities and policy makers will be involved in order to reach an optimum situation for the selected watersheds (low soil and water losses, high sustainability). The solutions found in this approach are expected to be supported by the different user groups in the area, which will provide a good basis for a successful implementation after conclusion of the project. The 3-year project, which started at the end of 1997, is funded by the European Union and the Netherlands Ministry of Agriculture, Nature Management and Fisheries. First results of the project will be presented and discussed in detail.

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A-0658

Land use scenarios to reduce water induced soil erosion in an agricultural catchment in the Netherlands. Jannes Stolte, Coen J. Ritsema, DLO Winand Staring Centre for Integrated Land, Soil and Water Research (SC-DLO), Wageningen, Netherlands, Tao Li, Wageningen Agricultural University , Netherlands

In a lateral moraine area with eaolian deposits in the Eastern part of the Netherlands, problems with water induced soil erosion are often encountered. The main problems occur in an agricultural area of about 5 km^2, with loess as the major soil type. Land use in this area consists of maize, sugar beat, winter wheat, grass and potatoes. In 1999, a land use planning will be carried out. Within this context, a study has been initiated to derive an alternative land use and soil and water conservation strategy for this area, aiming to reduce soil erosion most optimally. The area consists of five major sub-catchments varying in size from about 0.5 to 1 km^2. The physically based hydrological and soil erosion model LISEM has been used to simulate runoff and sediment loads for different land use and soil and water conservation scenarios. Within the five sub-catchments, input data for the LISEM model have been collected in 1998. In one of the sub-catchments, measurements of runoff and sediment loads have been carried out for calibrating/validating the model. In total, five different alternative land use and soil and water conservation scenario's have been evaluated with respect to sediment loads, runoff and erosion/deposition patterns. This has been done for four different rain event, i.e. a winter and summer period event with a two and a twenty-five years frequency. Land use and conservation measures evaluated are: (i) current situation (ii) soil tillage in autumn for arable land, reduction of parcel length to 400 m, and use of green manure in winter; (iii) same as (ii) with addition of specific land use elements; (iv) same as (iii) with field strips at 200 m distances, each 5 wide and perpendicular from the elevation lines; (v) same as (iv) with grassed waterways of 10 m wide. Results will be illustrated and discussed in detail.

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A-0660

Rainfall -runoff harvesting for controlling erosion and sustaining upland agriculture development. I. Sumarjo Gatot, J. Duchesne, Ecole Nationale Superiéure Agronomique, Rennes, France, P. Perez, CIRAD, Montpellier, France,C. Cudennec, Ecole Nationale Superiéure Agronomique, Rennes, France, T. Prasetyo, CIRAD, Montpellier, France and S. Karama, Centre for Soil and Agroclimate Research, Bogor, Indonesia

The main constrains in the upland agriculture development are : (1) very low of soil productivity, probably due to uncertain water supply (2) soil erosion rate more than tolerable soil loss, caused by high rainfall intensity and limited soil conservation practice. These conditions will promote to unsustainable in the development of upland agriculture. Several studies have been conducted in order to find out a solution to this problem. Unfortunately, the result is still expected. We think that, the approach has to change from soil erosion protection to run off control through rainfall-runoff harvesting. Taking into account these problems, rainfall-runoff harvesting researches are conducted in order to improve land productivity and strengthen their sustainability. The research take place in Kali Garang watershed, Semarang, Indonesia with rainfall about 4000 mm a year (ranged between October to March), land slope varies between 15-60% and land tenure less than 0.3 hectare. These conditions make it difficult to the decision makers to improve farmer's income and to maintain sustainable agriculture development. The results show that by rainfall-runoff harvesting using small reservoir, erosion can be controlled up to 50%, planting intensity are improved twice more than before, crops composition can be augmented even with the high economic value crops such as: chili, onions, melon. As well, water in the reservoir can be used for animal drinking and pisciculture, that means farmer's income can be improved directly with the soil conservation activities. Furthermore, by rainfall-runoff harvesting, critical land can be rehabilitated and the increasing of the critical land area can be controlled. To be applied in the field, we suggest to use a watershed scale as a unit of activity. Then, base on this scale it is possible to evaluate the effect of rainfall-runoff harvesting not only in the productivity and sustainability but also in the flood control in the wet season and drought protection in the dry season. This is an important part in promoting sustainable upland agriculture development especially in the develop and under develop country in the future. Keyword: rainfall-runoff harvesting, low productivity, land productivity, sustainable agriculture.

I. Sumarjo Gatot

A-0661

Deposition diagram studies - the residual erosion potential of soils. Istvan SISAK, Miklosne PALKOVICS, Katalin PLOTAR, Pannon University of Agricultural Sciences, Georgikon Faculty of Agriculture, Keszthely Department of Soil Science

Soil erosion decreases soil productivity as a primary effect but has many other adverse effects, too. One of those is the surface water pollution with nutrients in particulate form. Surface soil samples (0-10 cm) from seven experimental locations of the Hungarian Long-term Fertilization Field Trials were collected for this study in 1995. Different amounts of soil (1, 4, 16 64 and 256 g/l) were suspended (10 upside down turns) in distilled water in 3 replicates and after different deposition times (100, 1000, 10000 and 100000 seconds) the upper 5 cm of the suspension was sampled, filtered through a membrane with 0,45 micrometer pore diameter, dried at 105 C and the suspended solid content determined. It had not been determined after 100 seconds when 256 g soil was suspended because of the very high concentration. Selected soil properties were measured: clay, silt, sand and lime content and the KA value which is used in Hungary to characterise soil physical properties. KA is the water content of soil at a certain consistence when it gives the „yarn test". Its value is near the water content of soil at the point between solid and fluid consistence. The results were represented on double logarithmic time-concentration diagrams. The deposition lines for the higher soil to water ratios (16, 64 and 256 g/l) have been linear but those for the lower ratios (1 and 4 g/l) have levelled out after reaching a bottom. The individual lines could be brought into coincidence by one unit horizontal shifts to determine the characteristic deposition curve for the given soil. The initial deposition cannot be correlated with any soil properties. It have been quick at soils with high and low clay content as well. The possible explanation for the latter case is formation of aggregates in the suspension. The final suspended solid content have varied between 2 and 60 mg/l for the differnt soils and their values have shown close correlation (higher than 0.9) with the KA value. It is able to predict the background soil erosion and particulate phosphorus load (residual erosion potential of the soil). It might be in negative correlation with the lime conttent but this expectation cannot be proved with our experiment due to the low representation of calcareous soils.

Istvan SISAK

A-0663

Crop residue management and soil tillage in Southern Italy. Michele MAIORANA, Vincenzo RIZZO, Agronomical Research Institute, Bari, Italy

On the threshold of the third millennium, the agriculture must point to a more rational management of agronomic techniques and a greater protection of environmental quality. A recent report of the Intergovernment Panel of Climate Change (1995) pointed out that 20% of greenhouse effect is related to agricultural activities, as crop residue burning and deforestation. A contribution to the solution of this situation can consist in the carbon sequestration into the soil, by means of crop residues plowing in. This way, it is possible to reduce the CO_2 concentration in the atmosphere and, at the same time, to increase the soil organic carbon fraction. In the light of these considerations, the Agronomical Research Institute has been carrying out two long-term studies on the incorporation of durum wheat crop residues and on soil tillage systems since 1978. The experiments take place at Foggia, a typical area of Southern Italy, characterized by an "accentuated thermomediterranean" climate and by a silty-clay Vertisols, one of soils with the lowest organic carbon contents. The main crop in the area is durum wheat under continuous cropping or in rotation with vegetables, pulses, sunflower, sugar beet. In our researches 2 soil tillage depths (40-45 cm, by traditional moulboard plowing and 20-25 cm, by surface disc-harrowing) and 2 ways of straw disposal (burning vs. incorporation) are compared in a continuous dryland cropping of durum wheat. The results obtained so far have shown the following: i) from the point of view of both grain yield and quality, the treatments with crop residues ploughed-in and with the deeper tillage at 20-25 cm gave yields and protein contents more or less the same as those following burning and soil tillage at 40-45 cm of depth, at the moment the most common practices in the trial area; ii) the tillage at 40-45 cm of depth, especially with the straw incorporation, determined a lesser soil strength and a higher water infiltration rate.

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A-0664

Soil Conservation based Suitability Evaluation of Volcanic areas for Musa Production. Patrick Sama-Lang, Agricultural and land evaluation and Management Researcher CRBP/IRAD Ekona, Cameroon

The volcanic soils around the Mount Cameroon area (Muea, Ekona, Tombel, Kumba and Njombe) were surveyed. The results bases on soil conservation parameters were interpreted for suitability to Musa crop production. The Musa crop includes plantains and bananas. Soils are developed in young and old volcanic materials. Young volcanic materials are mainly mudflows of ash and lavaflows while old volcanic materials are mainly plateau and columnar Basalt. Mudflow soils are generally deeper and less stony than lavaflow soils. The same is true for the soils on old volcanic materials. The young volcanic or most recent soils are chemically richer while the old volcanic soils are chemically average or poorer and generally have a higher clay content. Soil conservation based, land suitability assessment was done for the Musa crops most abundantly produced here. Of the total surface area, 35% were suitable for platains and bannanas based on soil conservation. Because of slopes and other soil conservation related factors like rainfall, 65% of the area was repartitioned in three other less suitable soil conservation units. Soil physical conditions (depth and stoniness) ans slopes were the most limiting factors. The area is affected by adverse climatic conditions when evaluated for plantains and banana production especially during the dry season requiring irrigation. For extension or vulgarisation Musa crop requirements include production in frost areas under 25-28 C average temperatures. 1000-1500 mm/year average rainfall is ideal. Wind damage is a hindrance especially because of root and stem nematodes and borers. Wind speeds should be less than 50 km/h. Soils should be freely drained, well aerated and deep. They should be fertile loams without waterlogging.

Patrick Sama-Lang

A-0666

Height Calibration of Wind Erosion Made with BSNE-Samplers. D.E. Bushciazzo, Facultad de Agronomia, Universidad Nacional del La Pampa, Santa Rosa, Argentina, S.B. Aimar, EEA INTA Anguil "Guillermo Covas", Anguil, Argentina and T.M. Zobeck, USDA-ARS, Wind Erosion and Water Conservation Research

The amount of soil moved by wind varies inversely with height. The soil passing through a spatial plane within a given time (i.e. the mass flux) has been calculated by stout and Zobeck (1996) by means of the linear form of the empirical equation of Zingg (1953): f(z) - 1/2 = fo -1/2 (1+z/x) where f(z) is the mass flux at height z, fo is the mass flux at the soil surface, and x is a height factor. BSNE-samplers (Fryrear, 1986) are cheap and easy to construct, but they measure erosion above about 13.5 cm height. As most of the eroded material moves below the height, the use of equation (1) with data from BSNE samplers a can lead to errors. The aim of this study was to calibrate BSNE wind erosion sampler measurements with reference measurements that included samples obtained from the soil surface. Wind erosion measurements were carried out at two sites near Santa Rosa-city, Argentina (36.5° latitude S and 64.5° longitude E). Site 1 had an Entic Haplustoll and Site 2 a Typic Ustipsamment. Measurements were carried out on 9880 m2 fields. Soils in the fields were maintained bare and flat during measurements. Samples were collected from 10 dust storms occurred between 29 July and 3 October 1996. Measurements were carried out with BSNE samplers at 13.5, 58, 71.5, 96, and 147 cm height; modified BSNE samplers at heights of 7,12,and 22.5 cm; and a near-surface sampler with openings at 0.15, 0.7 and 1.5 cm height (Stout and Zobeck, 1996). The mass flux was calculated with equation (1) using: a) the material collected at 13.5, 58 and 147 cm height (Q_3); b) the material collected between 7 and 147 cm height (Q_8); and c) the material obtained from the whole set of samplers (Q_{11}). Results showed both Q_3 and Q_8 were 3 to 4 times lower than $Q_{11.}$ The amount of material collected above 13.5 cm height with BSNE samplers and with modified BSNE

samplers was while the amount of material collected with both BSNE samplers and with modified BSNE samplers was a 22.8% of the total amount of eroded material. About 77% of the material passed below 7 cm height. Simple regression analysis of mass flux calculated with data obtained from different heights gave the following results: Q_{11} =0.1423*Q_3 + 0.2646 (R^2 =0.99) and Q_{11} = 0.2221*Q_8 + 0.2483 (R^2 =0.99) indicating that equations (2) and (3) can be successfully used to adjust measurements made with BSNE samplers or with modified BSNE samplers.

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A-0668

Variability in Average Runoff and Soil Loss Values Obtained from Long-Term Plot Measurements. G. Govers, Fund for Scientific Research Flanders, Laboratory for Experimental Geomorphology, K.U.Leuven, LEUVEN, Belgium, M. Nearing, D. Norton, USDA-ARS Nat. Soil Erosion Laboratory, West Lafayette, IN USA

Although it is well known that soil rates vary considerably from year to year, this information is only rarely taken into account when interpreting soil erosion rates obtained from plot measurements: average soil erosion rates are usually cited and used without any mention of the uncertainty associated with them. We analyzed ca. 35 time series of soil loss and runoff obtained at different sites in the USA in order to quantify the uncertainty associated with the average soil erosion rates measured in a number of contrasting agronomical systems. From the time series a standard error of the mean was calculated, which was then used to estimate the expected standard error of the mean, the coefficient of variation and the 90% confidence interval for a 10-year measuring period (CI-10). Measured runoff values show coefficients of variation ranging from 5 to 60 % of the mean value, with CI-10 values between 10 and 95 % of the mean value. There exists a strong negative relationship between the relative confidence interval and the average yearly runoff. The relationship appears to be rather general, with no significant effect of local factors (climate, soils and/or agronomical practices…..). Variability for annual soil loss is even higher, with CI-10 values from 15 to120% of the average value. Although there is a tendency for the relative confidence interval to decrease with increasing average soil loss, the relationship is much weaker than for average runoff. Also, local factors appear to have a stronger effect on soil loss variability than on runoff variability. The variability found for runoff and soil loss variability than runoff variability. The variability found for runoff and soil loss is much greater than the variability in rainfall erosivity which has a relative confidence interval ranging from 25 to 40% of the mean. This reflects the fact that soil erosion is influenced by driving factors (related to the climate) and resisting factors (soil resistance to detachment, vegetation cover…) most of which are highly variable in time. Our analysis can be used to assess the uncertainty associated with an average soil loss estimation provided information about the length of the measuring period is available. It also shows clearly that a relatively high degree of uncertainty is associated with the soil loss values, even if measurement programs are maintained over relatively long periods. For a 10-year measurement period, the 90% confidence interval is on average ca. 75% of the mean value, which implies that a reported 10 ton ha^-1yr^-1 soil loss may in reality vary between 2.5 and 17.5 ton ha^-1yr^-1.

G. Govers

A-0668a

The TERON experiments on tillage erosion : an overview of the results of the first phase. G. Govers, W. Van Muysen, C. Kosmas, T.A. Quine, R. da Silva, D. Torri, E. Sibbesen, G. Heckrath and J.V. Giraldez, Fund for Scientific Research Flanders, Laboratory for Experimental Geomorphology, K.U.Leuven, Leuven, Belgium.

Over the last 18 months a co-ordinated effort was undertaken by the research groups in the TERON project to study experimentally the various factors controlling soil translocation and erosion by tillage. The experimental procedure adopted is similar to the one one described by Govers et al. (1994) and is based on the precise relocation of numbered tracers after a tillage operation. Experiments were carried out on 7 different sites, using local tillage implements. The results obtained from the tillage erosion experiments show that nearly all mechanised tillage operations cause a significant amount of soil translocation and therefore soil loss on hillslope convexities. A first analysis of the data shows that tillage erosivity is strongly determined by tillage depth, tillage speed and the condition of the soil at the moment of tillage. Tillage erosion can vary by a factor 2 to 3 due to variations in these factors. On the other hand, soil type as well as minor variations in implement design seem to be less important. For moldboard ploughing, the relationship between tillage depth and tillage erosion is non-linear, i.e. tillage erosion increases faster than tillage depth. The results question some assumptions made in current tillage erosion models. Until now, these models assumed tillage erosion by moldboard ploughing to be isotropic: i.e. the erosivity of a moldboard plough is assumed to be independent of the tillage direction. This assumption is based on a limited set of experiments carried out by Lindstrom et al. (1992). The results obtained show that this is certainly not always the case: the new data indicate that tillage erosion is far more important in the case of up- and down ploughing compared to ploughing along the contour lines. Considering the fact that tillage erosion by harrow and chisel implements is also strongly anisotripic, it is clear that tillage erosion models need to be adapted so that this anisotropy can be taken into account. If, on the other hand, later experiments confirm our findings that tillage translocation is relatively independent of implement design, it may well be possible to predict the erosivity of untested or new implements using a relatively simple model.

G. Govers

A-0669

GIS technology: a tool for resource assessment, an integral part of the locally led conservation process. A Rio Grande Basin perspective. Rafael Guerrero, Javier E. Ruiz and Dwight Curtis, USDA-NRCS, Fort Worth, Texas USA

GIS technology lends itself to the presentation of information that is vitally important in the resource assessment and locally led conservation process. GIS can be the tool that brings together a wide variety of information and data, allows for is presentation in formats that are easily understood and provides local decision makers the ability to evaluate information about issues that are of critical importance in their area. The Rio Grande Basin covers three states, two countries (US and Mexico) and crosses a variety of natural and social/economic conditions. A resource assessment brings together information from several sources to paint a picture of the conditions that exists in the basis. A broad perspective is important to understand the extent of possible issues and problems, but only when the scope of the assessment is narrowed does it become valuable to local interest. A resource assessment of the Rio Bravo RC&D brings the information to a local level. It is here where it becomes a foundation part of the locally led process that identifies issues and set in motion the process of bringing people from the local community together. Only through a group effort will the most important issues be identified and only together will strategies for dealing with these issues be developed.

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A-0676

Erosion Model For Tree And Bush Canopy Covers. Coutinho, M. A., Professor of Hydraulics and Water Resources. Instituto Superior Técnico - Depto de Eng. Civil - Secção de Hidráulica. Lisboa Codex - Portugal and e Antunes, C. R., Biophysical engineer. Msc of Hydraulics and Water Resources. HIDROPROJECTO, Engenharia e Gestão. LISBOA Codex - PORTUGAL

In many regions of the world, namely the Southern Europe areas with mediterrean climate the soil is used for cereals and other crops under threes. The main objective of the study was the development of a framework for an erosion model for vegetation canopies of trees and bushes. The model was constructed based on data obtained in previous research, in which the drop sizes of the throughfall were measured for single leaf and for a cascading set up of two and four leaves. Based on the estimation of throughfall energy for different canopy heights and various cover densities a general model was derived considering mixed land covers. The developed model allows a simplified estimation for the C factor, of USLE, for canopy covers and soil uses under canopy.

