Soil Conservation Issues on the United States

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Abstract: Soil conservation in the U.S. arose as a necessary response to land misuse and the natural process of erosion that had been mostly left unchecked from the opening of new lands for settlement and agricultural development. Shocking conditions early in the 20th Century stimulated corrective actions. Now, agricultural changes continue to threaten the fine balance of responsible soil conservation and severe erosion, not only in the U.S. but also elsewhere in the world. Because of its extreme importance, soil conservation is a very constructive and important topic for us to discuss. The paper we learn here can be disseminated as we move forward with soil conservation improvement and maintenance.

1 Historical overview

Historical records document the effects of soil depletion throughout the world (Hillel, 1991). Successive generations of people have often had to migrate to survive. Lowdermilk (1953) recognized that grasslands have long been recognized for their contribution in resisting soil erosion by water and wind. Soil conservation was not the main concern in the agricultural community after settlement in the U.S. As soils were "worn out," many moved on to new lands. But real concern arose over 100 years ago, with strong constructive action taken at a time of hardship. The massive erosion taking place, if left unchecked, would have had disastrous effects.

Table 1 Soil conservation terms

Conservation	the act of conserving; preservation from loss, injury, decay or waste (example, *conservation of soil*)
Era	a period of time marked by distinction in character, events, etc.
Ethic	the body of moral principles or values governing or distinctive of a particular culture or group

Legislation was enacted in 1935 to initiate the Soil Conservation Service (SCS), now the Natural Resource Conservation Service (NRCS) within the United States Department of Agriculture (USDA). The middle 1930's in the U.S. was a time of economic depression, severe drought and prolonged heat during several growing seasons, all of which led to the "Dust Bowl". Water and wind erosion of soil was rampant at that time.

H.H. Bennett, noted soil scientist, was an influential mover of the ideas and mission encompassed in the legislation enabling the SCS to be established (Table 2). At approximately the same time (1933) during the "Great Depression", an effort to stem both the tide of unemployment and the deterioration of several natural resources gave rise to the Civilian Conservation Corps (CCC). In the massive efforts to "put America back to work", young men were literally welcomed off the streets and farms to join the CCC. In large numbers they worked at a variety of conservation and reforestation projects, and they also helped with building early conservation structures, many of which were directed to soil conservation. With a wage of $ 25 per month, they were allowed to keep $ 5, with the other portion sent to the parents, where economic depression was very real. Many of those with CCC experience later were servicemen in World War II. Following the massive actions of the 1930's, H.H. Bennett characterized the situation as he looked back in 1939 "-- soil erosion problems arising from a false philosophy of plenty, a myth of inexhaustibility".

Table 2 Soil conservation service (SCS), 1935
(now the Natural Resources Conservation Service (NRCS)

"We had already ruined approximately100 million acres of land for practical cultivation. On another 100 million acres, from one half to all of the topsoil had been lost at that time".
H. H. Bennett, renowned soil scientist, in 1935

2 Erosion at work

Erosion by wind and water is a natural geologic process that shapes the land. Dramatic landmarks like the Grand Canyon result. Erosion also destroys as it grinds away shorelines and causes massive mudslides. In terms of the permanence of agriculture, one of our greatest natural assets, soil erosion represents a great loss. Soil erosion is accelerated with "people use". Lands under transition, like construction areas known as "off-site erosion", are especially susceptible, but usually short in duration. Erosion from agricultural land is a less visible soil loss. Gullies and ravines appear only after many years. At USDA's SCS beginning, there were limited data as to the actual losses from any specific piece of land. This was soon made public, and today these damaged lands are on display in dramatic photographic histories where we all can see the losses.

Up until 1950, much land had been plowed. In particular, the strong demand that fostered good prices for grain was met by the extensive plowing of the prairies. The native sod was difficult to break, but once accomplished, it was productive for a time. As the difficulties of drought and hot weather of the 1930's came on, the open prairies, both individual and collective, spawned "dust bowl(s)" (Table 3). When the westerly winds carried dust from the prairies into New York City, large masses of people became very alarmed. It was a combination of factors, including the dust storms, that prompted the U.S. legislature to act in 1935.

