Indigenous Technical Knowledge for Soil and Water Conservation and Soil Fertility Restoration in Foothill region of the Himalayas in North-West India

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Résumé
Les piedmonts de l'Himalaya au NO de l'Inde ont bien du mal à assurer la CES, un développement durable et la sécurité alimentaire. Les sols des versants sont grossiers, pauvres en MO et en nutriments ; les paysans sont pauvres et s'adonnent à une agriculture pluviale comportant une rotation maïs-blé. Les rendements en blé atteignent seulement 65% du potentiel. Le climat est sub-tropical avec 800 à 1400 mm de pluie. Les paysans ont développé De nombreuses pratiques de CES : labour avant la Mousson, bandes filtrantes, sarclo-buttage du maïs, paillage, tassement du sol sous canne à sucre, talutage des champs, terrasses, techniques capable de protéger les sols et de conserver l'eau et les fertilisants dans les sols. Ces pratiques peu couteuses, améliorées par des interventions des scientifiques demandent d'être adoptées par la majorité des paysans pour surmonter le défi.

Introduction

The part of Himalayan mountain chain, Shivaliks run in a continuous belt from Jammu in North-west to North-eastern states of India continuing through Nepal. The width of varies from a few kilometers to around 40 kilometers at different places and about 2000 km in length. The tract is dominant in Punjab, Himachal Pradesh, Uttaranchal and Jammu & Kashmir states of India. This foothill region or the sub-montaneous tract is rainfed in nature and the major occupation of the human in this area is agriculture.
The prime cause for the backwardness of the Shivalik belt is a reduction in soil fertility and productivity, due to massive soil erosion. Most of the farmers are depending on renewable natural resources for their livelihoods. For example, the inhabitants of the foothill region of North-west India have fragmented land holdings and generally resource poor. This poverty is partly due to inadequate availability of water for crops, livestock and other enterprises. However, the shortage of water is not caused by low rainfall as normally perceived but, rather by lack of capacity for sustainable management and use of available rainwater.
The climate is sub-tropical with average annual rainfall is 800-1400 mm about 80% of rain occurs in summer monsoon months and only 20 % in winter months. The farmers are economically poor and follow dry land agriculture with maize and wheat crop rotation. They are illiterate and tradition bound and little conversant with the available improved technology. Among various problems, encountered by the area, soil erosion is one of the most dominating problem in the area which aggravates because of the erratic, high intensive, short duration rainfall. There is great challenge for developmental activities including soil moisture conservation and nutrient management.
Farmers in the area had developed an innovative technology of soil and water conservation and crop production which has helped them to sustain so far. But this technology is not able

to meet the emerging challenges in ecological rehabilitation and to meet the need of fuel, fodder and food.
Farmers were ranked high in the social system and village management was in their hands. In order to manage land, water and vegetation, technical knowledge suitable to the specific conditions of a region was required. They gained this knowledge and developed skill through experience and learning by doing.
Traditional knowledge has a sound base as it has been tested and practiced over the years. It is appropriate technology in particular climatic conditions and in the living conditions of people. The indigenous practices which vary from place to place in the sub-hill region are stepping stones for development of any improved technology for soil and water conservation and crop production in the area. Efforts have been made to identify the existing indigenous practices followed by the farmers in the tract.

Methodology

The investigations in different areas of the foothills has been carried out since a long time by different agencies with a view to obtain comprehensive information on traditional knowledge of local people for soil and water conservation in relation to crop productivity in foothills of Shivaliks. The information was collected by means of informal interviews, interaction with old and young farmers, social agencies, village leaders and other agents involved in the area. In the present paper, we have tried to compile the information after thorough investigation in foothills of Shivaliks in Punjab and Jammu & Kashmir state.

Results and Discussion

Farmers' Condition : People of the area are generally poor, illiterate and tradition bound. They are little conversant with the available improved technology. Majority of farmers are poor and marginal having land holdings less than 2 ha which exist in small fragmented pieces. The farmers' capacity to invest is very limited. Inputs needed for improving soil fertility and productivity viz. fertilizers, pesticides, weedicides and improved seeds are generally not made by the farmer because of (i) uncertainty about the returns, (ii) poor economic conditions and (iii) lack of education and extension gaps.

Yield Gaps : Farmers in the area are obtaining only 2965 kg/ha of maize and 618 kg/ha of wheat on an average when there are satisfactory rains as per the survey of the area conducted by author recently. The average yield of wheat and maize in the area is about 45-80 % and 25-45 % less than that obtained in the irrigated conditions. It is found that more than 65 % lower yields were obtained in case of wheat in comparison to potential or maximum yield (Y_{max}) and main limiting factor in wheat was soil moisture/water.

Indigenous Soil and Nutrient Management Practices

Field bunding : It has been noticed that rain water is lossed which is essential for crops and in addition erodes soil, washes nutrients and disfigure farmers land. Formation of bunds is an easy, cheap and adaptive method which is supported by modern scientific knowledge to facilitate infiltration and percolation of rainwater to help soil and groundwater recharge, in addition to avoid surface runoff which often results in erosion of fertile top soil. In modern technology the proper shaped bunds with water disposal structures can be very effective.

Pre-monsoon ploughing : Ploughing the fields before onset of summer monsoon rains can make the field surface rough and cloddy, exposing more surface area for intercepting and increasing residence time for runoff. This is very economical and helps in imbibitions of rainwater into the deep soil layers and at the same time controlling pests and diseases. Reports from rainfed areas of Haryana state have proved the effectiveness of this practice in preventing soil loss apart from improving soil moisture. This practice is more effective if the farmer ploughs the field across the slope in hilly terrain.