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A-0678

People's Participation In Different Stages Of Soil And Water Conservation Programmes. G.L. Khatik, V. Kumar, V.C. Pande & H.B. Singh, Central Soil & Water Conservation Research & Training Institute, Research Centre, Vasad

People's participation may be defined as "concerted efforts by a group of local participants for achieving common goals and sharing benefits". Participation of rural farmers in soil and water conservation programmes at different stages such as planning, implementation and maintenance is inevitable. Participation of local people at the time of programme planning of soil and water conservation projects is much needed to take decisions, according to their suitability and needs. The programme should meet the basic needs of local people like, irrigation and drinking water; fodder for cattle and fuel for kitchen of local village people. The participation of local people in programme implementation and maintenance work is also much required because without protection and care of soil and water conservation structures by local village people the programme will not be successful. The village local people will be the ultimate beneficiary of soil and water conservation programme, therefore, such rural development programme should be made for the local people, by the local people and of the local people. The study was conducted in Mahi ravine area during 1995-96 in five villages of Vadodara district in Gujarat State, where natural resource conservation programmes were carried out by state Government. The respondents were grouped into four category i.e. marginal, small, medium and large farmers on the basis of size of land holdings. The People's Participation Index (PPI) was developed to measure the extent of participation by farmers in soil and water conservation programmes in Mahi ravine area. It was resulted that the people's participation in programme planning stage was maximum by the category of large farmers and minimum by marginal farmers. In the programme implementation stage the people's participation by all the categories of farmers was observed more or less equal. It was also observed that in the programme maintenance stage, maximum participation was contributed by large farmers and minimum participation by marginal farmers.

G.L. Khatik

A-0682

Have the Commons a Chance in the Himalayas? – Challenges for Sustainable Land Management in the Himalayan Foothills in India. R. Kotru, S. Preuss, R. Kumar Gupta, Indo-German Changar Eco-Development Project, Palampur, Himachal Pradesh, Indien

The foothills of the Himalayas comprises a stretch of more than 1000 km. Consisting of sandy loamy soils (predominantly inceptisole and entisole) the Shiwaliks form the fragile foundation of the geomorphological young Himalayan Mountains. In the Shiwaliks of Himachal Pradesh as elsewhere early settlement and approachability from the planes accelerated exploitation of natural resources. Individual property and community lands were legally developed under the English rulers on the basis of the disolution of the feudal system,. leaving in a first run the commons under the custody of the Village settlements. But ultimately, in a process of nearly 100 years the emerging Forest Department was made the owner of the commons. Today's scenario shows a confusing picture of land tenureship typical for mountainous regions world-wide. Tenure is oscillating between individual land ownership over state-owned community land with detailed local user rights, state forest lands with limited user rights and *ghair mumkin*, so- called culterable waste where neither traditional rights are effective nor formal state ownership enforced. The community lands form usually about 20% of the total land use (private agricultural fields and haylands 45%, state forest lands 20%, others/ghair mumkin 15%). Scarcity of water particularly in the hot summer months and a severe seasonal shortage of fodder (in quantity and quality) are main problems and are caused by the ever increasing human population and the high number of free grazing animals. Though people have coped with the depletion process through (male) out-migration, keeping of less animals and partial stall-feeding the downward spiral of ecological and socio-economic development is on and is most effecting the commons and the state forest lands. Their conservation-effective management is of utmost importance to improve the water balance and to supply the farmers with the necessary fodder resources. The focus of IGCEDP has been to increase the productivity of the commons and state forests through improved land management (temporary closure, regulated grazing, improved grasses, plantation of indigenous fodder trees, mostly vegetative erosion control measures) in the context of small watersheds. Combining short-term social and economic benefits and the fulfilment of basic needs with long-term conservation and rehabilitation goals has been the main attempt showing extremely promising success. Social benefits are of main importance in this context as functional institutional mechanisms for managing the commons are for the present framework the pre-condition for a sustainable livelihood in Changar. Main factors of a successful management of the commons have been: integrating the commons in the participatory process of land use planning while particularly assessing their problems and potentials and integrating them in the overall watershed production system; considering the important role women have in the management of the commons and supporting strategies where local women get immediate benefits through better management of community lands; clarifying and operationalizing a locally adopted „integrated" approach with a combination of agro-forestry, animal husbandry and socio-institutional support measures; promoting a mixture of community-control/management with individual management and responsibilities. Giving space for individual initiative and individual benefit generation without loosing the social control on the basis of equity consideration has been successfully implemented; being conceptually clear what sustainable land management means in this context: strengthening the local capacities in coping with change in a conducive political, institutional and legal framework.

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A-0683

Soil Water Characteristics of Typical Soils in South Florida. M. R. Savabi, D. A. Bulgakov, H. Weber, and N. Peherstorfer, USDA-ARS, Everglades Agro-Hydrology Research Unit,Miami, FL USA

Non-point source water pollutants resulting from agricultural areas have been implicated as a source of water quality degradation in south Florida. The nutrients loading from agricultural and urban areas has increased nutrient concentrations, particularly phosphorus at the Everglades National Park. It is reported that nutrient-enriched waters affect vegetation type and patterns. However, data on soil water characteristics of the dominated soil types are needed to predict the movement of agrochemicals in the region. The objective of this study is to investigate the soil water characteristics including infiltration and soil loss of the typical soils types in south Florida. Three typical soils from the region, Krome (sandy loam, moderately well drained), Chekika (silty clay loam, poorly drained), and Perrine Marl (sandy loam, very poorly drained) were used for this study. The soils were placed in a 1 cubic meter boxes with drainage tubes. The drainage tubes were used to simulate four different water table depth. The soils were packed to the field observed bulk density, however, the soil surface crust was crushed to present a freshly tilled soil condition. The study design consists of three soils, four water table depth, two rainfall simulator patterns and four replications. A rainfall simulator was used to simulate rainfall of uniform and variable intensity. Surface runoff and sediment samples from each soil box were collected during the 60 min. rainfall simulations. Results of our study will be presented at the meeting. The results indicates that the soil tested have different infiltration capacity and therefore produce different amount of runoff given uniform and variable in rainfall amounts. In addition, depth to water table has significantly affecting the runoff rate. Furthermore, vulnerability of these soils to erode is statistically different with probability level of 0.05.

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A-0688

Identification of severely eroded soils from remote sensing data tested in Rišňovce Pilot Area. Emil Fulajtár, Soil Fertility Research Institute, Bratislava, Slovakia

Highly eroded soils are common in agricultural areas of Slovakia. A detailed soil map that identifies these eroded soils is needed for land management and for the determination of taxes and commercial land prices. An attempts to map these soils done several decades ago using existing technology brought an inadequate results. With the introduction of remote sensing to the market new opportunities came to develop improved mapping tools. This paper describes a methodological study comparing different approaches to identification of eroded soils from remote sensing data. It is based on interaction of electromagnetic radiation with those soil properties which can reflect erosion such as organic matter content, soil moisture and soil texture. This relationship is well expressed mainly in areas with soils having dark topsoil and light subsoil. In such a condition the identification of an erosion pattern is simple. If the soil is severely eroded, it has lost a significant part of dark A horizon and the light subsoil having higher spectral reflectance is exposed. The Rišovce Test Area chosen as a study site is suitable for this study as it is covered by Chernozems and Luvisols with dark topsoil and light subsoil and is severely affected by erosion. Erosion patterns were detected from panchromatic black and white aerial photographs and SPOT PAN satellite image in several ways. Analogue interpretation of aerial photos was done in two ways. The simplest approach is hand drawing directly from aerial photos onto transparent sheets. A more exact approach is vectorizing the erosion pattern by computer from the scanned and georeferenced aerial photos mounted on a mosaic map. The satellite image was interpreted by analogue method vectorizing the erosion pattern on the screen, and by digital method based on mathematical classification. The results showed that the eroded soils can be mapped from both the aerial photos and the satellite images. The accuracy of the resulting maps is good, especially in the case of map developed by analogue interpretation. The satellite images have slightly lower resolution than the aerial photographs. The main limitation of both media is, that erosion can not be detected on the parcels with dense crop cover. The second problem are the light patches, which are not associated with erosion. They form "false erosion" patterns. These patterns, however, can be identified as they are not linked to topography and their shapes differ from the true erosion pattern.

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A-0689

Relations Vegetation –Soil in the Steppics Formations to *Stipa tenacissima* L. of the Algeria. Halima KADI-HANIFI ACHOUR, Unite de Recherche surles Resources Biologiques Terrestres, Institut des Sciences de la Nature Universite des Sciences et Technologie Houari Booumediene El-Alia

This work based on raised phytoecologics to alfa (*Stipa tenacissima*) of Alegeria is undertaken to two ecological levels : the soils are considered through either their type, either their physico-chimical characters. We searches for, besides the edaphics variables, the ecological parameters that have an influence on the diversity of vegetation. From the study of relations between the edaphics factors and the formation of alfa, appears the influence of the importance and the nature of the plant table cutting on the physical fertility (texture, water reserves) and chemical fertility (nutritive elements, capacity of exchange, matter organic) of the soil. The analogy of the effects of the drought and the anthropic action on the soil reduction of the organic matter rate, more and more big stabilization of humics compounds less and less available for the nutrition of the plants, reduction of the water soil retention and the nourishing reserves, modification of the structure and the structural stability. The predominant role played by the structure of vegetation in the acquirement of the edaphics characters as attests it the presence of structures geographically distant in the same group edaphics define. From the study of the relations flora-ecological variable it arises that the different Formations to alfa studied organize themselves according to a climatic gradient and especially edaphic partener to a reduction of all nourishing and physical potentialities. However, the analysis of flora detail shows the regrouping to the ecological plan syntaxons to different dynamic significance of their composition floristic brings them of groupings relatively closer surroundings whereas soil doesn't justify it, or their soil is evolved more that the present state of the plant carpet. This phase displacement between soil and vegetation explains himself by the length and the intensity of anthropic action. The centro-oriental matorrals soils are less preserved that those of the West, the reason is an influence of a very ancient antropique and accentuated effect to the East of the country more. Another aspect of this relations soil-vegetation survey permitted to raise a typology of the sails of these formations on the one hand, and of the *Uupa Renacissimia*, on the other hand. The forestry formations and some mattorals of *Pistcio-Rhamnetalia* repose on soils of relatively and trophic quality soils are evolved of fersiallitic type or brown calcareous. Other matorrals of *Cisto – Thymetalia* maintain themselves on truncated fersiallitics soils. Their horizon of surface lost their trophic quality. As for matorrals and to steppes to alfa in good state beloging to the *Anarrhino fruticosi-Astragaletalia armati*, their soils are brown and carbonized with a middling trophic quality. The steppics formations of the *Lygeo-Stipetea* develop themselves on the calcareous brown soils encrusted in depth. The surface of their soil is of a thicker wind veil. As for soils under alfa, they reflect the state of deterioration of the plant formation. Soils under alfa of matorrals, of the clear forests of Alep pine, of alfa steppes in good state, are evolved : fersiallitics brown, calcereous ; the upper surface texture is middle to fine, their trophic and hydric qualities are middle. Soils under alfa of matorrals degraded and the raised steppes are little deep, evolved little of combination colluvial evolved of type carbonized to chalky crust. The texture is middle to coarse. It is some chemically poor and physically very fragile soils. Soils under alfa cover with sand are calcareous soils to crust or chalky tile or of sierozern ; their coarse texture exposes them to the devastating action of winds.

A-0690

Regional Environmental Information System for Sustainable Land Use Planning. Ian E. Jarvis, Dave Kroetsch, D. Bruce Gleig, Agriculture and Agri-Food Canada, Eastern Cereal and Oilseed Research Centre, Ottawa, Ontario, Canada

In the face of present environmental challenges and growing population pressures, the data, data management and analytical capabilities of rural municipalities are inadequate for regional environmental planning. In particular, in most areas there is insufficient information available to address land and water resource quality issues. These data limitations are preventing the adoption of proactive planning measures, reducing our ability to develop sustainable rural communities. The conversion of agricultural resource lands and declining ground and surface water quality are evidence of this unsustainable resource use. Agriculture and Agri-Food Canada is working with rural municipalities in Eastern Ontario, local Conservation Authorities and the Ontario Ministry of Agriculture, Food and Rural Affairs to develop a pilot environmental information system using Geographic Information Systems along with current information management technology to address planning concerns. The database consists of seamless layers of soil, land use, agricultural land use systems, aquifer sensitivity and tile drainage at a scale appropriate for county wide land use planning in Ontario (1:50,000). The information system permits the user to view the data on watershed, eco-regional or any user defined unit to meet the requirement of the application. Development of the environmental information system will provide a regional context and information base for proactive decision-making, and improve the capacity to anticipate and prevent environmental problems on a cost-effective basis. The system is also supporting the development of planning tools to address issues like livestock expansion, nutrient management and agricultural land preservation. The project will ultimately transfer the grassroots capacity to manage, analyse and use the information to the rural community. A regional data users group will be established to ensure the long-term management of the system.

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A-0691

Co-operation between USDA and Bulgaria in agro-environmental water quality programme. Dimitar Stoichev, N.Poushkarov Institute of Soil Science and Agroecology, Sofia, James Starr, USDA/ARS, Beltsville Agricultural Research Center, Jerrell Lemunyon, USDA/NRCS, Arlington, Marvin Shaffer, USDA/ARS, GPSR, Fort Collins, Dimitranka Stoicheva, Milena Kercheva, N.Poushkarov Institute of Soil Science and Agroecology, Sofia, Venelina Koleva, University of Veliko Tarnovo

The objectives of a joint programme between USDA and Bulgaria were to obtain information on water contamination in the Yantra River basin, Northern Bulgaria, provide technical assistance, and transfer low cost, economically sustainable technologies to improve the environmental management of agricultural farming practices. The studies were carried out during the period 1994-1997on a small watershed in the region of Parvomaitsi village, situated in the central part of the Yantra River basin. The main ecological problems in the village are nitrate contamination of the groundwater and water pollution of the Yantra River by nutrients and different home solid wastes. During the last years some wells supplying drinking water were closed because their nitrate content had exceeded the maximum permissible contaminant level. The monitoring scheme of the project during the studied period was designed to obtain information for the different components of the agroecosystem along the selected watershed profile line. Groundwater monitoring was one of the most important ecological and social parts of the project. Agricultural activities were studied on four fields: 1) crop rotation, 2) pasture, 3) peach orchard, and 4) four household gardens. Cultural practices at these locations were intensive vegetable rotation, irrigation, manuring and frequent soil cultivation's. The balance and dynamics of the main nutrients in the plant-soil-groundwater system was assessed from data on the meteorological conditions, chemical composition of the precipitation, soil and soil solution characteristics under different land use, nitrate content in the plant production, and groundwater quality. The risk for nitrate leaching in the monitored variants of land use was estimated with the aid of the NLEAP (Nitrate Leaching and Economic Analysis Package) model. The goal of the educational programme of the project was to help the villagers to minimise groundwater contamination by improved management of their organic and home solid wastes. For this purpose discussions and demonstrations were organised, brochures were issued concerning collection, storage and use of manure, organic residues composting, and protection of drinking water. A riparian restoration zone was also created as part of the demonstration. The main results of the joint project was the assessment of agricultural related sources of groundwater nitrate contamination and the realisation of the educational programme. The specialisation of Bulgarian scientists and a graduate student in the agroecological monitoring on a watershed level were realised during the short-term training courses in USA and during the visits of US scientists in Bulgaria.

A-0694

Water Balance Components in the Canadian Mixed Wood Ecozone. R. de Jong,Eastern Cereal and Oilseed Research Centre, Agriculture and Agr-Food Canada, Ottawa, Canada and K.B. MacDonald, Land Resource Unit, Agriculture and Agri-Food Canada, Harrow, Canada.

The Mixed Wood Ecozone covers the lower Great Lakes-St. Lawrence River valley. Its gentle topography, fertile soils, warm growing season and abundant rainfall have made it an intensively farmed area. The weather is highly unstable because the region lies along one of the major storm tracks in North America and hence, the components of the water balance (precipitation, interception, runoff, soil water storage, evapotranspiration and drainage) are highly variable in both space and time. Knowledge of the magnitude of these water balance components, and the risk of their occurrence, is important for agricultural water management planning and design. The SWATRE simulation model was modified to account for the overwinter redistribution of water in the soil profile, and surface runoff calculations were incorporated using the USDA curve number methodology. The model was then run continuously over 30 consecutive years (1961-1990) to estimate annual and seasonal changes in soil water content, evapotranspiration, drainage and runoff. Simulations were made for three crop rotations (corn/soybean/winter wheat; continuous corn and pasture) at various locations, using selected local soils under conventional and conservation tillage practices. The annual water balance components of pasture, grown on a sandy soil, were similar across the entire Ecozone, except drainage which varied between 42 to 80 cm. Crop management practices influenced interception, runoff, evapotranspiration and drainage, but they did not affect early spring soil water storage. Under a corn/soybean/winter wheat rotation, soil type significantly affected the magnitude of the annual water balance components; however, the temporal variability in actual evapotranspiration was relatively small, regardless of soil type. The temporal variability in runoff from a sandy soil was less than that from finer textured soils, but the reverse was true for drainage. Inter-seasonal comparisons for continuous corn revealed that:(i) precipitation is approximately equally divided between the growing- and non growing seasons, but the temporal variability is higher in the growing season;(ii) soil water contents are lower, but more variable in the fall than in spring;(iii) more than 70% of the runoff and drainage occur during the non growing season, with the temporal variability fairly similar across the growing- and non growing seasons. Our simulations show that weather, soil and land use factors interactively influence the components of the water balance, and that each one should be properly characterised in soil water investigations.

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A-0696

The use of Potential Drainage Density for the delineation of erosional and depositional surfaces. E. Dobos, Assistant Professor, Dept. of Geography and Environmental Sciences, University of Miskolc, Miskolc-Egyetemváros, Hungary, M.F. Baumgardner, Associate Professor, Dept. of Soil Science and Agrochemistry, Gödöll Agricultural University, Gödöll, Hungary, E. Micheli, Professor, Dept of Agronomy, Purdue University, West Lafayette, IN USA

The appropriate use of our soil resources needs up to date land information. The quality of land resources conservation programs highly depends on the data that is used to assess land and water degradation, including soil erosion. GIS technology and digital elevation data can be used to extract high quality land data. The use of this technology and data for modeling the erosional processes has been studied by numerous researchers and was found to be a promising tool. Many function have been developed and employed for the characterization of the land surface form. However, the characterization of plain areas often represent a big challenge for the modelers. The shape of the surface - its concavity or convexity - has a significant influence on the surface water movement and therefor on the erosional processes too. Areas with very low relief energy, with almost zero slopes and with big extent of concave or convex patterns are difficult to delineate with the help of the slope or curvature functions. A new function, the potential drainage density function (PDD), have been developed and employed to delineate the erosional and depositional surfaces. This PDD function uses a drainage network that has been artificially created based on a digital terrain model. The relative density of the drainage network within a certain sized area can refer to the dominant shape of the surface and thus to its status in the erosional processes of the area. This function was found to be useful in the detection of the relative height and low elevations on the surface and can be used as a complementary information layer for soil erosion modeling.