In the noted dairy state, Wisconsin, a state with a healthy proportion of grassland crops, productive agricultural soils had an average annual erosion rate of 6.8 tons per acre in the late 1980's. This exceeded the acceptable loss of 5 tons that the NRCS had set. Conserving of this soil is very necessary, because the soil resource is only slowly renewable (to replace topsoil, 25—1000 years are required to build one inch). The 14—16 inches of topsoil estimated to be here in 1860, has now been reduced to about 6-8 inches. Even at this rate, an inch of topsoil would be lost in 30—40 years on sloping land.

Table 3 Mechanical Era, 1920—1950

Boom and bust, 1920's
Depression and begin to recover, 1930's
Drought and the "**Dust Bowl**", mid 1930's
World War II –global awareness shock

A rebirth in broader thinking about the environment was occurring as well. One of the forward thinkers was the noted wildlife specialist, Aldo Leopold, who wrote about the "land ethic" in 1949, in the *Sand County Almanac* (Table 4)

Table 4 Soil conservation, and the Land Ethic

land ethic "We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong , we may begin to use it with love and respect. There is no other wayfor land to survive the impact of mechanized man--"
Aldo Leopold, noted conservationist, in 1949

Following from the broader thinking of Leopold and others, a new look at conservation was developing. Yet the economics on the farm were such that the farm's soil conservation measures were deemed to be too costly when making grass cropping operations less efficient in the use of labor and machinery. Many farmers chose, or were forced to alter, their conservation practices. They ignored any potential decrease in land value because of soil erosion.

It was known that the perennial forage grasses and legumes were very effective in controlling erosion. The runoff studies conducted experimentally showed that the soil losses from a sloping corn field could be 100 times greater than losses from a field of similar slope but held in place by an established forage crop. Basically, the SCS (now NRCS) had cautioned that land having a 12% slope or greater should not be used for any type of crop that does not provide for complete, continuous coverage of the soil unless special soil conservation practices such as strip cropping or terracing are adopted. Studies were shown where a 5-inch rain in the state of Ohio caused 20 tons per acre soil loss from a plowed area that had less than a 10% slope. Where corn in an adjacent field had been planted into a herbicide-killed sod, soil loss from the same storm was 100 pounds per acre.

In Iowa, some interesting research reported by Timmons and associates studied progress in reduction of soil losses over time. The 21.1 tons per acre of annual soil loss in 1949 had been reduced to 14.1 tons per acre per year in 1967. Farmers had not achieved the 5 tons per acre per year goal. They cited the disregard of soil loss minimums and suggested the cause to be the need for income, sticking to custom, inertia in action, dislike of terraces making for inconveniences in farming, and failure of absenteee owners to insist that the renter use soil-conserving practices. Timmons made the observation that farmers felt they were doing a better job.

Other observations were made, as reported by Grant (1975). In Western Iowa where hilly land and loess soils make erosion an ever-present strong possibility, it was common to see alfalfa being plowed under in order that more corn could be grown. Surveys were conducted that covered 8 to 9 million acres where land had been converted to row crop production in 1973 and 1974. More than one half, i.e., over 5 million acres, had inadequate conservation and water management. Of these 5 million acres, 4 million acres had inadequate erosion control. Soil erosion rates were over 12 tons per acre per year. Some losses reached 25 tons per acre per year. With specific reference to midwestern agriculture, Brink and others wrote in *Science* (1977) "Five watersheds in southwesternWisconsin were examined. In 70% of 93 quarter sections, soil losses were two times that considered compatible with permanent agriculture".

Solid data over time would seem to "carry the water" necessary to continue the good work, but not so in the outlook of Trimble and Crosson (2000), writing in *Science*, and questioning whether or not the U.S. soil erosion rates are as sound as most people believe. The arguments are raging over this question, but let us hope that the questioning does not hinder the proven beneficial efforts of the past, nor dampen the needs of the coming generations. To err on the side of ample or better than ample soil conservation in the future would seem better by far than to err by backing off from that effort that has since1935 restored in large part the valuable resource, soil, in the U.S.

3 Soil erosion being checked

As the cropping patterns changed with less dependence on crop rotations to benefit the soil system (Table 5), it became necessary through other corrective measures to both control erosion from wind and water, while at the same time maintain soil tilth.

