Soil Resource Conservation Technology in Himalayan Foothills, India

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Abstract: Himalayan foothills- the Siwaliks, once known for their lush green vegetation, rich flora and fauna and perennial streams now give a spectacular look of desert with browsed bushes due to over exploitation and reckless use of land resources and over grazing. This process of desertification and ecological degradation which started about a 150 years ago and continued unabated defying sketchy solutions has remained a matter of serious concern since long.

Although some isolated efforts have been made by various agencies to rehabilitate these hills but no major breakthrough could be made. Seeing the gravity of situation the Government of India initiated "Integrated Watershed Development (Hills) Project (IWDP)" in submontane region of Shiwaliks in Jammu & Kashmir, Himachal Pradesh, Punjab and Haryana states in March, 1990 to prevent further degradation of land and to restore ecological balance in the area through multipronged approach on watershed basis.

The watershed development programme aims at preventing degradation of lands and increasing land productivity and simultaneously maintaining ecological balance in the area. In this paper efforts have been made to discuss various technologies developed and adopted for soil resource conservation in Siwaliks of Haryana under IWDP (Hills-1) program on watershed basis.

The technology which includes the water harvesting- an engineering aspect and alternative land use system - an agronomic aspect was adopted in two different watersheds representing the Agroecological zones of the *Kandi* area . The water harvesting was achieved through Hardware Treatments the first line of defence followed by Software Treatments the second line of defence. To sustain the effect of above treatments various Agroforestry Models were used as alternative land use.

The results of various technology adopted for watershed development showed that good number of small capacity WHS's were more successful in comparison to few WHS's of large capacity. Among software treatments V-ditch method of tree plantation and combination of *vetiver* and *bhabbar* (2 rows each) were more successful in arresting the erosion of bouldary and sandy soils of the project area. Sustainability of watershed development requires dispensing of "Seed & Fertilizer" - a traditional approach by adopting Alternative land use Patterns. The watershed management program cannot be achieved without people's participation. Therefore people's involvement right from the microlevel planning to equitable sharing of cost and benefits in the project is must.

Keywords: watershed development, water harvesting measures, soil working methods, agroforestry models, alternative land use, people's participation

1 Introduction

After green revolution in 60's there was sudden jump in the agricultural production which is almost stabilized. But to meet the demand of growing population the present food production may not be

* There are no Fig 2 and Table 1

sufficient in the coming years and until and unless the second breakthrough parallel to green revolution is made. This breakthrough may be possible through management practices using modern methods. But these efforts will be useless, unless there is enough good land for farming. If the top fertile soil of arable and non-arable land on which human life depends is washed away then the battle to achieve the 2nd green revolution cannot be won.

The water erosion has reduced the productivity of land in higher elevation and at the same time disastrous floods creates havoc in the lower regions as a result of sediment accumulation in the water courses and reservoirs. Soil and water resource in rainfed areas, therefore, need to be managed on watershed basis as the country still depends on rainfed areas for nearly half of its flood grain production.

The national consensus in respect of watersheds emerged in the early 80's. At present, the watershed development programme is getting headway through "National Watershed Development Project for Rainfed Agriculture". Basically, the purpose of integrated watershed management is to prevent degradation of land, and increase land productivity and to maintain ecological balance between land, water and flora and fauna in the area.

Siwaliks boardering the southern part of Himalayan mountain system were once known for their lush green vegetation. Presently, it is a conspicuous example of man made ecological degradation. The process of degradation and erosion commenced when vegetation and trees were burnt and cut; pasture over grazed and browsed the land surface indiscriminately to satisfy men's greed.

Although some isolated efforts have been made by various agencies to rehabilitate these hills but no major breakthrough could be made due to lack of integrated approach and site-specific technology. Seeing the gravity of the situation the Government of India took a serious view of the problem and initiated "Integrated Watershed Development (Hills) Project" (IWDP) in Siwaliks of Jammu & Kashmir, Himachal Pradesh, Punjab and Haryana in 1990—1991 to prevent further degradation of the hills and to maintain ecological balance through multi-pronged approach on watershed basis. *(Shanwal and Lohan, 2002; Shanwal and Panwar, 2002) . In this paper efforts have been made to discuss various technologies developed and adopted for soil resources conservation in Siwaliks on watershed basis under IWDP (Hills) program.