E. Dobos

A-0697

Comparison of Root-Water-Uptake Models. K.Y. Li, R. de Jong, Eastern Cereal and Oilseed Research Centre, AAFC, Ottawa, Ontario, Canada and J.B. Boisvert, Soils and Crops Research and Development Centre, AAFC, Sainte-Foy, Quebec, Canada

Soil water simulation models, which are used to quantify sustainable land management practices, require a description of root water uptake. Most models show a general agreement with field measured soil water content profiles. However, this does not necessarily mean that the individual water-uptake models are satisfactory and all perform in the same way, because each one of them is incorporated in a soil-water simulation model which differs from the next one in its way of dealing with the other components of the water balance and the imposed boundary conditions. In this study, four root-water-uptake models, including the linear model and the exponential model of SWAP, and the uptake models from EPIC and CERES, were incorporated in the SWAP soil water simulation model, and thus could be directly compared under the same soil, crop and weather conditions. Under normal root growing conditions, i.e. 30% of the total water use comes from the top 10% of the root zone if water is readily available, the exponential- and EPIC's uptake model behaved similar in terms of total root water uptake and its distribution across the soil profile. Under those same conditions, the CERES' uptake model significantly under-estimated water uptake, while the linear model slightly overestimated total water uptake, as compared to the other two models. The concept of 'water deficiency compensation', as used in the EPIC model, was found to be rather ineffective when incorporated into the physical based SWAP model. The performance of the selected models was not affected by the imposed bottom boundary condition (zero flux, free drainage, and water table), indicating that they could be used under many field conditions. Selection of a root-water-uptake model will depend partly on the availability of root distribution data. No root distribution parameters are needed for the linear model, but in soils with poor root growth this model may produce unrealistic results. It is thought that the other three models can potentially perform better under adverse rooting conditions, but they all remain to be tested under field conditions.

K.Y. Li

A-0698

Planning Approaches and Instruments in Natural Resources Management Projects. Helmut Eger, GTZ, Deutsche Gesellschaft fuer Technische Zusammenarbeit, Eschborn, Germany

Natural resources management is rarely linked to planning. In view of the constant decrease of natural resources planning becomes a necessity in order to counteract this situation. In most cases planning is carried out in a way that the analytical part predominates and little room is given to the actual implementation oriented planning. This is due to time and money constraints, which inhibit the progress of conclusive development strategies based on the data gathered. The planning process barely allows for approaches involving participation and planning methods with the result that planning does not contemplate any significant implementation strategies. Therefore, the paper will argue that planning approaches and instruments are important tools to achieve sustainable natural resources management. Examining planning has to include a thorough analysis of the different administrative levels within a country. Each level, be it the local, municipal, provincial or national level, is a planning level. Planning has to be linked on the horizontal as well as on the vertical level. The more vertical and horizontal links the more effective the planning. The optimum situation is the flow of information in both directions. Nevertheless, reality teaches that the vertical level is often characterized by hierarchical structures from the top to bottom blocking the continual flow of information. Lack of communication and coordination between the horizontal and vertical levels usually has a negative influence on sustainable natural resources management. The utilization of planning approaches and instruments has many advantages such as the limitation of problems through more communication between the different levels or a stronger consideration of the needs and interests of all people affected and involved. This participatory character of planning supports an iterative planning process, which is based on an interaction of all parties involved. In order to understand what planning can achieve and which potential it has case studies covering ten different countries will be presented. The projects discussed are located predominantly in Latin America. Recent natural resources management projects tend to use the above mentioned planning methods of furthering horizontal and vertical links between all institutions be it governmental or non-governmental as well as individuals. The objective is to find a common ground in order to come to a generally accepted agreement on the procedural rules and the actual implementation. Finally, the paper suggests how the different aspects of planning can and should be linked to become an effective instrument in natural resources management.

Helmut Eger

A-0699

Sustainable land Management Issues in Fiji. Inoke Ratukalou, Patimio, Taito Nakalevu, Mereseini Nagatalevu, Vilitati Seru, and Tony Dowling, Koronivia Research Staion, Ministry of Agriculture Forests & Fisheries, Nausori, Fiji

The Fiji group is situated in SW Pacific Ocean and consists of some 300 islands of which about 100 are permanently inhabited. Fiji enjoys a mild tropical maritime climate with distinct wet (2800-3600 mm) and dry (1300-1600 mm) zones on windward (SE) and leeward (NW) coasts of the larger islands. The main islands of Viti Levu (10,544 km^2) and Vanua Levu (5,535 km^2) account for 88% of the total land area of 1.8 million ha. Of this area 11% is flat with slopes <3°, 14% is moderately steep with 3-15° slopes, and 75% is steep with slopes > 15°. Of this 19% is suitable for sustainable agriculture, 11% requires minor and 32% major improvement, and 38% is unsuitable for agricultural development. Major agricultural industries include sugar, copra and coconut oil, cocoa, ginger, root crops, and rice. In 1993, these accounted for 21% of Fiji's GDP, 85% of foreign exchange earnings, and 47% of employment. Like most developing countries, Fiji faces the crucial issue of sustainable management and allocation of its scarce land resources. From 1956 to 1991 two major factors influenced land use: (1) land used for agricultural increased by about 200%; and (2) the population increased by about 100%. More people are turning to the land for a living. This is alarming given Fiji's small size, topographical harshness, and low-ownership realities. Arable lands are being lost to housing and industrial development. The following issues affect sustainable land use and management in Fiji: increased pressure on marginal steep lands; a shortage of arable land (estimated as 0.7 ha/capita using 1991 data); land-use planning conflicts and alienation of arable flat land; existing land-tenure systems; land degradation due to erosion and its downstream impact on waterways, fish habitats, beaches and near-shore reefs; high national dependence on the sugar industry, its quota contract system, and its use of sloping lands of marginal quality; small size of farm holding with 60% of farms <3 ha (mean of 6.2ha in 1991); use of intensive farming practices for economic and social survival leading to problems of soil infertility and low crop production; and logging and deforestation with 38% of total area under indigenous forest in 1991. The IBSRAM *PACIFICLAND* network is working with the Ministry of Agriculture, Fisheries & Forests (MAFF) to identify technologies to develop systems to increase yield sustainability, control soil erosion, and conserve fertility on marginal sloping lands of marginal sloping lands. MAFF has submitted a 'Sustainable Development Plan' before Parliament. This plan aims to address the above issues and promote Fiji's heritage by sustainably managing its scarce land resources for the benefit of present and future generations.

Inoke Ratukalou

A-0700

Effects of DEM grid resolution on erosion modeling of small watersheds using a WEPP-GIS interface. Thomas A. Cochrane and Dennis C. Flanagan, Purdue University and USDA-ARS, West Lafayette, IN USA

An interface was developed between the Water Erosion Prediction Project model (WEPP) and the Arc View GIS. Two options, the automatic method and the flow-path method, are provided within this interface to run WEPP using GIS data. The automatic method uses a series of algorithms to automatically extract hillslopes, channels, and other topographic parameters from a digital elevation model (DEM) for the application of the watershed version of WEPP. The flow-path method uses concepts in grid based DEM flow-routing to apply WEPP to all possible flow-paths within the watershed. The two methods were applied to five field size (0.59 to 2.7 ha) research watersheds, two from Watkinsville, Georgia, three from Holly Springs, Mississippi, and one small watershed (29 ha) in Treynor, Iowa. Both methods were evaluated for assessing watershed erosion using different DEM grid resolutions. Simulations were conducted

using 1, 3, 5, and 10-meter resolution DEMs for the field sized watersheds and 5, 10, 20, and 30-meter resolutions for the Treynor watershed. Comparisons to actual field measurements of runoff and sediment loss from the watersheds were conducted for simulations at each DEM resolution level.

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A-0701

Influence of cultural practices on sheetflow, sediment and pesticide transport: the case of maize cultivation under plastic mulching. Gascuel-Odoux, F. Garnier and D. Heddadj, Science du Sol, Institut National de la Recherche Agronomique, Rennes Cedex, France

In Brittany (France), Atrazine, an herbicide mainly used for maize cultivation, that represents 25% of agricultural land use in this region, is commonly found in streams. 90% and 33% of the weekly samples of five rivers between 1990 and 1993 had concentrations higher than 0.1 and 0.2 g/l, respectively. The highest were found shortly after the application periods. In this context it is important to assess the environmental impacts of maize agriculture. Comparative evaluations of different practices for weed control were performed, taking into account sheetflow, sediment and herbicide transport. Three weed control systems were evaluated: the traditional whole chemical weed control with tillage and without tillage to reduce runoff using bandwise mulch planting or bandwise decompacting; the combined strategy, using chemical application bands 20 cm wide in the vicinity of the maize plants between which the weeds were removed by tillage; and plastic mulching where herbicides were applied after plastic mulching, sometimes before, and might be incorporated in plastic composition. The study is focused on the effects of plastic mulching in maize cultivation. This agricultural technique that concerns 10% of the maize cultivation in this region is used to ensure a minimum crop yield when constraints of temperature exist. Field measurements were done under natural rainfalls (two slope positions, 13 rainfalls), then under rainfall simulator (4 metres long, 2 successive rainfalls), by using collectors intercepting runoff separately from plastic bands (three replicates) and from soil bands (three replicates). The first measurements under natural rainfall showed low runoff on plastic bands, and, despite a high variability from band to band, a high runoff and erosion on soil bands (four times higher compared to the traditional technique). The contrary was observed under rainfall simulator because an insufficient length of its measurements, water goes from plastic to soil in an irregular form. The herbicide outflow was higher when herbicides were applied on plastic, and equivalent when they were applied before plastic mulching compared to classical technique.

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A-0702

Land Degradation Assessment in the Sakae Krang Watershed Thailand. Dr. Apisit Eiumnoh, Mr. R.P. Shrestha, School of Environment, Resources and Development , Asian Institute of Technology, Klong Luang, Pathumthani, Thailand

Land degradation, particularly soil erosion and nutrient depletion in the Sakae Krang watershed (SKW), is dynamic and increasing its negative effects on the land productive through time. In the quest for a sustainable future, the government have been trying hard to combat the problem of land degradation for quite a long time, however satisfactory progress is not yet achieved. Satellite Remote Sensing (SRS) and Geographical Information Systems (GIS) are found effective tools for land degradation assessment, such as erosion and nutrient depletion. The SKW, located about 200-km Northwest of Bangkok is partly in the Huai Kha Khang World heritage which was encroached by people for agricultural crop production. The land use types were digitally classified from satellite data. The forest types, 33.76% include dry evergreen, mixed deciduous and dry dipterocarp forests. The agricultural crops are paddy (31.11%), sugarcane (28.61%) and other crops 3.11%. The waterbody is only 0.02%. The GIS was employed to create soil erodibility, rainfall erosivity, slope degree and length of slope and the P factor for soil erosion calculation. The soil nutrient reserve and the crop nutrient uptake were also analyzed using GIS techniques. The annual soil loss calculated using the USLW indicates that the area subject to very slight (29.27%), slight (37.52)% to moderate (23.81)% erosion. The average rates of nutrient loss in the area were 10.9 kg N, 0.16 kg P and 0.1 kg K/ha/yr. The methodologies and results will be described in details in the full paper and the oral presentation.

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A-0703

Polyacrylamide effect on sediment yield, runoff, and seedling emergence on steep slopes. K. Chaudhari, D.C. Flanagan, Purdue University and USDA-ARS, West Lafayette, IN USA

Previous studies have shown that polyacrylamide (PAM) soil amendments have been effective in reducing runoff and soil erosion by stabilizing soil structure and reducing soil sealing. Recent studies of PAM soil amendments have focused on agricultural lands, which typically have low slopes. It was hypothesized that the beneficial effects of PAM observed in previous studies could also be achieved on steeper slopes, and that grass seedling establishment would be improved due to a more stable soil structure. This study evaluated the effects of anionic PAM soil amendments on runoff, sediment yield, and grass seedling establishment on critically disturbed steep slopes, under both natural and simulated rainfall conditions. Natural rainfall studies were conducted at two sites near Logansport, Indiana in 1997 and 1998. The treatments tested were PAM applied alone, PAM applied with gypsum, and a control. For each treatment, three replicate plots (3m x 9m) were constructed on a 33% slope. All plots were tilled to uniform roughness, fertilized, and grass seeded. PAM was sprayed on the plots at a rate of 80 kg ha^{-1} in solution and powdered gypsum was applied at a rate of 5000 kg ha^{-1}. A system of collection barrels was used to measure runoff and sediment yield from natural rainfall. Another study was conducted using rainfall simulators to evaluate the effect of the same PAM soil amendment treatments on sediment yield and runoff under severe initial storm conditions on freshly disturbed soil. Both PAM treatments resulted in significantly reduced runoff and sediment yield in comparison with the control. Qualitative measures of seedling establishment demonstrate that both PAM treatments resulted in better grass establishment compared to the control. These results indicate that PAM soil amendments were effective in reducing runoff and sediment yield, and aided in grass establishment. Further study is warranted to explore the option of PAM soil amendments where currently traditional erosion control methods such as mulches are being used.

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A-0705

Polyacrylamide: Use, Effectiveness, and Cost of a Soil Erosion Control Amendment. V. Steven Green and Diane E. Stott, Purdue University and USDA-ARS, West Lafayette, IN USA

Soil degradation is a significant problem throughout the world. Use of soil amendments, including anionic polyacrylamide (PAM), is one of many options for protecting soil resources. PAM has been the focus of a substantial amount of research in the 1990s. PAM is a family of high molecular weight polymers that can be used as soil conditioners to help protect soil structure. PAM's applicability as a soil conditioner stems from its ability to stabilize soil aggregates as well as flocculate suspended particles. Part of the attractiveness of PAM is its versatility. PAM can be used in furrow irrigation where it reduces erosion and runoff while improving soil and water quality and water-use efficiency. Fields where PAM is used in the irrigation water experience an increase in furrow stabilization. PAM generates even wetting of the furrows increasing the amount of water available to the plant. Pesticide and fertilizer residues in the runoff and sediment are reduced to near zero. Yields in the bottom 1/3 of the field are dramatically increased. In rain-fed agriculture and sprinkler irrigation, PAM is used to reduce surface sealing and crusting as well as erosion. This results in decreased runoff while improving infiltration and seeding emergence. This reduces the cost of reseeding and reduces the amount of cultivation needed while improving crop yield. PAM is also used to stabilize steep slopes in construction, highway cuts, and other disturbed soils. PAM reduces the amount of erosion and rill formation. It also enhances seedling emergence and establishment during the recovery phase. The economics of PAM use can encourage its use in many instances and discourage its use in others. PAM is very cost effective in furrow irrigation systems where it can be applied at low rates through the irrigation water. In construction applications, PAM reduces labor and material costs. PAM can be cost effective in rain-fed agriculture under certain management regimes such as on soils highly susceptible to crusting and breaking the cycle of crusting-low seedling emergence-low organic residue production-crusting, etc. As a soil conditioner, PAM is another tool that can be used to manage our soil resources.

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A-0706

Quantifying the Spatial Variability Patterns of Soil Redistribution and Soil Quality in Hilly Landscapes on China's Loess Plateau. Y. Li, , M. Lindstrom, N.C. Soil Conservation Research Laboratory, Morris, MN USA, M. Frielinghaus, H. R. Bork , O. Wendtroth, Center for Agricultural Landscape and Land Use Research, Müncheberg, Germany, J. Yang and Y. Zhu, Institute for Application of Atomic Energy Agency, CAAS, Beijing, China

Soil erosion rates and soil quality indicators were measured along four hillslope tranescts in the Loess Plateau near Yan'an, China. The objectives were to (i) quantify spatial patterns and controlling processes of soil redistribution due to water and tillage erosion, and (ii) correlate soil quality parameters with soil redistribution along the hillslope trancests for different land use management systems. Water erosion data were derived from cesium-137 measurements and tillage erosion from the simulation of a Mass Balance Model along the hillslope transects. Soil quality measurements, i.e. soil organic matter, particle size analysis, bulk density and available nutrients were made at the same sampling locations as the Cs-137 measurements. Results were compared at the individual site locations and along the hillslope transects through statistical and applied time series analysis. The results showed that soil loss due to water erosion and soil accumulation from tillage are the dominant soil redistribution processes in range of 23-40 m, and soil aggradation by water erosion and soil loss by tillage are dominant processes occurring in range of more than 80 m within the cultivated hilly landscape. Squared coherence of net soil loss rate vs. slope angle indicates that soil loss rates do

not increase with a slope length of more than 60 m or slope angle alone. Changes in landscape structure or the changes in adjacent slope angle are responsible for the spatial patterns of soil redistribution in cultivated hillslopes. However, land use change associated with vegetation coverage can significantly change both the magnitudes and scale of these spatial patterns within the hillslope landscapes. There is a strong interaction between the spatial patterns of soil erosion processes and soil quality. Serious soil erosion has resulted in a reduction of soil indigenous fertility in the hilly landscape of the Loess Plateau. However, establishment of forest or grass can greatly affect the spatial patterns of soil erosion on soil indigenous fertility. It can be concluded that soil loss by water erosion and aggradation by tillage is the main cause for the occurrence of significant scale dependency of spatial variability of soil quality along hillslope transects.

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A-0708

Effect of Runoff and Sediment from Hillslope on the Gully Slope In the Hilly Loess Region, North China. Cai Qiangguo, Institute of Geography, Chinese Academy of Sciences, Beijing, China

In the hilly loess region, due to variation in geomorphological characteristics and to a lesser extent differences in soil characteristics, the relative significance of erosion processes and subprocesses varies with slope zone (upper hillslope, middle hillslope, lower hillslope, gully slope). Thus empirical relations established as well as parameters selected in these relations vary with slope zone. In addition, contributions of runoff and sediment from the hillslope have a significant effect on the gully slope. Data available show that if appropriate soil conservation measures are established to prevent the input of runoff, then the contribution of runoff and sediment by gully slope will be reduced by 29% and 64% respectively during an average storm, and by 61% and 84% respectively during the maximum storm.

Cai Qiangguo

A-0709

Evaluation Of Sustainable Management Alternatives In A Coffee Zone In Lara State – Venezuela. Fondo Nacional De Investigaciones Agropecuarias, Centro De Investigaciones Agropecuarias Del Estado Lara, Proyecto Zona Alta

Coffee is one of the more important crops in Lara State because of it production volumes, cultivated surface and population dedicated to the crop. The agronomic management used in the coffee zones is not the more adecuated and the technological innovations developed in the last decades for the crop are not adapted in an important manner by the small and medium size farmers due in part to the high imput and labor cost and to the anual fluctations in the product prices. In this paper are evaluated some sustainable alternatives in coffee farms, in order to improve the productivity and the sistem efficiency. Among this alternatives are crop diversification, use of organic fertilizer and not use of herbicides. The utilization of this alternatives give economics advantages with extra and cost reduction, and aditionally ecological advantages, improving soils properties and crop microclima. Nutritional levels at soil and leaves level were evaluated during four years, detecting suficienties of N-P-K and Ca. The sistems production costs were evaluated with important advantages over the traditional systems.