Table 5 Chemical Era, 1950—1980

Good post war economy
Fertilizers a great buy; herbicides and pesticides in
Row crops with big expansion
Conservation tillage for row crop land
Agriculture intensified, land pushed to overuse
Conservation out of style
Grassland agriculture holding its own

From the standpoint of maintaining fertility and productivity, a combination of rather common practices evolved. They were: (1) suitable tillage, (2) correcting the soil acidity in the humid areas, (3) replacing the nutrients lost through cropping, leaching, and erosion, (4) maintaining the supply of organic matter, and (5) using such measures as contour planting, strip cropping, terracing, and grass waterways to control erosion where rotations and cover crops were not sufficient.

Each of these common practices have sensible Best Management Practices (BMP's) that fit local soil conditions. For example, organic matter is a very important factor. The paper by Wedin and Hoveland (1987) indicates that with the large tonnages of straw from grain produced, there certainly should not be burning when the organic matter is needed for the soils.

Out of the mix of cropping changes and the needs to control erosion, the concept of *conservation tillage* started. *Conservation tillage* is tillage using a chisel plow, disk, or other implement designed to maintain roughness of field surface and leave most of the residues on the surface to provide suitable seedbed and weed control for the next crop. The roughness and crop residues reduce water runoff, water erosion, and also wind erosion.

In our present times (Table 6), there is once again a consciousness emerging to get cropping and grasslands into balance.

Table 6 Current Era, 1980—

Taking a closer look ahead
Sustainable agriculture movement gains
Environmental, ecosystems, agroecosystem
Information Age causing major changes now
Genetic engineering, precision agriculture, biotech
GRAZING COMES ON STRONG
Grassland agriculture gets attention
NRCS broadens scope

Of great importance is the fact that these concerns must be recognized at the higher levels of government. In Table 7, we note a statement in 1999 by our Secretary of Agriculture.

Table 7 Outlook for soil conservation

"Conservation challenges are mounting and intensifying more quickly than we are solving them. This report demonstrates that we must redouble our efforts to preserve farm and forest land, reduce soil erosion, improve water quality, and protect wetlands. All Americans concerned about clean water, clean air, and preserving our quality of life should come together to do more to address these conservation challenges. Stewardship of the land falls to all of us as Americans."
U.S. Agriculture Secretary Dan Glickman, 1999 USDA National Conservation Summit in conjunction with the 1999 release of National Resources Inventory

Because of the predictability of erosion, conservation efforts must be ever present. Moreover, the water impoundment structures, waterways, etc., many of which were earlier constructed, must be updated or replaced, or the gullies will return. The NRCS has spelled out some objectives for 2000 to 2005. They are: (1) to enhance natural resource productivity, (2) to enhance unintended adverse effects of natural resource development and use, (3) to reduce risks from drought and flooding, and (4) to deliver high quality services to the public.

4 Sustaining soil conservation in the "environmental" grassland agriculture

"Pastures are valuable conservers of soil and water resources. Because pasture plants are close-growing and have favorable rooting characteristics, land in pasture is much less subject to loss of valuable soil by erosion than is intensively tilled land. In addition, runoff of rain and melting snow is greatly slowed, allowing increased percolation of the water into underlying aquifers.” (Wedin, 1986). Humble beginnings indeed for the perennial grasses and legumes, but there are even bigger tasks ahead, once they have healed the wounds of soil and water erosion, and helped in stabilizing the soil resource. Let us consider how these species have helped in the past and will help in the future in soil conservation, and thereby with other resources as well.

Grassed waterways and critical area seedings Proven perennial grasses, and to a lesser extent legumes as well, make it certain that you can seed down and maintain grassed waterways and critical areas (cuts, fills, denuded or gullied areas, etc). Where grassed areas are to be maintained and properly handle an acceptable water flow, the need is great to have sound, proven species/varieties. Permanent cover requires special management in some cases as well. Adjacent to or mingled with cropped areas, there are also other interspersed areas of permanent vegetation that facilitate machinery traffic, livestock movement, and other uses. These areas are usually adjacent to or mingled with cropped areas.