2 Project area

2.1 Location and watershed characteristics

The IWDP (Hills) popularly known as Kandi Project falling in the submountaneous region of Shiwaliks in erstwhile Ambala district (now Panchkula, Ambala and Yamunanagar districts) of Haryana lies between 36° 16′ 15″ to 30° 55′ 45″ latitude and 76° 47′ to 70° 45′ E longitude. Topographically the contours of the area varies from 290 meters above mean sea level in the southern most to 1,499 meters in the north-west along the Himachal Pradesh State boundary.

The Project area is composed of five watersheds, 16 sub-watersheds and 162 micro-watersheds covering a total area of 1,91,669 hectares falling in 621 villages. Markanda and Dangri area the largest watersheds occupying nearly 30 and 26 per cent respectively, of the total geographical area of the project, followed by Ghaggar (21per cent), Yamuna (18per cent) and Sirsa Nadi (5per cent) watersheds (Shanwal *et al.*, 2002).

2.2 Geology

The Siwaliks being very recent in origin are only 18.5 million years old compared to Himalayas 40 million years old, Vindhyachal 1,000 million years old and Eastern Ghats 2,500 million years old. The sedimentation of Siwaliks (Tertiary rocks) took place broadly in three cycles i.e. (i) Lower Siwalik during Early Pliocene (ii)Middle Siwaliks during Mid Pliocene and (iii) Upper Siwalik during Early and Middle Pleistocene during Himalayan tectonic upheavals (Patnaik, 1995).

The Siwalik system is a 5,000 meters thick detrital stratified mass of sandstone, sandrocks, mudstone, and conglomerates.The modern sedimentation in the Indo-Gangetic plains is very similar to Siwalik formation except that with the passage of time the later became compact and elevated due to fault and thrust movement.

The presence of conglomerates faces in the upper Siwaliks suggests that deposition took place during decreased sinuosity of the streams due to increase in gradient. Due to decrease in sinuosity with the time, the sedimentation rate increased from 17 cm per thousand years in the Lower Siwaliks to about 45 cm per thousand years in the Upper Siwaliks. This is clearly indicated by the presence of hard sand stone in the Lower Siwaliks and loose fragile mass of sand rocks and conglomerates in the Upper Siwaliks.

2.3 Climate

The climate of the project area is sub-tropical, hot and sub-humid, continental and monosoonic. Most of the year dominated by prolonged hot period from March to September and characterized by three seasons, namely dry summer season from March to June, hot and humid rainy season from July to September and winter season from October to February.

The summer months are very hot with maximum temperature ranging from 35℃ to 44℃ in May and June. Winter months are fairly cool with minimum temperature ranging from 0℃ to 7℃ in December to February. As seen from the Ombrothermic diagram (Fig.1), during eight months the temperature remained more than 20℃ and four months had 15℃.

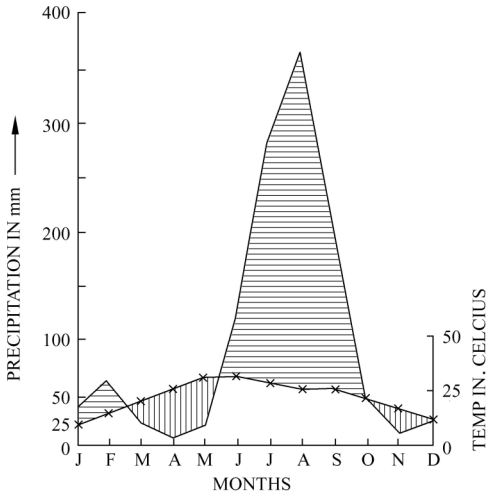

Fig.1 Ombrothermic diagram

Owing to high temperature, the relative humidity remained low from March to June (54 to 82 per cent), high (73—95 per cent) from July to September and medium in October to December (61—90per cent).