A-0710

Assessment of Agrodiversity at Landscape level under small scale farming systems in Arumeru distinct, Tanzania. Kaihura, F.B.S, G.E, Kaitaba, P.A. Ndakidemi and J.G. Mowo.

Agro-diversity "the diversity of cropping systems, crop species and farm management practices" is nowadays considered as a risk aversion and food security supporting strategy in small scale farming systems with unreliable and variable rainfall conditions. A study was carried out in Arumeru district, Arusha, Tanzania to establish baseline information on agro-diversity changes in diverse and dynamic agro-ecological zones in Arumeru district. Two transects, one on the windward side and the other on the leeward side of Mount Meru, were selected for the study. Each transect was subdivided into three distinct agro-ecological zones namely high altitude - high potential zone; middle altitude-medium potential zone and low altitude-low potential zone, based on total rainfall and cropping systems. Participatory Rural Appraisals (PRA) were carried out in each transect using methods which included semi-structured interviewing in groups, participatory diagramming, time line history, use of key local indicators and informants and shared discussions between experts and farmers. Others included soils characterization and assessments of cropping, livestock and land management systems. The objective of the study was to evaluate agro-diversity and conservation approaches in different agro-ecological zones. The soils were dominantly Andosols with pockets of Vertisols in the low altitude zone. The parent material on which the dominant soils were formed is a light material (pumice) of volcanic origin. Soil fertility ranged from high to medium. Available phosphorus and total nitrogen in topsoil significantly limited production, especially in the high altitude-high potential zone. Water erosion and nutrient leaching were also most evident in the high altitude zone. Organic matter, pH, exchangeable potassium and base saturation were significant parameters of the subsoil as indicators of observable differences between microclimates in different farms. There were 47 cropping systems, 10 indigenous soil conservation measures and 9 improved soil and water conservation practices identified in four agro-ecological zones, most of which were found in the high altitude zone. In this zone, conservation is a survival practice due to limited available land. Average farm size ranged from 0.6-9.0 ha in the low altitude zone, 0.9-6.3 ha in the middle altitude zone and from 0.2-1.8 ha in the high potential zone. Crop and livestock production were major sources of household income supplemented with several off farm activities. Per capita income ranged from 1,200,000 Tsh (1791 US$) in the middle altitude peri-urban zone to 350,000 Tsh (522 US$) in the high altitude high potential zone. The data indicate that under conditions of limited resources and unreliable rainfall, agro-diversity is a rational farming practice to reduce risks of food insecurity under resource poor farming systems. The results also have wider implications for national, regional and international land use and land management planning for sustainable agricultural production in diverse tropical environments. Any conservation interventions must build on the existing agrodiversity.

Kaihura, F.B.S

A-0711

Community Stewardship in Action – The Countryside Exchange Conference Area: Conservation Action: Sustaining Our Land and Water. Judith LaBelle, President of Glynwood Center, Cold Spring, New York USA

Glynwood has designed and conducted Exchanges in over 60 communities across the United States, Canada, England, Scotland and Wales. Purpose: To illustrate how the Countryside Exchange program can mobilize broader community support and cooperation for local conservation efforts. Content: Many conservationists have come to realize that the protection of land and water resources requires support and action at the community level. Yet this is not easy. It requires an understanding of the interdependence between the concepts of a healthy environment, economy and community and the willingness to achieve all three goals simultaneously. The Countryside Exchange program provides an unique opportunity to achieve conservation goals by blending them into a broader community development process. The Exchange brings together international teams of volunteer professionals, from many disciplines, to work with communities and help them create a balance between the need for economic development and conservation of cherished community resources. The Exchange serves as a catalyst - using the visit by a group of objective "outsiders" to help identify shared community concerns and develop a collaborative action plan that is implemented at local and regional levels. The Exchange is also cited as "one of the most valuable professional development experiences available in this field." Exchange team members experience a renewed appreciation for a team approach and come to understand that each profession plays an important, but balanced, role in the community. The proposed presentation will explain how the Exchange process works and provide concrete examples of how it has fostered conservation in a number of different communities. The Chesapeake Bay Watershed will receive particular emphasis. Since 1994, conservation organizations such as the Chesapeake Bay Program, the Alliance for the Chesapeake Bay and the National Park Service have sponsored the Exchange program as a means to work with upstream watershed communities and "help them help themselves." In Spring Creek, Pennsylvania, for example, the Exchange "fostered a change in attitude about the importance of cooperative action for the watershed's future," resulting in new citizen and inter-municipal efforts on a variety of conservation issues such as stormwater management and transportation planning. Participants will also be able to consider if they themselves would benefit from participating as an Exchange team member.

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A-0713

The effect of agricultural management practices on soil carbon dynamics under different climatic conditions. S. Gameda, Land Resource Program, Eastern Cereal and Oilseeds Research Centre, Agriculture and Agri-Food Canada, Ottawa, Ontario CANADA, G. Roloff, Departamento de Solos, Universidade Federal do Paraná, Curitiba, PR BRAZIL and R.S. Desjardins, Land Resource Program, Eastern Cereal and Oilseeds Research Centre, Agriculture and Agri-Food Canada, Ottawa, Ontario, CANADA

Addressing the contribution of agriculture to greenhouse gas (GHG) emissions requires an understanding of the impacts of agricultural management practices on soil carbon dynamics under different climatic regimes at a variety of spatial and temporal scales. This paper will report on studies that were conducted for selected Canadian agricultural regions to determine the contribution of pertinent variables to soil carbon dynamics. Results from analyses conducted to disaggregate the effect of soil type, landform, agricultural management practice (crop rotation and tillage type), and climate on long-term soil carbon dynamics will be reported. Outcomes of the study will serve in the assessment of different agricultural production and climate change scenarios, as well as for planning policies for GHG mitigation.

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A-0714

Erosion Rate Estimation Using Usle And Wepp On A Brazilian Watershed. Ranieri, S. B. L.; Sparovek G.; Demaria, I.C.; Flanagan, D.C., University Of São Paulo, Piracicaba - Sp - Brazil

Several land use planning studies in tropical regions use erosion estimation as an indicator for land degradation. The Universal Soil Loss Equation (USLE) is the preferred model due to its simplicity and reduced number of input parameters. However, for watershed applications the USLE has several important limitations due to land use heterogeneity and hillslope complexity. Recently, process-based models have been developed to allow estimation of erosion and other hillslope processes, and these models require more complex input data. Experiences with process-based model application under tropical conditions are limited, especially at the watershed scale. The objective of this work is the development of USLE and Water Erosion Predict Project (WEPP) application technology for a sugarcane-growing watershed in Southeast Brazil. The models will be compared in relation to outputs, complexity, application cost and GIS compatibility. The cost vs. benefit relation for more complex process-based erosion prediction technology will be discussed. The study area is the Ceveiro Watershed (2,000 ha) located in the state of São Paulo in southeast Brazil. This area is intensively cultivated with sugarcane. The first part of the study has been developed in a sub-watershed (86 ha) with representative conditions for the whole area. Data collection for USLE application consisted of soil survey, land use and management mapping, slope and aspect calculation and climate data set analysis. Soil samples were collected in 89 sampling points and analyzed for chemical and texture attributes. Land use was mapped based on aerial photographs. Management practices were assessed by landowner interviews. Slope and aspect were calculated from altitude contour maps using GIS technology. All data were georeferenced and the USLE parameters were calculated using GIS formulas. Average soil loss for the watershed was estimated at 39 $Mg.ha^{-1}.y^{-1}$. The input data for WEPP application are being prepared, and an interface file builder program to convert vector UTM georeferenced slope data in single Overland Flow Element (OFE) and multiple OFE WEPP slope files will be developed for the WEPP Hillslope version. This program will also write composite management and soil files for multiple OFE hillslopes and re-georeference WEPP output files allowing GIS importation.

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A-0717

Usle c factor for sugarcane as a tool for land use planning. De Maria, I.C.; Cerri, C.E.; Dechen, S. C. F.; Sparovek, G., Instituto Agronômico, Campinas - SP – Brazil,

Since colonial times Brazil has exported sugar, and more recently (1973) a national project to produce alcohol as a substitute fuel for gasoline has increased the demand for the sugarcane crop. In 1996/97 sugarcane fields occupied 6,750,000 ha, and resulted in production of 14,390,000 m^3 of alcohol and 13,600,000 tons of sugar. This area represents 25% of the world's sugarcane fields and 12% of the sugar production. São Paulo State (Southeast Brazil) is responsible for 62% of the overall Brazilian production. Due to the magnitude of these numbers, not only the economical importance but also the role of sugarcane in environmental safety should be considered. The Universal Soil Loss Equation (USLE) is a valuable tool for land use planning to assess soil degradation; erosion induced crop productivity loss and system sustainability. However, data for tropical conditions and management are scarcely available. Data for sugarcane production systems under intense and high input cropping systems were not found in the literature. USLE C factors were estimated for different sugarcane cropping technologies covering most of the management systems from Southeast Brazil. Previously, cropping and management C factors for USLE were calculated by computing 12 years of soil loss data under natural rainfall for sugarcane and continuous fallow in an oxisol. The six stage Soil Loss Ratio (SLR) and the distribution of rainfall erosion index for São Paulo State resulted in a C value of 0.11. This value represents one specific management system called 12 month sugarcane, actually adopted in a small part of the sugarcane growing fields. The C factor for more representative management conditions was calculated using soil cover measurements for crop stage periods. The SLR values were defined using USLE crop canopy/soil loss ratio relationships. The soil cover values were adjusted to three management systems:12 month sugarcane, 18 month and 18 month plus green manure (Crotalaria juncea). The C factors for these conditions were respectively 0.238, 0.314 and 0.217. The different C factors (0.11 from soil loss and 0.238 from cover measurement) for 12 month sugarcane was possibly due to a dependence between the cover effect and soil type once the model was calibrated using soils with higher erodibility. Probably there are also other contributing factors beyond soil cover controlling erosion processes in sugarcane (such as the ratoons). The range among the three different management systems indicates that this factor can be as important as the crop choice in the land use planning to reduce soil erosion.

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A-0718

Agroforestry and soil conservation in Brazilian agriculture. Msc Luís Fernando Guedes Pinto, R. Alexandre Fleming, Campinas - SP - Brazil

Soil degradation of is one of the most important issues in tropical agriculture and it produces significant environmental, social and economic impacts. Agroforestry has proven to be one system that promotes soil and water conservation in the tropics, besides contributing to increased biodiversity, CO_2 balance and socioeconomic development of producers and communities. Research in the Amazon and Atlantic Forest regions of Brazil has been conducted to study the potential benefits of agroforestry to the nation. Agroforestry has been successfully developed to create alternatives for small producers and local communities. The efforts have focused on ecology and management of complex systems and the recovery of knowledge of traditional peoples, aiming to conserve the existing ecosystems and promote socioeconomic development of these groups. However, research has not been yet been applied to the development of agroforestry in the south-center of the country, which is the main agricultural region of the Brazil where crops such as soybeans, sugarcane, orange, and corn are grown on more than 10 million ha. The production systems there are based on monocultures, intensive use of machines and agrochemicals. Therefore, the design and management of these agroecosystems plays a crucial role in the degradation, conservation or restoration of the natural resources of soil, water, native ecosystems and biodiversity. This paper presents the importance of research and development of agroecosystems as an alternative to improve the quality of agriculture in this region of the country and to decrease negative environmental and social impacts. A strategy to implement agroforestry in south-central Brazil is also proposed. Agroforestry should be first implemented on degraded soils, in order to recover their productivity and on soils with a high susceptibility to degradation and erosion. It should be designed to be integrated with forest fragments in a landscape perspective, aiming to increase biodiversity and create biological corridors within monocultures. For the use of agroforestry by producers and the success of the initiative, tree species should have some of the following characteristics: low competition for nutrients and water, reduces run-off and erosion, recycles nutrients, provides economic benefits like timber, fruits, energy, rubber and other products.

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A-0719

Soil Erosion of an Indurated Volcanic Soil from the Semiarid Area of the Valley of Mexico. Eusebio Jr. Ventura, L. Darrell Norton, USDA-ARS-National Soil Erosion Research Laboratory, Purdue University, West Lafayette, IN USA, J. Luis Oropeza, and Benjamin Figueroa, Soil Physics Section. Natural Resources Institute, Colegio de Postgraduados, Montecillo, Edo. De Mexico, Mexico.

In the Valley of Mexico, the presence of volcanic soils with indurated horizons is associated with semiarid conditions. The hardened subsurface layers, locally called "*tepetates*", appear at the soil surface due to erosion of the overlying topsoil. The extensive areas of tepetate are not only a significant source of sediment affecting off-site areas, but also marginal lands of low productivity. The objective of this study was to evaluate soil erosion and different control practices in an indurated volcanic soil locally known as "yellow tepetate". A portable rainfall simulator was used in the field in two sizes of plots: 1m x 7m and 1m x 1m in order to study rill and interrill processes separately. Under natural rainfall, USLE plots 22m x 2m were established and soil loss and runoff were recorded on a daily basis for three soil management treatments (tillage, no tillage and fallow), with and without artificial cover. An extra cover crop treatment (Barley) was evaluated. In the laboratory, a programmable rainfall simulator was used to study the effect of gypsum on erosion, runoff and infiltration using small erosion pans 32 cm x 45 cm. Field simulated rainfall experiments indicated that natural tepetate produced runoff faster than the cultivated tepetate. However, the cultivated tepetate produced ten times more sediment at higher intensities, suggesting that runoff should be reduced. The high value of rill erodibility of this tepetate (34.1×10^{-3} s m^{-1}) supported this fact. Under natural rainfall, the highest annual erosion rate (118.3 Mg ha^{-1}) and total runoff (166.9 mm) in the yellow tepetate corresponded to the fallow treatment (bare soil surface continuously tilled). Soil surface cover significantly reduced the amount of erosion in the till and no-till treatments. In the laboratory, surface-applied gypsum significantly increased the final infiltration rate and reduced total runoff and erosion for two different aggregate sizes. Gypsum increased the amount of electrolytes in the soil solution and in the runoff, increasing the ionic strength, promoting flocculation of particles and preventing soil dispersion and surface crusting. Reclamation of tepetates trough tillage may initially reduce the amount of runoff and increase infiltration. Rill erodibility, however, is increased. Therefore, reclamation and conservation practices should be designed to prevent runoff from occurring and increase infiltration in the interrill areas. The use of gypsum and surface covers could be a low cost alternative to control soil erosion and increase productivity in the tepetate areas of the Valley of Mexico.

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A-0723

WEPP Simulated Tillage Effects on Runoff and Sediment Losses in a Corn-Soybean Rotation. A.Z.H. Ranaivoson, S.C. Gupta, and J.F. Moncrief, Department of Soil, Water and Climate University of Minnesota, St. Paul, MN USA

There is considerable concern regarding the transport of diffuse source contamination to the Minnesota River. According to one survey, the Minnesota River is one of the 20 worst polluted rivers in the United States. Approximately 625,000 tons of sediment and 1600 tons of total P per year are being transported by the Minnesota River to the Mississippi River. The Minnesota Pollution Control agency has estimated that 40% reduction in sediment is necessary to achieve the federally mandated water quality goals in the lower Minnesota River. A paired watershed study was undertaken to evaluate the impact of tillage system on runoff and sediment losses from small watersheds in the lower Minnesota River Basin. The study is in the calibration phase of the watersheds. In this paper, we are presenting the results of WEPP simulations on tillage effects on runoff and sediment losses from these watersheds under a corn-soybean rotation. The simulation results showed that 30-year average runoff and sediment losses were higher with CLIGEN generated climatic records than with the historical records. Furthermore, CLIGEN generated runoff and sediment losses were both significantly lower with chisel plowing compared to moldboard plowing. Similar analysis with historical climate records, however, showed that only sediment losses were significant lower and there was no effect of tillage on runoff and sediment losses from these watersheds. Average runoff with historical weather records was higher in soybean years than corn years. This was mainly due to two large events that occurred during the soybean years. It appears that climate plays a much more important role in determining runoff and sediment losses from these landscapes and in turn the water quality of the Minnesota River. Presence of surface residue is important in reducing runoff and sediment losses from these landscapes, but their effect on the Minnesota River Water quality may be secondary to the effects of climate. Sensitivity analysis of the model showed that runoff and sediment losses were somewhat sensitive to the discretization of the watershed into hillslopes and channels. It is suggested that hillslope should be selected such that they approximate the rectangular area along the channel length, as best as possible. Validation during the calibration period showed the WEPP predictions of runoff and sediment losses from these watersheds were reasonable in comparison to the measured values.

A.Z.H. Ranaivoson

A-0724

The Effect of Geometric Mat Design on Erodible Nigerian Sandy Loam Soil. C. I. Ijioma, Institute of Erosion Studies, Federal University of Technology, Owerri, Nigeria

The soils of the rain forest region of Southeastern Nigeria have been found to be highly erodible with a lot of sediment yield from newly constructed embankments silting up rivers and drinking water streams. Studies are presently being conducted on the development of simple processes for such embankment protections. At the Institute Studies, Federal University of Technology, Oweri, Nigeria, fibres sourced from coconut tree trunks, coconut pods, and palm trees have been woven into geofibre mats to temporarily check run off, and soil loss from newly constructed embankments before the full development of vegetative covers. In an on going study, the performance of geofibre mats, made from coconut pods and of different internal cell geometry's on four different slopes of 3%, 6%, 9% and 12% on sandy loam run off plots were compared. During natural tropical rainstorms of varying intensities, the amount of sediment yield and the effective diameters of the grain size distributions of the soils from the differently protected plots were compared with those from the unprotected control plots. The geofibre mats with square internal cell geometry were found to be most effective in reducing sediment yield than the rhombus shaped and the diamond shaped mat cells. It was also observed that for each mat design, the effective diameters, the uniformity coefficients and the filter material characteristics D_{85} of the grains decreased from the square cell design to the diamond design. These findings have become useful in the attempts to locally produce geofibre mats that will be available to soil conservationists and farmers in the developing country.

C. I. Ijioma

A-0725

Wind Erosion Estimates With RWEQ and WEQ. D. W. Fryrear, W. Chen and C. Lester

Estimates of wind erosion from agricultural lands have been made using the Wind erosion EQuation (WEQ) since its release in 1965. While reasonable for the Central Great Plains, the estimates were not reasonable in higher or lower rainfall regions. To improve wind erosion estimates in all regions, the Revised Wind Erosion Equation (RWEQ) was released in 1998. The RWEQ incorporates new technology for describing plant residues, soil conditions, management systems, and the impact of weather. The estimates of erosion with RWEQ and with WEQ were compared with measured erosion in 16 locations in 7 states. With RWEQ the correlation between measured and estimated erosion was significant, but with WEQ the correlation was not significant. The estimates of potential wind erosion from various management systems were made using the same basic inputs to WEQ and RWEQ. The systems include wheat-fallow, wheat-sorghum-fallow, continuous sorghum, sorghum-cotton, corn, cotton, tobacco, tomatoes, and water melons. In the high rainfall regions, the estimates with WEQ were about 1/10 the values from RWEQ, while with no-till sorghum in Colorado the RWEQ estimates were 1/10 to 1/20 the estimates from WEQ. RWEQ includes terms for standing residues and estimates the decay of the standing residue. Estimated erosion with trees was less with RWEQ than with WEQ even though RWEQ estimates erosion from four directions for each 15 day or less time period. With RWEQ erosion from wind barrier systems is based on the wind reduction patterns to the lee of the barrier, and the soil surface conditions during that time period. WEQ assumes a 10-H protected zone to the lee of the barrier and no adjustments in soil surface roughness by weather.