Filter strips : Runoff from fields occasionally concentrates and run on the field in small channels called rills. Runoff from these rills, concentrate and breach the field bund at vulnerable point, where often gullies on agricultural fields develop. Gullies then cut into the fields, and these fields slowly may go out of cultivation owing to this water erosion. Automatic response of the farmer was to strengthen the water outlet point to save fields. This he did either by putting stones at the point where bunds breached or put some strong stemmed vegetation like *Sachharum munja*. Such strips are commonly found on boundaries of different fields. Filter strips are innovative cheap way of safe disposal of excess runoff from the fields. Recently efforts have been made in certain development projects to put vegetation on whole field boundaries. Farmers have objection to this on the basis: a) These obstruct to their movement in the fields, b) These vegetative boundaries harbour rodents and pests.

Haloding : It is an important monsoon season indigenous practice for maize crop. In this an inverted plough is run in inter row spacing in a month old maize crop. The practice destroys weeds, does earthing up and creates shallow ditches between the rows. The ditches intercept and detain running rain water. In addition, earthing up supports the plants, aerates the rooting zone and decrease resistance to growing roots. The practice of haloding has been found to decrease weeds, conserved water and increase maize yield by 24 per cent than control.

Soil mulching : This is also one of the refined indigenous practice used for conserving soil moisture for raising a successful winter (wheat) crop. In this practice, at maturity of maize it is harvested and the field is ploughed on the same day in evening hours. Next day in the morning hours the field is planked. During night, the exposed clods pick up moisture from cool air and get softened which easily break on planking and form fine surface soil mulch. This checks surface evaporation and conserve profile water. By creating soil mulch at the first opportunity, the farmer conserves the profile water by checking upward movement through breaking the continuity of capillaries towards the soil surface.

Hoeing, compression and mulching : Farmers in the area also grow rainfed sugarcane. The quality of jaggery made from this sugarcane is relatively better and fetches good premium in market. Practice of hoeing, compression and mulching is common in rainfed sugarcane raised during the month of February. When the sprouted plant attains a height of about 10 cm the farmer carries out inter row hoeing. He then gives a good thrashing with a wooden log/ baton, especially made for the purpose to break the clods and compress the surface soil layer. After this, the farmer spread the available organic residue on the soil surface in between the rows.

Organic farming : Farmers in most of region of foothills of Shivaliks are aware of the soil condition, i.e. low in organic matter and poor in fertility. They are also very much concerned about soil erosion, nutrient loss and water scarcity impairing crop yields. Farmers apply Farm

yard manure (FYM) obtained from their animals. But its quantity is far lower than recommended and it is only possible to apply in the fields adjoining the village. Also crop residues are also applied by many of the farmers with large landholdings which help in addition of organic matter and nutrients. The wheat crop stubbles are generally ploughed in the soil, but only when there is sufficient moisture in the soil.
In Doon valley, farmers use FYM in the fields before sowing. In lowland areas, for paddy they go for green manuring also. Use of chemical fertilisers has increased but people retain their belief in traditional methods. Farmers do not dig compost pits for the collection of cowdung, residues and garbage. Instead they accumulate the matter in heaps in the open for decomposition. The reason behind it is that decomposition is slow due to low temperature and little sunshine. In pits compost would not get ready in time. In the open rapid decomposition takes place. This practice is traditional but has a scientific basis.

Cropping knowledge : Typical situation exists in the area where Maize-wheat sequence and sugarcane is also grown on the upper slope transect and at the middle slope transect, rainfed horticulture is being practiced and however, on the lower slope transect, forestry is generally practiced. The farmers of the area are not at all using chemical fertilisers for crop production but they are practicing organic farming.

Mechanical Soil and Rainwater Conservation Measures
As per the survey by CSWCRTI, Dehradun, the farmers of Doon Valley usually construct terraces for cultivation known as *nala* with risers known as *pusata*. These terraces are small but there are many of them. In one hectare of land a farmer possesses 125 *nala*s. In these it is possible to manage rainwater. Construction of terraces depends upon space and grades of land. The farmers, with their expertise, are able to prepare fields for crop production. According to scientific recommendations cultivation is allowed to 33 per cent of land slope. But in the hills, farmers are able to make terraces from top to bottom of the mountain terrain without taking into account the land slope. With terraces they construct loose boulder retention walls (risers) by putting grass on them. These grasses keep stones and land intact.
Farmers make the slopes of the terraces inwards to check soil erosion and enhance *in situ* moisture conservation. On mild slopes farmers construct shoulder bunds to protect their lands from soil erosion and grow vegetation over the bunds, particularly grasses for binding the soil. Farmers of the hill region used to make brushwood or longwood check dams across the drainage channels for controlling soil loss by means of local materials. They are economical. Gabion walls and stone check dams are by and large cost intensive and beyond not affordable to hill farmers.
Farmers in the Doon Valley in order to train torrents use *Ipomea carnea* and *Arando donex* plants sps. as vegetative spurs, and they are found to be very successful.

Rainwater Harvesting
The region of Garhwal comes in the high rainfall area and in the lack of proper management system most of the rainwater goes waste as runoff. Farmers of the hill region have their traditional technology for making small dug-out ponds to harvest rainwater. They construct such ponds at several places and use the water for survival or for supplemental irrigation. In foothill region of Punjab and Himachal Pradesh, farmers have rainwater harvesting structures in the form of village ponds for domestic and livestock use and farm ponds for irrigating winter crops during stress. But there is need of improvement over the traditional practices where at the bottom LDPE sheets can be placed to check seepage losses.

Conclusions

All these traditional practices adopted since ages and transmitted from one generation to other, are easy, beneficial for soil fertility management, reducing soil erosion and optimum crop yields. But there is need to refine these traditional practices on scientific basis to produce full potentials and ultimately improve the soil fertility and socio-economic status of the farmers in the region.