The average annual rainfall of the area is more than 1,100 mm. About 80per cent of the annual rainfall is received in four *Kharif* months of June to September (Fig.2). October, November and sometimes December are dry months, which affects the sowing period of *Rabi* crops.

2.4 Natural vegetation

The largest of the truly indigenous trees are *Khair (Acacia catechu), Shisham (Dalbergia sissoo)* and *Kikar (Acacia arabica).* The important grasses are *Bhabbar (Eulaliopsis bianata)* and *Khas (Vetivera zizanioides).* The shrub jungle consists mostly of *Phul lakri (Lantana camara), Gandhela (Murraya koenigii)* and *Jhad (Zizyphus nummularia).*

2.5 Soil and land use

2.5.1 Soils

The soils of this area are light in texture (loamy sand to light sandy loam), neutral to alkaline in reaction (pH 7.0 to 7.5), non-saline (EC<1dS • m^{-1}) and poor in nitrogen and phosphorus and responsive to zinc and potassium. Some patches of sodic soils (pH 9.0 to 10.6) are also reported near Sukhomajri and Morni hills (Dinesh *et al.*, 1988, Shanwal *et al*., 1988).

Taxonomically the Great Group Association reported by Dinesh *et al.*, (1988) and Shanwal *et al*. (1988) are Eutrochrepts-Udorthents and Ustochrepts-Ustorthents-Udorthents.

2.5.2 Land use

Most of the project area is highly undulating with slope varying between 5 to 10per cent. As per land capability classification most of the agricultural lands fall under class II and III and agroforestry lands under class IV and forest land under class V and VI.

The main land of the project area is under forest and culturable constituting about 90per cent of the total area (Table 1).

Table 1 Percent land use pattern in Kandi Project area, Haryana

Sr.No.	Land Use	Percent
1.	Forest	31
2.	Culturable	59
3.	Non-agricultural use	7
4.	Permanent pastures and grazing lands	1
5.	Barren and unculturable	1
6.	Culturable waste	1

Rabi and *Kharif* are the main cropping seasons with 50.8 and 49.2per cent, respectively of the gross cropped area. Wheat and gram are the major *Rabi* crops accounted for 24.6 and 13.2per cent, respectively, whereas, maize and paddy are important *Kharif* crops which constitute 14.4 and 5per cent of the cropped area. The other important crops are groundnut, pearl-millet, sorghum, pigeonpea, lentil, urd etc.

The horticultural crops like mango, chikoo, peach, guava, citrus etc. are also grown by some progressive farmers. In general, these crops have been neglected due to shortage of moisture. Some forest trees like *Khair (Acacia catechu), Amaltas (Cassia fistula), Jamun (Syzgium cuminii),* Mango (*Mangegera indica)* etc. are also raised for local needs.

2.6 Socio-economic status

The main occupation of the people of the area is agriculture. About 60per cent are the cultivators and agricultural labourers, 30per cent are other than agricultural labourers and 10per cent service and business persons. About 35per cent persons are literate out of which 73per cent are male and 27per cent are female.

The overall average operational holding per thousand is 2.6 ha. The operational holding shows that 6per cent of the area is in the size group of 1 ha, 21per cent in 1 ha—2 ha, 33per cent in 2 ha—4 ha and 40per cent in the group of more than 4 ha.

About 22per cent of the cultivated land is under irrigation with the help of *Cools* (ground water) and remaining 78per cent is rainfed. The average annual per capita income of farming household is Rs.2334/- whereas, the per capita income of non-farming household is Rs.1190/-.

3 Conservation technology

The non-arable lands on hilly tracks are not fit for cultivation due to slope, erosion, shallowness, stoniness and climate. However, more land can be utilized for recreation, pasture and afforestation. Mechanical measures and soil working method for establishment of vegetation are the best soil and water conservation practices on such lands. For arable lands upto class III(Land Capability classification) having 3—4 of slopes alternative land use system is adequate, but the support of mechanical measures are must on higher slopes. The various technologies developed and used for both arable and non-arable lands in the project area on watershed basis are discussed below.