A cleaner environment The use of perennial grasses as a necessity and adjunct to maintaining a clean environment are increasing. The voter - the taxpayer - the public in general--are demanding clean water and reduction in insults from wind erosion. Sediment damage near sites of erosion or downstream from these sites is not acceptable. Wildlife habitats and the visual resource are becoming much more important to the public.

Needs, Some Examples Spelled Out Using Iowa as an example of a top-ranking state in crop production, there are about 12 million acres of the 22 million acres in row crops or hay in any year which are designated as Highly Erodible Land (HEL). The NRCS assisted individual farmers to develop conservation plans (mandatory by 1995) if the farmer was to remain eligible for government support in any shape or form thereafter. At that time, NRCS in Iowa had estimated that about 500,000 acres in terraces needed to be built and seeded down. Some of the existing terraces and grassed waterways needed to be upgraded such that all acreages would be in compliance with the new regulations. It is evident that when the need of sod-forming grasses for both agricultural and the non-agricultural uses are totaled, total acreages are great indeed.

Selecting grasses and legumes to do the job Discussed in the paper “How Forages Fit Into the Cropping Systems” were the uses of many species, particularly for the Midwest area of the U.S. Widely adapted varieties for special conditions are needed in all geographic areas. For example, one company lists THE ALL-PURPOSE DURAMIX that includes smooth bromegrass, perennial ryegrass, reed canarygrass, Kentucky bluegrass, and switchgrass. Certainly, such a broad spectrum will allow some of the species to grow.

Research issues In 1990, a substantive report looking ahead was published following a major Workshop held in 1989 (Larson *et al.*, 1990). In the end they wrote as follows:

“ IN CONCLUSION Soil erosion continues to be a major problem with respect to land use and environmental quality. Our goal should be to improve soil and water management on all lands. To do this, we must match the productive capacity of all soils and landscapes with proper use”. In the complete published report, they listed the priorities for study in the nation (1) Landscape Processes, (2) Erosion and Soil Properties, (3) Productivity Changes Caused by Accelerated Soil Erosion in a Landscape, (4) Decision Aids to Implement Conservation, and (5) Technology Transfer.

Benefits and opportunities beg call for action Just recently, the American Forage and Grassland Council (AFGC) has prepared a position paper, and a much abbreviated enumeration of three potential needs: benefits areas are set forward (Table 9). For the need “*forage crop and grazing management*” a potential benefit arrived at both directly and indirectly is the “revitalization of rural communities”. Large increases are possible with enhanced management in the grazing livestock system to capture more of the energy (McClymont, 1973). His conceptual diagram depicts the “energy” into the forage: livestock system through the growth total of the primary product, in this case legume:grass. The grazing process “eaten” is at best 60 to 70% of that grown, and of that eaten, partition to maintenance of the animal (M) and product (P) (e.g., live weight gain, milk) reduces the marketable usable product more. All points of the flow can be improved and will have an influence on the final product and the efficiency all along the way.

In the second needs: benefits,*"nutrient management"* is highlighted. The benefit is environmental protection. An illustration here is the matter of certain grasses and legumes become essential for the cleansing of the environment, just as soil conservation has been to save the soil.

In the third instance, i.e., "*resource conservation management*", all natural resources used in agriculture need attention and the benefits of grassland agriculture. For example, carbon trading, as pointed out by Keeney (2001) is a good illustration in that the benefits are obtained via grassland agriculture. It has been reported that grasses held in place, holding the soil where it belongs, also have the potential to sequester 4.4% of the total U.S. emission of U.S. gases (Robertson, *et al*., 2000). Retained, cleansed soil of grassland agriculture will be a product for all of society. The compensation to these stewards of the land will somehow need to be made. And, using adopted grasses and legumes, first to stabilize the soil, then to reduce soil erosion, will, thanks to their biodiversity (Reich *et al*., 2001) bring us to the future that bodes well for the flow from soil to plant to livestock to humans.

Table 8 American forage and grassland council (AFGC) position Paper, 2001

Increased attention to Forage Crop and Grazing Management will lead to *Revitalized Rural Communities.*
Increased attention to Nutrient Management will lead to *Environmental Protection.*
Increased attention to Resource Conservation Management will lead to *Conservation of Key Natural Resources, including Soil, Water, Air, Carbon, Biodiversity, and Wildlife.*

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