D. W. Fryrear

A-0727

Farm Women Group Approach For Promotion Of Land Stewardship During 21st Century. Mrs. Shanthin and Dr. B.K Narayanaswamy, SACRED (NGO), Staff Training Unit. UAS, Bangalore Karnataka, India.

The Unfortunate experience is that inspite of providing various kinds of services to rural women at the local level, these services cannot be made to function adequately and effectively without a machanism of an intergrating management services operating at the village level. The task of land stewardship cannot just be undertaken by the Government alone, particularly in view of constraints of time and resources. Indian planning commission has pointed out that NGO'S are require to get local women co-operation and participation in the implementation of land stewardship programs what NGO'S can do in these circumstances, is to act as a catalyst and provide a link between the Government and rural women. They are amenable for the highest class of talents in the field of rural women development. More than that NGO'S begin to play increasingly important role in the consciousness raising, motivating and mobilising these automised women groups and helping them to organize for social action with their selective task, personal leadership, flexible structure, NGO'S can innovate, adopt themselves to more circumstances experiment and take risks to play a path finding role as pilot action research project in the field of land stewardship. The planning commission is also clear on empathetic role of NGO'S as providers of welfare measures and as mitigators of hard ship to rural women. Some NGO'S have done yeoman service to rural women in India at the village level. In these cases most of the rural women have become innovators and adopted land stewardship. Keeping this in view a study was conducted during 1997 with randomly selected 40 NGO'S in India. In all NGO'S women groups have proven to be effective for extension contacts and used women group concept to motivate local action for land stewardship. The NGO'S projects focused on the participation of women involved in agriculture in rural areas. Farm women were formed into groups for social and economical activities related to saving and credit. For strengthening and support as a joint venture made provision for seed money. The seed money was used to take up various activities of land stewardship. The seed money amount was given as a petty loan to the ready members and the return should be within the specified period with interest as specified by the group. In some occasions group members worked together and shared the cost instead of buying individually. Women group project contributed women to gain confidence in acquiring the skills of production in land stewardship. Women empowered to learn and share from each other. Poor status women used group as center for learning technologies of land stewardship. Hence, the findings of the study is useful for scientists, planners and administrators in designing strategies for local action to land stewardship during 21st Century.

A-0728

XXVI National Congress of Hydraulics and Hydraulics Works. E. Amore, C. Modica, V. Santoro

When lumped models are used to predict sediment yield from a catchment empiracal coefficients which represent topographic soil and vegetation characteristics of the area must be computed. Such coefficients vary greatly within the area, and therefore a method to account for such heterogenetics must be chosen. Previous applictions of lumped models evaluate each coefficient by weighting the values for each homogenous soil according to its area. Such a method does not take in account the effects of the position of the soil, i.e. of its distance from the point of origin of overland flow, whic causes some detachment and conveys sediment yield through the area. With the reference to USLE (and derived models) a method to evaluate the slope length in order to consider the position of an area in a series of soils is here presented. The method is applied to a sicilian upstream of a reservoir, the results are compared with those of the weighted mean technique and both are finally compared with measurements of deposited sediment in the reservoir.

Elena Amore

A-0730

Diurnal Soil temperature variation of some bare profiles of alfisols in India. P.K. Tarafdar and S. K. Dey, Department of Soil and Water Conservation, Bidhan Chandra Agricultural University, Mohanpur, West Bengal, India

The present study aims to investigate the diurnal variations of soil temperature in different depths of some bare alfisols in India at various seasons of the year. Average soil temperature for every depth of each soil series follows in the order of summer> monsoon> post-monsoon>winter. However, the variation of soil temperature for each of the soil series maintains the order of summer > winter > post-monsoon > monsoon. Under each season, the diurnal variation of soil temperature becomes highest in the uppermost layer and decreases rapidly with increasing depth.Surface soil layer starts heating immediately after sunrise while the soil layer of 20 cm. and 40 cm. depth starts

heating after 2nd and 4 hours of sunrise respectively for each season of the year, Increasing depth of soil shows pregressive delay in attaining the maximum temperature. While the subsurface soil layers of 20cm. and 40 cm. depth reach to the maximum temperature, the surface soil layer at the time becomes cooler. Soil temperature furnishes significant positive correlation with air temperature and evaporation but negative correlation with wind velocity. The ordinary least square linear regression model is fitted which explain 90% of variability relating the effect of influential regressor variables like metereological parameters on soil temperature as response variables.

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A-0731

Recent Progresses in Soil Erosion Process Research and Their Impacts on Erosion Prediction Model Development. Chi-hua Huang and L. Darrell Norton, National Soil Erosion Research Laboratory, West Lafayette, IN USA.

Soil erosion process research produces knowledge and science used in the development of current process-based erosion prediction model. The USDA-ARS water erosion research program at West Lafayette, IN has been the focal center in soil erosion process research and erosion prediction model development. This presentation will highlight past efforts in developing erosion process concepts that lead to the development of current process-based Water Erosion Prediction Project (WEPP) model. Recent progresses in soil erosion process research include: 1) quantification of the near-surface hydraulic gradient effects, i.e., seepage vs. drainage condition, on erosion; 2) development of a multiple-box system that can simulate hillslope hydrologic conditions and evaluate sediment mass balance relationships; and 3) identification of dominant erosion processes and controlling sediment regimes as the surface hydrologic condition is changed. Results from these studies demonstrated the capability of a multiple-box system to quantify erosion process scenarios from deposition-dominated to detachment- and transport-dominated regimes. Our data also show that the dominant erosion process depended on slope gradient, rainfall intensity and soil erodibility and an increase in soil erodibility from the seepage condition triggered a transport-dominated regime while a decrease in soil erodibility from profile drainage limited sediment detachment and enhanced sediment deposition. These data provide challenges to some current erosion process model concepts, such as: rill-interrill separation, sediment feedback or detachment-transport coupling, and the uniqueness of the sediment transport capacity. These findings improved the erosion science and provided new erosion control strategies that may have additional environmental benefits from the traditional erosion control practices. Impacts and future directions of the soil erosion process research and model development will be discussed.

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A-0732

A GIS-based methodology for land stress evaluation. Rami Zurayk, , Faraj El Awar, Hussein Hodeib, Christine Sayegh, and Shady Hamadeh, Faculty of Agricultural and Food Sciences, American University of Beirut, Lebanon

Land degradation results from a number of interacting forces that are related to the biophysical and socio-economic characters of a specific ecosystem. It is therefore largely dynamic and requires both reductionist and holistic analysis. When studying large areas, it is necessary to separate zones where urgent intervention is required from those which are stable under the current land use. Achieving this complex task requires 1) the selection of land quality indicators appropriate to the natural and socio-economic environment, 2) the use of a flexible, dynamic methodology that easily allows a number of permutations and "what-if" scenarios, and 3) replicability and moderate cost of the used methodology. In developing countries, the issue is further complicated by the chronic lack of both long and short term data. This paper reports on an attempt to delineate stress areas in Irsal, a dryland zone in Lebanon. The study area covers over 250 Km^2, includes both highlands and steppes, and spans over a pluviometric gradient ranging from less than 250mm to over 500mm per year. Traditionally an agropastoral area dominated by integrated cereal cropping and semi-nomadic small ruminant farming systems. However, Irsal has witnessed in the past few years a significant shift toward an orchard based cropping system. The concurrent decline of agropastoralism has been accompanied by an increase in urbanization and the spread of stone quarrying, a recent land-disturbing activity. With minimal primary and secondary data such as class II soil survey, mean annual precipitation, existing SPOT imagery, and field surveys, we have created digital coverages of the following: Relief, Soil Erodibility, Rainfall Erosivity, Land Cover, Grazing, Agricultural Practices, Urbanization, and Quarrying. Thematic maps were produced, and the impacts of the different factors on soil erosion, potential land use, and landscape integrity was quantitatively assessed by factorial scoring. Finally, overlay analysis allowed the creation of a dynamic land stress map showing high priority intervention areas and trends of change over the past 30 years. The approach is now being refined for replication in various localities in Lebanon.

A-0733

Water Harvesting in Dry Marginal Lands. Faraj El-Awar, Rabi Mohtar, Rami Zurayk, and Mazen Makke

Irsal is a dryland area in northeast Lebanon on the western border of the Syrian Badia. The area is categorized as semi arid with dry hot summers and very cold winters. Recent shift from cereal cropping system to rainfed cherry orchards in the region is limited by low fruit yield. The critical factor in this development is the availability of water during the summer months for irrigation. This paper focuses on using Geographic Information Systems and hydrologic modeling for planning a water harvesting scheme in Irsal watershed. Suitable sites are located and ranked for small irrigation reservoirs to harvest rainfall and snowmelt during winter and early spring to be used for summer supplemental irrigation. ARC-INFO is used to determine hydrologic parameters needed by the watershed model to estimate the potential water yield in the area. It is used to build a reservoir suitability index (RSI) map based on watershed topography, land cover/use, soil hydraulic characteristics, and water harvesting efficiency. A methodology for developing the RSI is developed and implemented using the spatial Analytical Hierarchy Process (AHP). The area hydrology is modeled using the Watershed Modeling System (WMS) environment. The work is intended to help the local community and the regional planners in selecting sites for water harvesting reservoirs based on multiple constraints.

A-0735

Current Wind Erosion Monitoring And Modelling Techniques In Australia. John Leys, Department of Land and Water Conservation, Gunnedah, Australia, Grant McTainsh, Griffith University, Brisbane, Australia and Yaping Shao, University of New South Wales, Australia

Methods for wind erosion monitoring and modelling have been developed in Australia. These technologies allow measurements and predictions of wind erosion to be made at plot, field, regional and continental scales. Measurements of wind erosion utilise a variety of approaches including simulation with portable field wind tunnel, and passive and active dust traps which collect dust samples for later analysis. For high resolution data, piezo-electric cells have been used to measure sediment flux and threshold conditions for wind erosion. Other techniques have focussed on using the dust storm meteorological record to interpret long term land condition and changing wind erosion activity at a regional scale. The above measurements have also been used to test and develop a new process-based wind erosion model. The Wind Erosion Assessment Model (WEAM) can be used at a variety of scales from plot to continental. For regional and continental scales, WEAM is coupled with an atmospheric prediction model and a geographic information system and database. The system has the capacity to identify erosion sources and associated dust emission levels, and to some extent, the environmental factors responsible.

A-0736

Soil Management and the Greenhouse Gas Balance of Agroecosystems in Canada. Ray Desjardins

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A-0738

Effects of Soil Conservation and Erosion Management on Soil Carbon Pool in Different Ecoregions of China. Chengmin Huang et al.

A-0739

Soil Management Options for Carbon Sequestration in Europe with Particular Reference to Conservation Tillage, Residue Management and Land Use Change. D.S. Powlson

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A-0740

Carbon Sequestration and Transport in Sediment Leaving Small Tilled Watersheds. L.B. Owens, R.W. Malone, G. C. Starr and R. Lal

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A-0741

Soil Organic Carbon Sequestration Potential of Adopting Conservation Tillage in U.S. Cropland. R.R. Allmaras, H.H. Schomberg, C.L. Doughlas, Jr., and T.H. dao, USDA-ARS, St. Paul, MN USA, Watkinsville, GA USA, Pendleton, OR USA and Bushland, TX USA

Predicted trends in the soil carbon sink (removal CO2 from the atmosphere) indicate a switch from a negative to a positive sink in croplands of US and Canada. Earlier analyses indicated a positive sink would not occur until about 2010, when no-tillage was adopted on 80% of US cro pland, but more recent analyses using carbon models suggest a positive carbon sink already. Trends in crop residue return, changes in adopted tillage systems, and comparataive carbon storage in long-term field trials together indicate that a positive sink may already have been achieved in about 1980. Reduced use of the moldboard plow was the key factor. Although crop residue returns have grownmuch since the 1960 ear, carbon storage was suppressed by continued use of the moldboard plow until about 1980. Adoption of CRP, cover crops, and continuous cropping to replace summerfallow were not included in the analysis that was focused

upon tillage systems for production of corn, sorghum, soybeans, and wheat. This approach must use regional data bases to provide quantitative estimates, but it has a mechanistic advantage to better link carbon storage to associated production and conservation benefits.

R.R. Allmaras

A-0742

Selective Transport of Soil Size Fractions, C and N by Erosion and Deposition Across Two Conservation Tillage Watersheds. G. Starr, R. Lal, L. Owens, R. Malone and J. Kimble

A-0743

Carbon Sequestration in the No-till and Plowed Chronosequence in Tropical Areas of Brazil. Joao Carlos de Moraes Sa

A-0745

Global Dimensions Of Vulnerability To Wind And Water Erosion. Paul Reich[1], Hari Eswaran[1] And Fred Beinroth[2], [1]usda Natural Resources Conservation Service, Washington Dc, And [2]university Of Puerto Rico, Mayaguez, Pr

Soil erosion is a natural process that is accelerated by inappropriate management of the land. The propensity of a soil to erode is a function of both the kinds of soil and precipitation characteristics such as intensity, duration, and interval between successive storms. To capture some or all of these variables affecting water induced erosion requires detailed modeling. Current models have various degrees of credibility, as it is difficult to capture the combinations and permutations of factors that determine erosivity. The present global assessment employs a simplified model by only considering the soil and climatic variables affecting the process. Certain parent materials, such as loess, are highly erosive but are not considered due to lack of databases. The purpose is to obtain global and regional estimates of areas of land susceptible to different intensities of erosion. The areas of high risk demarcated on maps identify regions, which require additional attention to conservation. The actual intensity of erosion is a function of many factors, the most important of which is the level of management as determined partly by the socioeconomic status of the land users. The relationship between erosion vulnerability and the inherent land quality (ILQ) is shown in the table. Nine ILQ classes stratify land based on soil and climate characteristics and range from I (best) to IX (worst). Of the 131 million km^2 land area globally, about 56 million km^2 (43%) are susceptible to water erosion, yielding about 5 billion tons of sediment, and about 33 million km^2 or 25%, to wind erosion. The actual area subject to human-induced erosion is expected to be about the same magnitude but the amount of soil loss would be 10 to 100 times that estimated in this study.

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A-0746

Introduction of a Spectrum of Sizes into a Dust Prediction Model. L.Berkofsky, Jacob Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Sde Boker, Israel,

Dust Modeling. In attempting to devise a model for dust prediction it is important to realize the threshold drag velocity is related to particle size. This is shown in the well-known graph of variation of threshold friction velocity with grain diameter (Bagnold, 1941). Although one may introduce a single grain size or a spectrum of sizes and the initial instant in prediction equations, if the variations single grain size or a spectrum of sizes at the initial instant in prediction equations, if the variation of friction velocity is not taken into account, the concentration prediction will be incorrect. If, for example, one starts with a single grain size, and an observed concentration, the simultaneous prediction of wind and concentration will, in a short time, lead to a new friction velocity. This then demands the introduction of new grain sizes corresponding to this velocity, and the simultaneous introduction of new dust concentration equations. Then, new initial concentrations must be known to carry forth the concentration prediction of new grains. We show how to determine which size grains are introduced at each time step, and, equally important, how to calculate the concentration of each grain size at that time. Methods. We may introduce a spectrum of sizes in the following way: We start with initial values of C_k (dust concentrations at the top of the surface layer z =k) and C_{CR} (dust concentrations in a thin layer near the ground). We are also given initial values of wind velocities. We calculate the friction-velocity U_* (see Berkofsky and McEwan 1994). We then compare this value with various threshold friction velocities given in the graph by Bagnold (attached). If $U_* > U_{t,}$ we introduce the equation for C_{GR} for the smallest diameter (and corresponding fall velocity) for which $U_* > U_{t}$. Thus for 1μ particles, U_t = 100cms^{-1} , for 10μ particle, U_t = 32 cms^{-1} . These are for the maximum and minimum diameters of atmospheric dust particles given in Bagnold. Fig. 1, p.l. If we pick U_t = 32 cms^{-1}, any U_* greater than that will activate particles sizes up to that U_*. This approach necessitates a discrete spectrum, i.e., if U_* = 40 cms^{-1} , grains of 7μ diameter will be lifted. If U_* = 50 cms^{-1} , grains of 4μ diameter will be lifted, etc. Each time grains of a certain diameter are lifted, we have to know the initial concentration (μgm^{-3}) of that size in order to integrate the corresponding C_{GR} equation. Suppose we assume that the mass transport of dust obeys the same type of formula as for sand. The equation derived by Gillette (1974) for the vertically integrated sand transport, using roughness height and saltation height as integration limits, steady state dust concentrations profiles and logarithmic profile, yields an expressions for the horizontal particle flux. $Q = U_* K_1^{-1} Z_o C_{GR} \{ (Zs/Z_o) /(\Gamma +1) -1/(\Gamma +1)^2]\}$; $Q = \rho U_*^3 / g (0.25 +.33 V_G / U_*) (1-U_t^2 / U_*^2)$ Equating these expressions yields and expression for C_{GR}; $C_{GR} = k_1 \rho U_*^2 [(0.25 +.33 V_G / U_*) (1-U_t^2 / U_*^2)]: Zo \{(Zs/Zo)^{\Gamma+1} (\Gamma+1)^{-1} \ln(Zs/Zo)- (\Gamma-1)^{-2}]\}$ Since everything is known, C_{GR} may be calculated for each grain size. Results. Since we have not yet carried out numerical integrations, all that can be said at this point is that a few calculations using equation (3) yield values of C_{GR} in the right ballpark.

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A-0748

Elevated CO_2 Impacts on Microbial Activity and Soil Organic Matter in a Southeastern U.S. Soil. Diane E. Stott[1], Hugo H. Rogers[2], and Stephen A. Prior[2]. [1]USDA-ARS National Soil Erosion Research Laboratory, West Lafayette, IN and [2]USDA-ARS Soil Dynamics Laboratory, Auburn AL.

