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Watershed Development Initiatives in the *Shivaliks* of North India: A Perspective

S.S. Grewal[1,*]

Abstract

The degradation of the natural resource base in the *Shivaliks* of north India remained a serious problem much before independence and continued unabated thereafter. The routine soil conservation works like contour bunding, terracing, check damming and particularly *choe* training works were prioritized initially. The institutional frame work to tackle the problem was established during sixties. The watershed based technology to reverse the trend of environmental degradation emerged from the famous Sukhomajri watershed development project which clearly demonstrated that the rainwater harvested from the hilly forest watersheds and used for gravity irrigation to unproductive rain-fed lands can generate economic, ecological and social benefits to the communities which get motivated to protect the forests to which they were denuding before. The concept was replicated under the Operational Research Projects at Nada and Bunga in Haryana, Relmajra in Punjab and Behdala in Himachal Pradesh.The overwhelming success of these projects lead to the first World Bank funded Kandi Area Watershed Development Project for Rain-fed Areas (KAWDPRA) in Punjab but badly suffered from coordination problems. The World Bank then supported an ambitious Integrated Watershed Development Project Hills-1 in the *Shivaliks* of four states of north India basically to reverse the trend of degradation with cost effective package of practices and institutional development. With satisfactory results, the project was extended with revised guidelines as IWDP-II with addition of Uttar Pradesh. Subsequently, the Govt. of India Ministry of Rural Development supported Integrated Watershed Management Program (IWMP) first in the *Shivalik* district of Punjab but due to groundwater depletion problem, it was extended to 11 plain area districts. Ultimately the program was converged with the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) with major focus on water resources development Har Khet Ko Pani, More Crop per Drop. The introductory part of the paper presents the *Shivalik* ecosystem features. Taking a historical perspective, the detail of programs and watershed development projects taken up to reverse the trend of degradation has been presented. Key lessons learnt from these watershed interventions, institutional innovations, role of community mobilization have been described. Major un-addressed gaps, implementation constraints, institutional loopholes and a comparative and critical analysis of previous studies/ publications including constraints in replication are discussed. The policy implications for current and future watershed development programs are deliberated. Since the valuable information on various facets of *Shivalik* ecosystem was scattered in diverse sources, bundle of files and not put on public domain, an attempt has been made to compile for the benefit of watershed managers, policy planners, funding agencies and other stakeholders.

1. Introduction

The *Shivaliks* of north India are located below the rocky Himalayas and above the alluvial plains in a long narrow belt spread in the parts of four northern states of India namely Jammu and Kashmir, Himachal Pradesh, Punjab and Uttarakhand covering an area of 4.2 million hectare (GOI, 1998). The *Shivaliks* are considered as one of the eight most degraded ecosystems of the country The erratic distribution of rainfall, lack of irrigation facilities, limited availability of suitable land for cultivation, heavy soil erosion and fertility depletion, small and fragmented holdings, low yields, frequent crop failures, scarcity of food, fodder, fuel wood and large scale dependence and heavy biotic pressure on natural forests are the

[1]*Former Director, Regional Research Station for Kandi Area Ballowal, Punjab Agricultural University*

Corresponding Author:
E-mail: drgrewal0114@yahoo.com (S.S. Grewal)

major limitations of handicapped ecosystem. High intensity monsoon rains, undulating and uneven topography, heterogeneity of rock formations, presence of calcareous soils with high pH in pockets and high silt content and inadequate vegetation cover are some of the conditions which contributed to instability of slopes, landslides, land slips and rampant soil erosion. These low hills suffered from denudation caused by excessive human and livestock pressure.

The process of land degradation in the *Shivaliks* started about 150 years ago and has continued unabated and defied solution (Mishra and Sarin, 1987). An FAO study (FAO, 1991) has shown that success stories are few but failures are common in conservation programs attempted to stem the problem of soil erosion. The lack of success in the past was attributed to the failure of programs which attempted to treat the symptoms of the disease rather than the cause. Secondly, most of the programs were imposed from above disregarding the pressing requirements of the land users. Although the prime responsibility for arresting land degradation rests with the Government, land and water resources can be best conserved and rehabilitated by those who make their living from these resources (Bhumbla, 1976: Bajwa, 1983; Hudson, 1991).

The area once dotted with perennial springs and gentle streams got converted into a tract of ferocious torrents overflowing with muddy water and choked drainage systems with huge debris washed down from barren hills. The flood water erode banks, deposit senile sand on fertile land, inundate large areas, disrupt communication network and cause innumerable other problems down below in the alluvial plains. The unrestricted tree felling, over grazing and clearing of land for agriculture were responsible for large scale denudation of the forest. An area dotted with perennial springs and gentle streams got converted into ever widening and deepening ferocious torrent beds (called choes) which brought flash floods from the denuded hills (Holland, 1928; Grewal *et al*., 1990; Grewal *et al*., 2002).