The continuing rise in atmospheric CO_2 has important implications for terrestrial carbon processes. For example, plant growth is typically stimulated by elevated CO_2 because CO_2 is the substrate for photosynthesis and water-use efficiency increases. Stimulation of root system development associated with increased growth immediately lead to hypotheses of changes in soil and rhizosphere microbiology, especially as related to the C flow within the soil. Enhanced plant growth also suggests greater deliver of C to soil, and thus potentially greater soil C storage in terrestrial ecosystems. AS part of a larger project, we studied the C storage and changes in microbial activity in two agro-ecosystems, soybean and sorghum, a C_3 and a C_4 crop respectively. The soil used was the Blanton Loamy Sand (loamy, silicious, thermic Grossarenic Paleudalt) located in Auburn AL. Treatments consisted of 360 ppm CO_2 in ambient atmosphere, 360 ppm CO_2 in open-top chambers and 720 ppm CO2 in open-top chambers. Soil was sampled after the sixth year. Cores were divided into 4 depth samplings: 0-5 cm, 5-10 cm, 10-15 cm and 15-30 cm. Microbial enzymatic activities measured included: B-glucosidase, arylsulfatase, phosphatase, amidase and fluorescein diacetate hydrolase. In addition total C and N, dissolve organic C and carbohydrate C was measured. Susceptibility to crusting and surface sealing was determined using the Griffith fall-velocity tube. While differences in activity with depth were significant, with the surface layer having the greater activity and C sequestration, differences between CO_2 treatments were minimal. Despite a six-year exposure to elevated CO_2, this loamy sand from the southeastern United States was unable to sequester addition C, probably due to the warm climate and rapid organic C turnover.

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A-0750

Distribution Coefficients for Pb by Batch Adsorption and Column Desorption on Alluvial Aquifer Materials. Emmanuel E. Udoh, Nosa O. Egiebor and Kafui Nyavor, Environmental Engineering Program, Chemical Engineering Department, Tuskegee University, Tuskegee, AL USA

The quantification of adsorption-desorption using either batch or column procedures is an informative technique in chemical product development and soil/aquifer remediation strategies. The batch procedure has the advantages of simplicity and speed, which has favored its frequent applications, although the column method is believed to be more representative of field conditions. In line with exploiting these advantages, this paper examines whether or not sediment partition coefficients for lead (Pb) from batch adsorption are similar to and can be substituted for those from column desorption. To meet this objective, the adsorption-desorption of lead was carried out using a model ground water solution with homogenized alluvial aquifer materials as adsorbents. The batch adsorption was studied at three different initial concentrations and at a pH range between 2 and 10, for the determination of the partition coefficients. The column desorption experiment was carried out at similar pH and initial metal concentrations as well as at four different flow rates. To obtain comparable partition coefficients to the static batch conditions, the desorption data were transformed using a double extrapolation technique. This technique extrapolates the desorption data first to the zero volume, and then to the zero-flow conditions, for the determination of the partition coefficients . With a correlation coefficient of 0.91, the obtained partition coefficients for lead from the batch adsorption approximates those from the column desorption.

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A-0751

Reintroduction Of Lumbricus Terrestris Into No-Till Maize Fields In Indiana, USA. Eileen J. Kladivko, G. L. Willoughby, and J. G. Graveel, Agronomy Department, Purdue University, West Lafayette, IN USA

No-tillage practices are being used on many farms in the US "Cornbelt" as an effective means to reduce soil erosion. No-till results in increased soil organic matter, improved

soil aggregation, and often greater water infiltration rates than on conventionally plowed soils. Populations of shallow-dwelling (endogeic) earthworm species usually increase under no-till (Kladivko et al., 1997) compared to conventional tillage systems. The deep-burrowing (anecic) species Lumbricus terrestris, however, is often not present in no-till fields in the Cornbelt even after five or more years of the no-till practices. Farmers are very interested in seeing L. terrestris return to their no-till fields as a means of improving soil functioning in their systems. This study was designed to answer some practical questions posed by farmers in this region. The objective of our experiment was to determine whether introduction of L. terrestris into no-till fields would be successful on a variety of soil types in Indiana, USA. We coopered with farmers and experimentally introduced L. terrestris into 18 no-till or conservation tillage fields. Mature L. terrestris were released in spring and/or autumn 1994 into eight quadrats in each field. L. terrestris establishment and population growth was estimated each spring over the next 4 years by counting active middens in each quadrat. All fields showed at least some survival and establishment of L. terrestris after the introductions. After a 2-year period of relatively steady or declining populations, some fields experienced large increases in population density and areal extent of populations in 1997 and 1998. However other fields continued to have low populations and little evidence of population expansion beyond the immediate vicinity of the quadrats. Results indicate that introductions of L. terrestris into no-till fields may be successful on some soils, but the rate of population growth and expansion may be slow enough to discourage large-scale efforts by farmers. The soil properties or field characteristics that determine relative degree of success of introductions are also not yet clear, suggesting that small-scale trial introductions would be advisable on any field prior to a decision to embark on any large-scale efforts.

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A-0752

Soil Quality Improvement With Cover Crop Mixtures. Kate Ryan, Eileen Kladivko, M. Hickman, S. Brouder, C. Nakatsu, and J. Graveel, Agronomy Department, Purdue University, West Lafayette, IN USA

Many farmers have a great interest in improving soil quality within their fields. Intensive tillage and the loss of sod-based rotations and routine applications of animal manure over the past 40 years in the Midwest of the USA, have resulted in a general decline in soil physical and biological conditions. This is particularly the case on soils in the eastern cornbelt originally developed under forest vegetation. Farmers would like to have available a selection of practical ways in which to improve soil quality within their overall farming system. While for some farms this may mean reintroducing hay crops and animals into a longer rotation, other types of strategies are needed for many farms in the eastern cornbelt. Winter cover crops are one such tool available to improve soil structure, biological diversity, and overall quality. A mixture of morphologically diverse cover crops may be able to mimic the beneficial effects of longer (3-4 yr) rotations within a shorter time period. Our strategy is to use a mixture of cover crops each winter in a 2-year corn-soybean rotation, to biologically intensify the system and optimize the use of ecological niches. This research and demonstration project is a joint effort among university researchers, farmers, a crop consultant, and extension personnel. The objectives of the study are to 1) evaluate the potential for cover crop mixtures to improve soil structure, microbial biomass and diversity, and nutrient conservation and availability on four Indiana soils under no-till and conventional tillage systems and a corn/soybean rotation, 2) determine the impact of cover crop mixtures on corn and soybean yields and weed suppression on four Indiana soils under no-till and conventional tillage systems, and 3) evaluate and demonstrate cover crop mixtures and the resulting soil quality changes, on four farmers' fields in Indiana. Results from the first year of the four-year study will be presented.

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A-0755

Mobilities In Soils And Uptake Of Trace Elements By Crops. Podlešáková Eliška, Research Institute For Soil And Water Conservation, Prague, Czech Republic, Nmeek Jan, Czech Agricultural University, Dpt. Pedology And Geology, Prague, Czech Republic

We intend to set up critical soil loads of trace elements (tes), which refer to the pathway soil-fodder (food) plants. They can be derived from data, characterizing not only tes contents, but also their mobilities in soils and their uptake by crops, leading to critical plant loads from the viewpoint of zootoxicity and phytotoxicity. Mobilities were studied by means of the sequential analysis (zeilen, brümmer 1989) and a simplified tes speciation: 1m nh_4no_3 = mn, (0.01m $cacl_2$ = mc), mobile species, 0.025m edta = ed potentially mobilizable species, conc. $Hclo_4$+hf+hno_3, total content (to). Pot experiments were carried out with samples from 54 representative soil units (contaminated in the field and geogenic extremes) and testing plants radish (oats, spinach). Element–specific and soil-specific features of tes bonds have been revealed. Factor analysis shows that tes mobilities of mn, cd, co, zn, ni (be) depend inversely on ph (and clay content) and correlate on the 1. Factor level with plant uptakes. The second factor comprises the tes pool. Multiple regression analysis proved the possibility of tes mobilities prediction from ed, to and ph and transfer prediction from mn (mc), ed and/or to. Substitution for tes critical loads can be used for normsetting. For less mobile elements and tes with a low transfer coefficient (< 0.01) prediction of mobilities is possible from ed and to contents. Mostly high total contents of tes in soils can be proposed for as, cr, cu, pb, v, which indicated the level guaranteeing that no increased transfers have been found at. Only very high anthropogenic, especially fluvial pollution, characterized by high solubility (ed/to) needs precautional measures. Pot experiments and tes mobility studies were also performed with samples of representative soils after a simulated contamination with cd, zn and ni. The results provide a valuable information about the buffering soil potential against pollution in the sequence psamments < udalfs < eutrochrepts < spodic dystrochrepts (for some tes) < ustolls. The mentioned feature is indicated by the decrease of the mobile fraction and transfer into plants after the same addition of tes.

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A-0756

Indigenous Knowledge of Land Stewardship in China. Aihe Wang, Assistant Professor, Purdue University, Department of History, West Lafayette, IN USA

China's extraordinary economic growth over the past two decades has been accompanied by an equally extraordinary ecological crisis. A signal of such crisis is the record-breaking flood of the Yangzi River this summer. The major cause of the flood is serious soil erosion in the upper river valley that has drastically increased in the past four decades. The erosion now covers about 65% of the upper river valley and carries 720 million tons of soil each year through the Three Gorges to the middle and lower river -- more than the total soil amount of the Mississippi, Amazon, and Nile together. While the environmental destruction of the upper Yangzi is the result primarily of human activities in recent decades, the upper Yangzi region has been open for agriculture for two thousand years, sustaining a highly diverse population of different ethnicity's, life styles, and economic activities. Agricultural expansion in the region was accompanied and sustained by the development of indigenous knowledge of land stewardship and water control. Recovering this indigenous knowledge is essential for the success of solving China's soil erosion problem. This paper examines this indigenous knowledge, including geographically and ethnically diverse traditions of land stewardship, cultural beliefs and practices aimed at sustaining resources, and Chinese conceptions of the relationship between human beings and nature.

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A-0757

The evaluation and time-space distribution property research of soil erosion potential danger based on GIS. Chen Jie, Agricultural Division of Financial Department in Fujian Province, China

The potential danger of soil erosion is decided by the anti-eroded number of years, and it is one of the important specifications for evaluating the intensity of soil erosion. The effective soil layers of the majority parts of the red soil area in the south of China are thin,so the potential danger of soil erosion is of important instruction in the treatment of soil erosion, soil renovation and agricultural production practice. Based on the example of Fujian Nanan of China, we use GIS and RS technology in this research, draw up the soil erosion models chart in the basis of two times remote sensing testing soil erosion in quantity of 1988 and 1996, respectively. We make use of soil general investigation achievement material to draw up the soil layer thickness chard and soil density chart, then make the soil and-eroded number of years chart. With the help of GIS, we evaluate the potential danger of soil erosion in the research area, discuss the time-space distribution property, and provide scientific basis for the plan of soil preserve.

Chen Jie

A-0759

Effects of Nitrification Inhibitor on Nitrate Leaching in Cotton Production Systems. R.K. Malik and K.C. Reddy

In the light of energy and environmental concerns, the efficient utilization of nitrogen fertilizer has become and important goal. Nitrate, a product of mineralization process, is mobile and considered a significant ground water contaminant. This study was designed to investigate the effects of nitrification inhibitor, Carboximethyl Pyrazole (CMP) @ 0.56 kg a.i. ha $^{-1}$ on nitrate leaching. Three sources of nitrogen, fresh poultry litter (FPL), composted poultry litter (CPL) and urea @ 0, 45,90 and 135 kg N ha^{-1} rates were treated with CMP. These were compared with non CMP treated plots. The treatments were arranged in a randomized complete block design (RCBD), replicated four times. Nitrification inhibitor significantly reduced NO_3N up to 41 days from planting (DEP). Increase in nitrate rate increased NO_3-N significantly up to 41 DFP. The plots with CPL had significantly lower NO_3-N concentration in the surface soil. These data indicate the possibility of using CMP as a means to reduce nitrification and consequent nitrate leaching. However, to have longer effect, one may need to further experiment on rates and dates of treatment.

A-0760

Conservation Tillage Effects on Soil Erosion in Cotton Production Systems in North Alabama. E.Z. Nyakatawa, K.C. Reddy, and J.L. Lemunyon, Department

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Despite being one of the most profitable crops for the southeastern USA, cotton (Gossyplium hirsultum L.) is considered to create a greater soil erosion hazard than other annual crops such as corn and soybeans. Reduced tillage systems and cover cropping can reduce soil erosion and leaching of nutrients into groundwater. The objectives of this study, which was conducted in North Alabama from 1996 to 1998, were to assess the impact of no-till (NT) and mulch-till (MT) systems with a winter rye (Secale cereale L.) cover crop and poultry liter (PL) on soil erosion estimates in cotton plots using the Revised Universal Soil Loss Equation (RUSLE). Mean soil erosion rate estimates in plots under NT and MT tillage systems were less than 11 tons $acre^{-1}yr^{-1}$ limit. Application of nitrogen in the form of ammonium nitrate or PL resulted in the development of a better canopy cover in cotton, which significantly reduced soil erosion rates compared to nitrogen application. The above results suggest that NT and MT tillage systems with cover cropping and PL can reduce soil erosion and thus improve sustainability of cotton soils in the southeastern USA where erosion is a major problem.

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A-0765

Analysis of Some Socio-Economic Factors That Affect the Adoption of Agroforestry Technologies in Ghana.

It is clear that agriculture must be the core of any development initiative that aims at making a lasting positive contribution of predominantly agrarian communities. However, farming systems in many agrarian economies, particularly in the developing world, have led to dependency instead of development owing to the use of modern input intensive production systems, major components of which are imported, or due to poor natural resource conservation practices. There has therefore arisen an international concern to find alternative farming systems that are environmentally and economically sustainable as well as culturally acceptable to farmers in the developing world. Agroforestry, a holistic approach to land use based on the contributions of trees and shrubs with crops, pastures or animals on the same land unit either in sequence or at the same time and with a consequential ecological and economic benefits has been suggested by several development experts. Interest in agroforestry as a concept, land use technology and rural development tool is derived from its potential to solve a variety of land use problems that effect developing countries including soil fertility improvement, fodder and fuelwood supply among others. Given the immense agricultural and environmental potentials of agroforestry it is no wonder that it is being promoted for adoption in most part of the third world, especially in Sahara and Sub-Sahara Africa where productivity is low and more marginal lands are increasingly being brought under cultivation.

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A-0766

Decline in Agricultural Production and Productivity in Ghana. Vida Narh (Ms), Women Support Network – Ghana, , Accra-North Ghana

Agricultural production and productivity has evidently declined in Ghana as a direct result of the periodic drought under-rained cultures, pest epidemics and a degraded environment. Again agricultural production, influenced by non-farm and off-farm activities, has often been disrupted considerably by civil disturbances domiciled in the rural farming area. Monetary and fiscal policies have also been in appropriate with a constant misallocation of limited resources. This, coupled with inefficient marketing, processing and other support infrastructure, has also had a fair share of the decline. The fertility decline would eventually hamper and endanger subsistence in the rural farming community, the sufficiency of which serves as the principal focus of food security in Ghana.

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A-0767

Enhancing Research on Mucuna as Cover Crop. Micheal Ofosu Yeboah, Multi-Purpose (COOP) Society, Accra-North Ghana

The use of mucuna as cover crop is relatively new in many African countries but The technology is receiving attention in recent times. As a new technology, its success Will depend, among other things, on the availability of information. This paper discusses the factors that may influence adoption of mucuna as cover crop and suggests a) ways of improving efficiency f mucuna trials and b) research needs of the technology. The information that formed the basis of this paper was derived from a 5-year research experience on mucuna as cover crop in Ghana. Pressure on land due to population growth has brought about intensification of land use in many African countries. The major agronomic problems which limit yield under intensive use of land in Ghana and other countries include weed build-up and decline in soil fertility, Chemical Fertilizers and herbicides are effective in solving these problems but are not affordable to the majority of farmers in Africa.

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A-0768

The Role of Legumes in Soil Fertility Improvement. Mark Addae Mensah, Multi-Purpose Coop. Society, Accra-North. Ghana

Organic matter is a requirement for soil fertility regeneration but its availability through long fallow or forest canopy conditions is now out of contention. We have to grow the plant residue possibly as leguminous cover crops or take advantage of the abundant weed flora which is feasible only through chemical scorching. A low-moisture cropping technology for the preservation and improvement of the soil moisture and soil organic matter must of necessity utilize the legumes for their nitrogen substituting qualities and for their soil improvement abilities to reduce the farmer's expenditure, yield loss and declining soil fertility. Agricultural production does not appear capable of matching the rapid population growth as evidenced by widening food deficit often met by increasing grain imports to feed the growing often restless urban population in sub-Saharna Africa. Food deficit, without significant improvement in productivity, even in a low income elasticity of demand cereals and non-cereals, is expected to widen.

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A-0769

Factors That may Influence Adoption of Mucuna as Cover Crops. Patience Acquah, Women Support Network- Ghana, Accra-North

Mucuna is capable of controlling aggressive weeds and improving soil fertility. It is therefore, likely to be adopted in areas with serious problems of weeds (e.g. spear grass) and/or soil fertility. In order to use mucuna, the farmer will have to sacrifice his land for 1 or 2 seasons as improved fallow. This may be a problem where land is extremely scarce. On the other hand, mucuna is not likely to be adopted in areas with abundant land because farmers will rather leave the land to natural fallow than to invest in mucuna establishment. Thus mucuna has a greater chance of being adopted in areas where land is neither abundant not too scarce. The establishment of mucuna is a long-term investment in land improvement. It entails land preparation, planting and 1 or 2 weeding but its effect is not immediate. Such an investment is not likely to be undertaken where there is no security in land ownership. A long growing season or a bimodal rainfall regime could permit mucuna to be planted, such that it will not coincide with food crops and thus reduce pressure on labor and/or land. On the other hand, a comfit for labor and/or land is likely to occur between mucuna and food crops in areas with short growing seasons. Among others.

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A-0770

Technological Interventions to Improve Soil Fertility. Samuel Awuah, Andea – Ghana, Accra-North. Ghana

Indication are that Ghana's required nutrients will continue to be supplied by regeneration of fertility under fallow and there is the need for continued research on appropriate grain-legume rotations as the main input of nitrogen in the cropping systems, to reduce the external demand (World Bank, 1991). It is worthwhile therefore to develop cropping systems that keep the fertilizer nitrogen budget to a minimum while ensuring optimum yields. Appropriate research and production technology must respond to the fertility decline. The length of the traditional food crop bush-fallow is not long enough to restore the soil fertility at the moment under the farmer's socio-economic conditions but the advantages inherent in the fallow could be restored however within this period if a food crop legume replaces the bush fallow. This offers an extra income for the farmer as well as improvement of soil structure and fertility at minimal cost, a good incentive to sustain production.

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A-0771

Effect of Farmyard Manure and Method of Land Clearing on Soil Properties and Maize Yield. Jeremiah Heljel FOFAG - Ghana

Land clearing and organic matter application enhance land productivity and plays an important role in sustainable crop production. Traditional slash and burn prior to crop production is the major cause of declining soil productivity in the shifting matter, exposes the soil to erosion and rid the land of valuable traditional and economic trees that might have beneficial association with the soil. However, burning eases cultivation and makes the soil more friable, encouraging quick growth of young plants, especially in the forest zones. It is generally believed that, incorporating sufficient organic matter into the traditional slash and burn method could improve soil fertility and enhance crop yield. A study was therefore carried out to investigate the effect of poultry an cow manure on soil properties and maize yield.

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A-0772

Communication of U.S./Mexico Border GIS Research through a Bilingual Multimedia Approach. Daphne F. Minton, Dr. Mark V. Finco, Dr. George Hepner, Jesus Gomez, Kelly Boardman, Department of Geography, University of Utah, Salt Lake City, Utah USA

The communication of GIS research results to policy makers and citizens is a difficult, but vital task. This task is made even more difficult in a multi-cultural, multilingual environment. A bilingual multimedia product has been developed to communicate the results from five years of GIS-based research along the US/Mexico Border. One objective of this project is to present technical research results in a format that facilitates communication with our research methods and results and to share special data sets with a bilingual an bicultural audience. As a prototype, another objective of the project is to convey our mistakes and methodology to assist others in similar efforts. A WorldWide W- like, multimedia appearance was desired for the communication product. However, the use of "technology" would have constrained document layout and necessitated high speed Internet access, potentially limiting the audience. Rather than accepting these limitations, an Adobe ® Portable Document Format (PDF). Document on CD-ROM was chosen for the multimedia presentation. This format allows for the use

of text, images, graphics, data visualization, videos and animations in a wide variety of formats on a widely accepted media. In this paper the multimedia product is displayed and its salient design features highlighted. The methods used in developing and producing this product are detailed. This paper provides a resource for those considering the use of a multimedia product for communication of research results. Introduction. Since 1993 researchers at the University of Utah, Department of Geography, have conducted a wide variety of research projects along the U.S/Mexico border using GIS (Finco and Hepner., forthcoming; Bowen *et al.* 1995; been shared with the scientific community through journal articles, conference presentations, and these, but they have not been shared with local policy makers or the citizens of the border communities. In order to communicate these results to the border community a bilingual multimedia communication product was developed.

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A-0773

TEAM: The Texas Tech Wind Erosion Analysis Model. James M. Gregory, Texas Tech University, Lubbock, TX USA, Roel Vining, USDA-NRCS, West Lafayette, IN USA, Lawrence Peck, Texas Tech University, Lubbock, TX USA, J. Kent Wofford, Texas Tech University, Lubbock, TX USA

TEAM is a wind erosion simulation model that provides outcomes of soil movement or deposition for up to 10 sequential land segments. Land segments can vary in soil type and cover conditions. A windbreak can also be used at the end of each segment. The amount of suspended material (dust concentration) including a PM10 calculation is determined at various heights at the downwind end of each segment. The current TEAM program is being expanded to generate dust concentrations at various distances and heights for downwind estimates of dust loading into the atmosphere. TEAM is designed to evaluate soil conservation practices and to evaluate offsite damages from sediment and dust.

A-0774

Hydraulic modeling of irrigation-induced soil erosion. Theodor S. Strelkoff and David L. Bjorneberg

The hydraulics of water flow in furrows are predicted for individual events by the experimental simulation software, SRFR, 400 series. This is accomplished through numerical solution of the unsteady equations of mass and momentum conservation coupled to generally applicable empirical equations describing infiltration and soil roughness and to a known furrow configuration and inflow hydrograph. The result is a grid of points, in distance down the furrow and time, at which water velocities, depths, and boundary shear stresses are known for the event. Selection of appropriate field values for the infiltration and roughness coefficients yields infiltration distributions and runoff in agreement with measurements. The hydraulic flow characteristics are coupled to site-specific empirical determinations of soil erodibility, and to general empirical sediment-transport relations, and general physically based deposition theory to yield estimates of soil erosion, flux, and deposition at various points along the furrow as functions of time. Total soil loss off the field and ultimate net erosion and deposition along the furrow follow. At this initial stage of the investigations, a single representative aggregate size is assumed adequate for the analysis. The results are compared to measurements of sediment concentrations in the furrow quarter points and in the tailwater. For a given representative aggregate size, the results are heavily dependent on the choice of transport formula. The Yalin (1963), Laursen (1958), and Yang (1973) formulas are programmed for investigation, as are a variety of computational options. Preliminary comparisons suggest the superiority of the Yang formulation, with the Laursen formula overpredicting transport, and the Yalin formula substantially more so.

A-0775

Semi-Permanent Houses Threaten Termites In South-Western Uganda : What Of Their Role In Natural Soil Conservation And Productivity? Bakuneeta, Christopher, Department of Zoology, Makerere University, Kampala, Uganda

In a study carried out in Queen Elizabeth and Lake Mburo National Parks by the author, termites and their termitaria were noted as keystone species in the savanna ecosystem of the two National Parks. In addition to housing the termites, the termitaria formed a refugia for both trees and animals. The study highlights their role in biodiversity conservation and recommends for their conservation in and outside Protected Areas. However with increasing deforestation in the countryside, most people are finding it cheaper to build semi-permanent brick houses than wooden houses. Since clay (the main soil type for brick-making) which used to be in "no-man's land" is now owned (e.g. fenced), people in south-western Uganda have resorted to making bricks from termitaria soils as these contain more clay than the surrounding soils. This is a new development in the region that is not only threatening Macrotermes as the main, large mound-building termite species but also soil productivity which the termites have been promoting and sustaining. According to the author, the threat to the termites might indirectly threaten the high food productivity (matooke, milk and beef) which south-western Uganda has been supplying to the capital city and its surburbs. The paper recommends for immediate applied research so as to advise the Government on what action to take.

A-0777

Changing land Use Patterns and Constraints to Sustainable Land Management in the Degraded Landscape of the Irangi Hills, central Tanzania. Richard Kangalawe and Carl Christiansson, Environment and Development Studies Unit School of Geography, Stockholm University, Stockholm Sweden.

This paper presents experiences from studies on land degradation in the Kondoa Irangi Hill, Central Tanzania. Characteristics of this area is severe soil erosion marked by spectacular gullies and extensive sand fans. The main land-use of the area has traditionally been arable agriculture and livestock keeping. Because of high population pressure, the land resource has at least since the turn of the century been highly fragmented and over-utilized for cultivation and grazing, resulting in pronounced land degradation. Degradation has rendered large areas of land unsuitable for agricultural activities. The emphasis of this study has thus been to examine the diversity of actions and approached that the local community had taken to deal with land resource management in general and degradation in particular and how sustainable such undertakings have been. To address the issue of sustainable land management in such environment the paper attempts to first look at how land degradation is perceived by the local people. It also focuses on key indicators that are used by farmers to determine the quality and suitability of their land resource for various uses. Experiences from this study have shown that the local people in the area are well aware of the phenomenon of land degradation. The latter is reflected by the evident soil erosion features e.g. deep gullies, extensive sand fans due to sedimentation in low lying parts of the landscape and declining soil fertility in agricultural fields. Examples of local people's actions to cope with land degradation include (i) attempts to use even the rather infertile sand fans (ii) temporal or permanent movement to new areas (iii) adoption of new crop varieties while abandoning some old ones (iv) surviving without livestock, and (v) increased concerns on land conservation measures in their agricultural system. The severe land degradation inspired both Tanzania's pre- and post- independence governments to introduce several land conservation measures to remedy the situation. Among such measures were population resettlement to relieve pressure on the overpopulated areas, for example, from the Kondoa Irangi Hills to the Maasai plains (in the east); forest clearance during the tsetse fly control campaigns in the mid 1920s to 1950s; construction of soil conservation structures such as contour bunds; and planting trees and sisal along contour lines. Experience indicates that such conservation measures were not all received positively, neither did all the local people participate in their implementation. The paper analyses these conditions. It further looks into some of the land management strategies that are today being implemented by the local people. Finally, the paper looks at the various constraints that have, over decades, slowed down and/or hindered local people's active participation in taking necessary actions towards sustainable land management and conservation initiatives.

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A-0778

Impact of Twenty-four Years of Conservation Tillage on Yields and Physical Properties Of a Poorly Drained, Silty Clay Loam Soil. Gary C. Steinhardt, Terry D. West, David A. Gehring and Tony J. Vyn

Long-term tillage plots were established at the Purdue University Agronomy Farm in 1975 to compare the performance of four different tillage systems on a poorly drained Chalmers silty clay loam (Fine-Silty, mixed , mesic Typic Haplaquoll.) These plots have been planted each year through 1998. The four systems used are: moldboard plow in the fall, chisel plow in the fall, ridge-till and no-till. The cropping system has been continuous corn, continuous soybean, corn/soybean rotation and soybean/corn rotation. Weeds are controlled with herbicides and in the full width tillage systems with cultivation. Weed escapes are controlled to the extent possible, so that tillage is the only variable in the study. On this poorly drained soil, full width tillage has a decided advantage over no-till with continuous corn. Yields for corn in rotation with soybean are higher than continuous corn. Yields for corn in rotation planted no-till are closer to the yields of the full width tillage. Soybean yields for rotations are higher than for continuous soybean. Yields for no-till planted soybean is close to those for full width tillage regardless of rotation. Soil physical properties have been studied by a recording penetrometer. The non-tracked areas between rows for no-till are very comparable in penetration resistance to full width tillage. Tie tracks through the plots have much higher penetration resistance.

Gary C. Steinhardt

A-0780

The Effect of Soil Chemical Properties on Six Months Growth Performance Of 16 African Provenance's Of Faidherbia albida A. Chev. At Noiweit in Semi Arid Baringo District Of Kenya. O.G. Dangasuka, Department of Forestry, S. Gudu, Department of Botany and J.R. Okalebo, Department of Soil Science, Moi University, Eldoret, Kenya.

Variation in soil chemical properties is one of the environmental factors which normally influence provenance evaluation, and its knowledge is often useful in assessing performance of provenances. Field trials of 16 African provenance's of F. albida was set

up at Noiweit in April 1997. Tree height, stem collar diameter and branch number were measured 6 months after transplanting seedlings into the field and the soil pH, C, N, P, Na, K, Ca, Mg, Exchangeable acidity, and Particle size distribution were analysed for each of the 5 blocks. The Eastern and Southern African provenance's had superior growth performance in all traits, compared to the West African provenances. East African provenance's had intermediate collar diameter values between Southern and Western African populations indicative of the south to north clinal variation. Rama from Ethiopia was categorised among West African provenance's with regard to branch number. Overall, based on the field study, the Eastern and Southern African provenance's were completely integrated and formed a separate entity, while the West African provenance's formed a distinct group. There were significant differences (P=0.05) in the performance of the trees among the 5 blocks probably due to the observed variability in soil physical and chemical properties. The soils of Noiweit were found to be clay loam and acidic with a pH range of between 4.37 and 5.22, with adequate levels of K, Mg and Ca. Trees in block 2 had superior growth in higher total N content. Blocks 1, 2 and 3 had better growth performance, while block 4 and 5 had stunted growth which could be attributed to soil deflocculation caused by the higher exchangeable. Na concentrations as well as higher pH, Exchangeable acidity and Ca concentration in the latter two blocks. The Ca:Mg ratios in blocks 1, 2 and 3, were all about 1:2 the lowest acceptable ratio, while block 4 and 5 had a ratio of about 1:3 indicating reduced Ca availability to plants in the two blocks.

A-0781

Organisational And Human Resources Development Aspects Of Enhancing Cooperation Between People And Institutions. James Mascarenhas

Conservation and management of natural resources has been a concern in development for several decades. There exists today, however, a universal urgency to develop approaches to natural resources management (NRM) which are appropriate, low cost, and sustainable. This urgency is dictated by exploding populations in the third world, and a wide spread and accelerating degradation and destruction of natural resources by communities trying to meet their food security & livelihood needs. Consequently there is an ever increasing number of organisations and institutions, Government, Non-Government, Donor and Research and several other who are currently addressing this important issue in various ways. As a result of this engagement, conventional approaches to NRM have also undergone substantial changes. For example from merely addressing soil conservation and afforestation sectorally in the past, today more emphasis is given to integrated treatment of the land on a watershed basis. This is more comprehensive. Similar-ly, there are attempts to change from centralised and strictly target driven 'blue print' approaches to ones which are more participative, flexible decentralised, and 'process' driven. Vigorous efforts are also being made to increase the involvement of client communities in the development process, particularly with refer-ence to NRM in order to bring about a balance in what were hitherto predominantly technocratic approaches. A variety of institutions for the purpose of par-ticipatory NRM have evolved and will continue to evolve in the future, as we come to grips with the realities of following this path. One of the main features of this evolution have been the advent & inclusion of NGOs as necessary & legitimate instruments of change particularly interms of organising and enhancing popular participation in NRM programs. This initself has led to the recognition and for Community based institutions to drive and manage the process of program implementation interms of NRM/WSD programs. Once intervening agencies start to get engaged with local communities as partners in the development process, several complex-ities arising out of social, political, economic, environmental, and, pure and simple human dynamics begin to emerge and con-front them. Bringing about change also means generating new ten-sions, which have to be successfully and appropriately managed. New roles emerge for the various actors. These must be identified, negotiated and defined. It must be realised that this is not a task for anyone of us individually, but for all of us collectively. In order to be truly effective, any institutions that are created with the objective of participatory RNR must be innovative, flexible, sensitive and responsive. More institutions that are created with the objective of participatory RNR must be innovative, flexible, sensitive and responsive. More important, they must be learning organisations which are able to facilitate and enable participatory processes to take place - not only within the communities but also within the development agencies themselves. This underlines a strong need for inputs in the areas of human resources development (HRD), organisational devel-opment (OD) and institutional development (ID). Particularly important is the need to address the behavioral, attitudinal and cultural aspects of individuals, organisations and institutions. In particular, strategies must be evolved which would enhance the participation & stake of client communities in the program and also enhance their capabilities to manage the assets that are created in their habitats. This paper attempts to share some experiences in regard to the above. It does not address technical or policy aspects. Instead it restricts itself only to issues concern-ing participation. For the sake of convenience, the issues touched upon are related to the context of watershed development (WSD). However the same principles would apply to convenience, the issues touched upon are related to the context of watershed development (WSD). However the same principles would apply to other forms of natural resources such as forests or marine resources. The paper does not aim to provide answers to the problems, only to raise issues and questions that need to be addressed.

A-0783

Saturated Transport of Atrazine under Two Tillage Systems. Alton B. Johnson, Reginald D. Burks, and Arkon L. Burks, Mississippi River Research Center, Alcorn State University, Alcorn State, MS USA

Atrazine, 6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine, is a pre-emergence herbicide used for weed control in corn (Zea mays). This herbicide is considered to be relatively mobile in soils. The objective of this study was to determine the transport characteristics of atrazine in a conventional tillage system with no winter cover (CT) and a no-till system (NT) with hairy vtech (Vicia villosa Roth ssp. Villosa) as winter cover. Miscible displacement experiments were conducted on intact columns under saturated condition to quantify transport parameters of atrazine. Dispersion coefficients describing nonreactive bromide breakthrough curves (BTC) for CT were lower than NT with average dispersion coefficient for NT 5 times higher than CT. Average bromide breakthrough per volume for CT was 1.2 times higher than NT. The BTCs of NT were asymmetric, indication preferential flow in the no-till system. Peak atrazine breakthrough concentrations and distribution coefficient (K_d) for CT were lower than the no-till.

Alton B. Johnson

A-0784

Evaluation of Wind Erosion Models for Use on Military Training Lands. Edward L. Skidmore, Richard G. Nelson, and Alan B. Anderson, USDA-ARS Wind Erosion Research Unit, Manhattan, KS USA

The ability of lands to accommodate and continually support active military training and testing without serious degradation has been identified as high priority by the Department of Defense. Consequently, the Department of Defense is currently developing the Army Training and Testing Area Carrying Capacity (ATTACC) methodology. However, this methodology has not been applied to those locations at which wind erosion is the predominant erosion mechanism and, in certain instances, failure to account for erosion caused by wind under-estimated land deterioration and over predicted carrying capacity. The objective of this study was (1) to evaluate various wind erosion models according to criteria specified by ATTACC and, (2) to identify modifications to the most appropriate model(s) for use on those military training exercise lands for which wind erosion is the dominant erosion mechanism. Wind erosion models being evaluated in this study include the Wind Erosion equation (WEQ), the Revised Wind Erosion equation (RWEQ), Wind Erosion Prediction System (WEPS), Environmental Policy Integrated Climate (EPIC), Wind Erosion Assessment Model (WEAM), and Texas Erosion Assessment Methodology(TEAM). Each model is being evaluated according to criteria suggested by ATTACC which includes the science behind the model, temporal and spatial domain of the model, erosion processes modeled, model accuracy with respect to "real-world" situations, input data requirements (availability and cost), domain of use, potential for further enhancement and long-term support. A sensitivity analysis comparing the selected models is in progress and will be reported at the Conference and submitted for inclusion in the Conference Proceedings.

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A-0787

Effect of Ration of Exchangeable Ca to Mg on Soil Clay Flocculation, Seal Formation and Infiltration. Katerina M Dontsova. and L. Darrell Norton, Purdue University, ARS-USDA, West Lafayette, IN USA

There is evidence that Mg can have negative effect on soil physical properties, when its concentration is relatively high comparing to Ca. This fact is generally accepted for sodic soils. However, even for soils that do not have sodic properties there is also a possibility for deterioration of soil structure due to Mg. Some of the consequences include surface sealing, decreased infiltration, increased runoff and erosion during rainfall events. High Mg concentration in soil solution can be natural or induced by input of dolomitic limestone. In this paper, we studied the influence of modified Ca/Mg ration on surface sealing of four soils varying in organic matter content, clay content and mineralogy from the US Midwest. Part of the study was a laboratory experiment in which flocculation behaviors of soil clays were studied at difference Ca/Mg ratios and solution electrolyte. We also modified Ca/Mg ratios of bulk soils and measured infiltration, runoff and soil detachment under simulated rainfall. Samples of the surface seal were taken after the rainfall and thin sections were prepared and analyzed. This study showed that Mg has a specific effect on soil clay flocculation and surface sealing due to different hydration behavior than Ca. There was a good relationship between Ca percentage on the clay surface and in solution and optical transmittance of clay suspension as an indicator of clay flocculation. In rainfall experiments Ca-treated well-structured soils had final infiltration rates two times greater than Mg-treated soils, total infiltration was increased significantly as well. The Ca treatment decreased soil losses to half of those from Mg treatment. Thin sections of the surface seals showed evidence of greater aggregate destruction and clay translocation under Mg treatment.

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A-0788

On-farm Assessment of Contour hedges for Soil and Water Conservation. Samson Angima, Mick O'Neill and Diane Stott

This is an ongoing study to assess the impact of contour hedges on soil and water conservation under direct farmer management practices at the Kianjuki catchment area. Twelve runoff plots (six on 20% slope and six on 40% slope) are arranged on two terraces on two farms. There are two treatments with three replications for conserved and non-conserved plots. Data for three rainfall seasons indicate more soil conserved by hedges than the non-hedged control on both slopes. For the three seasons 1997 long rains, 1997 short rains and 1998 long rains, a seasonal average of 120 t/ha of soil were lost from the conserved plots compared to 157 t/ha for the control plots on the 20% slope. For the 40% slope 118 t/ha of soil were lost from the conserved plots compare to 151 t/ha of soil for the control plots. The advantages of using hedges as conservation strips were observed for both soil loss and fodder production. An average of 3.4 t/ha of fodder for the 1988 long rains season were harvested from the conserved plots at no loss in maize yield (average maize yields for both treatments were 2.7 t/ha for the three seasons). As part of integration of agroforestry practices towards soil conservation, these results reflect a support practice subfactor of 0.99 for the 20% slope and 0.98 for the 40% slope on a scale of 0-1 (where 0 is more soil conserved and 1 no soil conserved), for use in soil erosion prediction using the Revised Universal Soil Loss Equation (RUSLE).

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A-0789

Effect of Agricultural Management on Runoff and Soil Loss in Nicaragua. P.Strauss, Federal Agency for Water Management, Institute for Water and Land Management Research Petzenkirchen, Austria, A. Mentler, M. Pfeffer, Institute for Soil Science, University of Agriculture, Vienna, Austria and G. Murillo Malespin, Universidad Nacional Agraria, Managua, Nicaragua

Soil degradation by water erosion is a major agricultural and environmental problem in Nicaragua. In contrast to the high risk of soil degradation only limited data to quantify this phenomenon exist. One of the main areas of public interest is the waterhsed „Cuenca Sur" , which drains directly into the capital Managua. Economic pressure has led to increasing agricultural use during rainfall events. To evaluate the effects of traditional agricultural use on soil loss and runoff amounts and prove the applicability of the USLE as a tool for erosion management planning, we conducted a three-year plot study. The experimental design consisted of six plots (22.1 m x 2m) with corn, beans and bare soil. Corn and beans were grown in rotation for „ primera" and „ postera" each year and managed traditionally. The Soil can be characterized as Durisol (FAO), exhibiting a duripan layer, locally known as Talpetate, at a depth of about 25 cm. Mean soil losses were measured to be 60 t ha $^{-1}$ a^{-1} for corn and 130 t ha^{-1} a^{-1} for the bare plots. Thus tolerable limits of soil loss were exceeded by far. While soil losses of beans were higher in the first growing season (primera), corn and bare plots exhibited higher soil losses in the second growing season (postera) of the year. High soil losses of the plots in the primera were the result of extreme rainfall events which occurred regularly only few days after planting. These events caused large rills in all plots which were responsible of more than 60% of total soil losses of a year. Due to the limited data of the study only preliminary examinations of USLE K-factor values could be done. Anyway, a comparison of measured and calculated K-factors revealed that calculated K-factor values were about 10 times higher than measured K-factors. Rainfall threshold values for runoff initiation were observed to be above 10 mm of rainfall which is in the same order of magnitude as suggested by the USLE. A linear relationship (correlation coefficients between 0.8 and 0.9) between R-factors and total soil losses of single events could be found. Use of the Hudson-index could not improve this relationship.

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A-0790

Effects Of Terraces, Grass Strips And Tree Hedgerows On Land Production On Steep Slopes In Cetral Kenya. Joseph N. Mwangi, Joseph M. Miriti, Joseph M. Mutua and Francis J. Musembi, National Agricultural Research Centre, Muguga, Nairobi.,

The effects of three soil and water conservation practices on land production in central Kenya were studied on a field site of nitosol, bimodal rainfall and ground slope of 22 percent between 1996 and 1998. The treatments in this study were *Calliandra calothyrsus* hedgerows, forward sloping bench (Fanya juu) terraces, Napier grass *(Pennisetum purpureum)* strips and a control each replicated three times in a completely randomised design in plots of 6xl9m. Napier grass was grown on the terrace embankments to stabilise them and maximise on land use. Land production was quantified in terms of maize and fodder yields where applicable. The effective maize cultivated area in the terraces, Napier grass strips and *Calliandra calothyrsus* hedgerow treatments reduced by 22, 14 and 12 percent respectively. Fodder yield from the terraces and Napier grass strips was 11.9 and 23.4 tons/ha respectively. There was no fodder harvested from the *Calliandra calothyrsus* hedgerow treatments. The maize yield from *the Calliandra calothyrsus* hedgerow (2.82 ton/ha), the terrace (2.34 ton/ha) treatments and the control (2.24 ton/ha) outyielded the Napier grass strips (1.60 ton/ha). These results can help the small-scale farmers practising mixed farming on steep slopes in Kenya to decide which soil and water conservation practice to adopt depending on whether they want to grow more fodder than maize or vice versa.

Joseph N. Mwangi

A-0791

Community Conservation Lessens Impaets of Hurricane Georges. Manual Paulet, IICA, Sede Central, Costa Rica.

In September, 1998, with east-west trajectory through all its length Hurricane Georges passed through the Dominican Republic. Winds were not in excess of 200km/hour, but, the trajectory, the slow speed of displacement over the land and subsequent rainfall about 3OOmm in less than six days- originated landslides, erosion and flooding without precedent even compared to previous more intense events. In December, 1998, an USDA/IICA mission together with members of the national agricultura and hydraulic resources organizations toured around the critical areas to appreciate the impacts on soil and water. Evidence was observed that there are inevitable impacts of such events. Yet, significant damage was observed from runoff or erosion precipitated from lands which showed the cumulative deteriorating effects of year after year missmanagement of lands, not only this hurricane or any particular stonn. In communities like the municipality of San José de Ocoa with integrated conservation programs sustained for more than twenty years there was less significant damage observed. It is desired that the evidence left by Hurricane Georges will help make people aware of the need to adopt sustainable integrated soil and water conservation programs.

A-0799

Soil Conservation Policies In The State Of Parana, Brazil: The role of agricultural research to attain sustainability. Osmar Muzilli, M. Sc., Agronomist, Soil Scientist. IAPAR - The Agricultural Research Institute of Paraná. Londrina, Paraná, Brazil

The State of Parana is located in the Southern part of the South American continent, being part of the main common market center of South America - called Mercosul - which encompases 100 million people in four countries and it is the Continent's principal consumer market. The Tropic of Capricorn pass through the Northern part of the State and, in this situation, the climatic conditions in Parana range from Tropical to Sub-tropical and Temperate zones, with temperatures ranging between 30 to 80 F. The Sub-tropical and Temperate Zones get frost in the winter (from June to September). Parana's relief consists of a narrow coastal plain, which is separated from the interior of the State by an abrupt wall - The Serra do Mar mountains. At west side of the mountains there are 3 successive plateaus. More than half part of the State is above 2000 feet in altitude. A very fertile soil, derived from basaltic rocks and covering almost 40% of the Parana's area made possible, in the span of half century, to reach a diversified and productive agriculture. Since the beginning of the colonization, started about 70 years ago, the Tropical zone of Parana was a main world coffee producer, reaching almost 2 billion coffee trees in 1975, when a very severe frost killed all coffee plantations, leading to many changes in the agricultural economy of the State as a whole. As a result, Parana's agricultural profile changed to a mechanized cropping systems, based on soybean or corn growing in the summer season followed by wheat in the winter season. In the Sub-tropical zones, the land occupation consisted on cleaning

large areas originally covered by forest or native pastures, which were rapidly replaced by the mechanized cropping systems, following the Green Revolution model based on modern inputs and technology use. In the initial stage of the mechanized cropping systems expansion, the conventional tillage procedure consisted on burning the wheat crop residues with fire after harvesting, followed by intensive use of heavy disc harrow disc, promoting strong soil surface disagregation, as a traditional practice for crops stablishment. The presence of compacted layers bellow a disagregated soil surface was a common problem caused by intensive mechanization, restricting root development and crops stablishment, reducing the water infiltration capacity and facilitating the soil runoff even in heavy clay soils derived from basaltic rocks. As consequence, soil erosion became a severe problem in most parts of mechanized areas in Parana. In the short-term, the seeds, herbicides and fertilizers lost by erosion resulted in additional costs to farmers. In the long-term, agricultural and environmental sustainability decreased. Terracing and planting on contour lines were, at that time, the main strategies adopted by farmers to control the soil erosion caused by the heavy rains occurring in the same period seedbed was being prepared. These practices were promoted at farm level by the extension service, according to the existing technologies, as a first soil conservation programme - the PROICS - supported by the State Government in 1969. IAPAR - the Agricultural Research Institute of Parana - was established in 1972, as a State government agency encharged to promote applied research for technology development on scientific base, to provide support for sustainable agriculture in Parana. Looking for a better soil management strategy, IAPAR was the Brazilian pioneer research institution to develop no-tillage systems, as a key point to ensure sustainable agriculture in the Tropical and Sub-tropical zones. An important part of the strategy to ensure success with no-tillage in Parana was to design cropping rotations systems based on soybean and corn growing in the summer period, followed by wheat or winter crops such as oat - or summer legume crops such as *Crotalaria* - as soil cover crops in rotation with the summer cash crops. After 15 years of experiences, the benefits of cropping rotations under no-tillage were confirmed by an increasing in the average yields of soybean and corn at lower costs, improving the profitability of the farming systems. The combined effects of crop rotations with cover crops in no-tillage systems, showed a better protection against raindrop impacts on soil surface, an equilibrium on soil temperature improving, as consequence, the moisture retention in the soil surface layers and a better water infiltration in the soil profile, leading to stable mechanized cropping systems even on ondulated landscapes, susceptible to erosion hazards. After 1985, IAPAR was also pioneer in developing no-tillage cropping systems based on animal power traction, actually adopted by almost 3 thousand small farmers in Paraná mainly to save labor in the field operations. All these research efforts were done in straight cooperation with farmers, through long-term on-farm trials, in order to adapt and validate the technology according to the different agroecological and socioeconomic circumstances. The research advances provided by IAPAR on soil and water conservation and farming systems development, were the main technical support for a land management programme on mechanized areas at the watershed levels in Parana - the PARANARURAL Programme. A main task assumed by IAPAR in this Programme was to participate in the development of soil management and conservation strategies and to provide training courses to the extensionists, in order to make them able to organize and establish integrated land management plans within farmers at watershed levels, focusing on farming systems approach for the different agricultural zones. Since 1987, the PARANARURAL Programme has been run by the State government with financial loan coming from the World Bank. The Programme was recognized by FAO as one of the best efforts towards agricultural sustainability in the Tropical and Sub-tropical areas, focused on soil and water management, which covered a total area of 6.9 million ha in the State of Parana and benefit some 280 thousand farmer's families in a period of 8 years.

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A-0800

Soil Protection Policies in Europe - An Overview. Dr Bernd M. Bussian, Federal Environmental Agency, Berlin, Germany

Within Europe a variety of policy approaches is found to protect soils. It is evident that despite very different attitudes in the individual European countries concerning issues and problems of soil protection and despite different types, extent and depth of measures, instruments and regulations on soil protection, there is a general fundamental understanding of the medium soil as a resource that needs protection. In December 1999 in Bonn, Germany the participants of the International Workshop „Soil Protection Policies within the European Union" agreed that soils are finite, increasingly scarce and non-renewable resources with varying biological, chemical and physical properties. These should be protected and preserved as such and together with other environmental media in order to maintain the soils important ecological functions and their functions related to human health, human activities, groundwater protection and food production. Soils are subject to reversible and irreversible damage which should be reduced, and wherever possible avoided in order to limit the risks and dangers for soils and soil functions. The existence of contaminated sites shows that the use or exploitation of natural resources such as soils can have adverse consequences even if they are not immediately evident. The importance of soils and their protection has been recognized globally and continentally and guidance have been developed for their protection by a number of international initiatives, declarations, conventions, and action programs. On the level of the European Union a range of measures promoting soil protection have been adopted. On the national level there is a multitude of actions by the EU member states and by other European countries. A specific situation is found in those countries that have a soil protection act. The German soil protection act may serve as an example for these cases. In view of the continuing deterioration of soils in Europe, there is a need to start and improve such soil-related activities and to develop a comprehensive approach in order to co-ordinate and, where appropriate, combine elements from the existing measures. The Bonn-workshop also stressed the importance of international action to facilitate information exchange, joint research, monitoring and reporting, etc. The presentation will give a synopsis of the different approaches within Europe to protect soils at a legal level and will refer to the German soil protection act. An report of the concerted activities on soil protection within Europe will be given.

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A-0802

Changes in Sandy and Loamy Soil Structure and Protection of Natural Soil Function by Sustainable Agricultural and Using Municipal Waste Biomass in Urban City Areas Berlin-Germany. Dr. A. Karim Rakei, College of Soil, Berlin/Germany

The soils Site of arable land of Berlin as cultivation function of Food Production is providing/after many year and soil nursing/attendance and addition municipal waste Biomass like Fertilizer, suffice supplying with the Macro-Nutrition N-P-K-Mg. Using rate is 1-2 kg/m2/Year. The result of this soils Site is a significant changes in the soils structure of sandy Sand and loamy Sand site. The grow of Plant-Biomass responsibility part of Waste Biomass from private Homes and Green Fields areas and community Parks are suitable like Fertilizer and must to stop resp. be change the using mineral Fertilizer/manure using of especially P-, K- and Mg-Element. The statistical rate for optimal Using rate in the waste Biomass is-Nutrition Combination 5:5:10:5 (N:P:K:Mg). With using Limestone ascend/increase especially, Ca-Mg- Content and soil water Capacity and regulation of soil acidity again. Conclusion: -Recycling waste Biomass from private Homes and Green areas and Community Parks. Stop the using mineral Fertilizer and No-name soil conditioner matter. -One step near to natural land using with Ecological and Economical Consequences in the City area. –One step near to biological Food production. -Reconstruction the natural nutrition cycle in the area.

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A-0804

The Degradation of Soils and Vegetation in the Mediterranean Mountains. K. Mediouni and N. Yahi

The Mediterranean Mountains soils and vegetation are generated by climatic changes occasing since the pliocene 40000 Bp and stabilizing at the neolithic 6000Bp. The dryness and the increase of temperature did not change fundamentally by the light rains occurred later. The actual edaphic conditions result from past and present anthropic influences. The vegetation is mainly thermophil and the soils vary from the red fersialitic to the rendziniform, lithosols, etc. All of them are sensitive to the erosion factors. In the examples cited, the stopping of pedogenetic activities, the edaphic regression are accompagned with regressive transformations of vegetation in successful ???? processes induced by frequent and violent fires. The result is the reduction of bioecological potentialities of forest and pastoral resources. The degradation from the cedar forest to the therophytic and geophytic lawn is simultaneously related to the reduction of horizons and the complete departure of soil Edaphic sequences of passage from brown forest soil to are exposed in parallel with regressive successions of forest phytocenoses until rupicol therophytic lawn. The degradation by fires generates synusial formations built by massive and rustic pyrophytes that have ??? capacity of multiplication. These diachronic processes of vegetation regression along north south transect. The climatic pejoration due to the continentality appear through the progressive installation of nano and hemi-cryptophytic low species with sectoral distribution but having stenoic ecological characters. The parallelism between soil and vegetation through the action of fires is due to the sylvopastoral activities. Some pastoral practices are used which reduce lignous vegetation density and substitute them by palatable herbaceous in order to ease he acces of flocks to the different pastures. The sociocultural practices being are proposed.

A-0805

The Precision Agriculture Education Network. Robert Welch, Assistant Professor, Lansing community College, Lansing, Michigan USA

A precision agriculture education network is being developed by community colleges in the Midwest, which will be disseminated across the country. Lansing Community College in Lansing, Michigan, in partnership with Hawkeye and Kirkwood Community Colleges in Iowa are developing a precision agriculture education network. The network with the three schools in the lead involves other community colleges, high school programs, business, industry and universities. The National Science Foundation Grant in Precision Agriculture has allowed the schools to launch an extensive curriculum development and dissemination program. Workshops and seminars in cooperation with industry and state agricultural associations are being held in a six-state area. Programs

for educators and industry advisors are being developed and offered across the country. Lansing Community College in Lansing, Michigan has established the Michigan Precision Agriculture Network and is developing an active web page and national newsletter featuring precision agriculture education and technology developments. The Network partners are numerous and growing as technology develops. Learn how you can be part of this developing network.

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A-0807

Participatory soil and water conservation in India-experiences from the KRIBHCO Indo-British Rainfed Farming Project. Paul D. Smith, Centre for Arid Zone Studies, University of Wales, United Kingdom

Serious soil erosion in the hill areas occupied predominantly by tribal peoples in India has long been recognised. The erosion stems partly from widespread deforestation, and the increasing population pressure that force farmers to cultivate more marginal land and to abandon traditional conservation methods such as green manuring. All farmers report that yields have declined drastically over the half century. Though there have been some attempts to initiate soil and water conservation activities, most have adopted a very top down approach and with a perception among farmers that interventions had been taken out of their hands. "Participation" amounted to agreeing to do the work and the sense of ownership has been low which has effected maintenance of physical works. The KRIBHCO Indo-British Rainfed Farming Projects (KRIBP (West) and KRIBP (East)) have developed participatory approaches to natural resource management in general and soil and water conservation in particular. The projects are funded by the UK government and the Government of India and are being implemented by KRIBHCO, is a national fertiliser co-operative. It was found that hamlet level savings and credit groups of 20 to 30 households were effective units on which to base soil and water conservation and other natural resource management activities. Participatory approaches were used in group level planning, implementation and evaluation. Examples of some of the PRA techniques used are presented. There are still unresolved issues related to the payment of subsidies for terracing and similar work, particularly questions of equity and these are examined in full. A key factor in the success of the project has been the use of village level soil and water specialists and the selection, training and function of these are outlined. Though the project is generally considered to be a success, questions and problems raised during the implementation of the soil and water conservation activities are clearly described.

Paul D. Smith

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A-0808

The magnitude and relative importance of tillage erosion at TERON investigation sites: medium-term data from ^{137}Cs measurements. T.A. Quine, Y. Zhang, G. Govers, W. Van Muysen, J.V. Giraldez, G. Heckrath, C. Kosmas, E. Sibbesen, R. da Silva and D. Torri.

Caesium-137 (^{137}Cs) measurements have been used to investigate the spatial patterns of soil redistribution rates at sites in each of the countries involved in the TERON project : UK, Belgium, Spain, Denmark, Greece, Portugal and Italy. In each case detailed sampling was undertaken in landscapes which were considered likely to be susceptible to tillage erosion, namely rolling agricultural land subject to cultivation for more than 40 years. A 2D model of soil and ^{137}Cs redistribution (cf. 1D approach described by Quine *et al.* 1996) was used to derive separate estimates of the spatial distributions of tillage and water erosion rates from the ^{137}Cs measurments. This approach employs a diffusive relationship to simulate soil and ^{137}Cs redistribution by tillage. Water erosion rates are based on deviations between measured ^{137}Cs distributions and those simulated for tillage alone. The tillage erosion data are evaluated by comparison of the diffusion constants employed in the simulation of ^{137}Cs redistribution by tillage with diffusion constants derived in experimental investigations. The ^{137}Cs-derived water erosion data are evaluated qualitatively by examination of the spatial distribution and quantitatively by comparison with independent water erosion data, where available. Finally the ^{137}Cs-derived tillage and water erosion data are employed to assess the severity of tillage erosion at each site, the relative importance of tillage erosion with regard to on-site impacts and the synergistic relationship of tillage and water erosion.

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