Against the huge magnitude, complexity and diversity of the problem, individual farmers could not pick up the courage to fight the battle. The group action was missing and the rape of the hills has continued. The area is inhibited mostly by 'Gujjar' community, who are traditional graziers. They maintained large herds of cattle and goats to sustain the livelihoods. The foraging Gujjars' attacked the tiring hills with renewed vigor as they yield less and less (Bajwa, 1983). It is reported that the *Shivaliks* had thick luxurious natural forest full with wildlife and perennial streams before becoming the target of human greed. The settlements of loyal followers were attempted by the Britishers as reward for their help and support. The Britishers exploited the forest wealth for meeting the timber and fuel-wood needs of military cantonments (Holland, 1928). As more and more areas were cleared by new settlers, agriculture flourished first along the rivers and streams and then extended to interiors. The desperate search for more and more agricultural lands forced the resource poor farmers to cultivate marginal sloping lands and thus denuded the sensitive areas of their protective vegetation cover. A vicious cycle of poverty and denudation was in operation for the last more than 150 years and continued unabated.

The *Shivaliks* ecosystem is characterized by water scarcity, low and uncertain crop production, small holdings and resource poor small farm economies (Grewal, 2018). The limited access to irrigation reduces the prospects of assured economic returns to the larger section of the farming community (Yadav *et al*., 2015). Water scarcity, therefore, limits economic growth in whole of this foot-hill region. The foot-hill agriculture could not benefit much from the green and white revolutions mainly due to the lack of assured irrigation facilities. The Government water supply schemes meet only fraction of the drinking water requirements. Traditional ponds, wells and springs, the traditional common property resources are not being maintained due to lack of community involvement.

Most farmers depends upon livestock to supplement low farm income but then face acute fodder shortage and hence depend upon illicit grazing in the nearby forests causing problems of denudation (Bhumbla, 1976). In the high risk farming, the use of recommended inputs is made very hesitatingly and sparingly. Male members migrate to cities for employment or move with livestock to distant pastures. In the absence of

decision-making elite of a family, the acceptance of new innovations and research recommendations remains quite low. A store house of natural forests and rich in fauna and flora, rehabilitation of *Shivaliks* remained an area of priority much before independence and thereafter (Photos).

Several state, central and foreign funded projects operated in the *Shivaliks* of north India basically to reverse the trend of degradation by adopting participatory approaches of natural resources management for poverty alleviations and sustainable economic and ecological development. There was no comprehensive document enlisting the status of degradation, implementation of soil and water conservation/ watershed development schemes and projects to address these problems of degradation and their consequences, analysis of success and failures. Unfortunately, most of the information could not be placed in the public domain. The lessons learned from the implementation of such projects would be useful for policy planners and other stakeholders. It is important that such information is compiled in a historical perspective for younger officers and field functionaries, students and fellow research workers. An effort has been made to collect information from the diverse sources and placed in a historical perspective after a detailed review so that valuable information on outcomes of millions of dollars spent are not lost in the bundles of files and reports.

PHOTOS*: Shivaliks* of North India

2. Materials and Methods

2.1 Study Area

The study relates to the *Shivaliks* hill region of north India located below the rocky Himalayas and above the Indo-Gangetic alluvial plains in a long narrow belt spread in the parts of four northern states of India namely Jammu and Kashmir, Himachal Pradesh, Punjab and Uttarakhand covering an area of 4.2 million hectare (GOI, 1998) (Fig. 1).

2.2 Climate of the Study Area

Most of the *Shivalik* region enjoys semi-arid type of climate characterized by extreme summer temperature above 40^{0}C in May-June and near freezing winter temperature of 4-5^{0}C in December and January. October to November is autumn and February to March is pleasant season of spring. The normal wind velocity is 10-12 km/hr. The sunshine hours are 11 to 12 hours in summer and 8-9 hours in winter. The relative humidity is nearly 90% in the rainy season and varies from 70 to 85 in other months of the year. Frost occurs for 8 to 10 days during December-January. Hailstorms are also received occasionally.

The mean annual rainfall of region is 1100mm with low of 600 to high of 2200mm. The monsoon season starts normally by the end of June and continues up to end of September. Early/late start and early/late withdrawal of monsoon rains are very common. Almost 80% of the mean annual rainfall is received during the monsoon season and about 15% in December-January which is referred as bi-modal pattern of rainfall distribution (Fig. 2).

October and November are dry months (no rainfall) of the year. The 10 year data indicate maximum rainfall intensity is around 120mm hr^{-1} and one day maximum rainfall may exceed 200mm which causes flash floods. Three day continuous rainfall is around 450mm. There are frequent gaps between rainfall events varying from 15 to 25 days intermittent dry spells which cause drought conditions even in monsoon season.

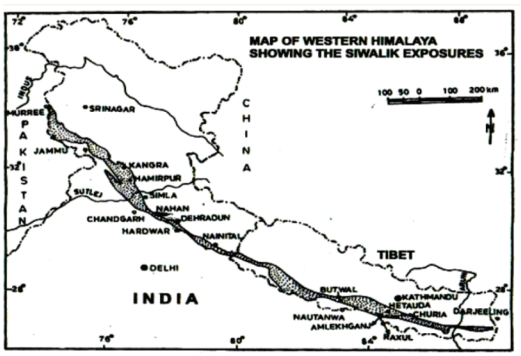

FIGURE1 Geographical setting of *Shivaliks* in foot hills of India

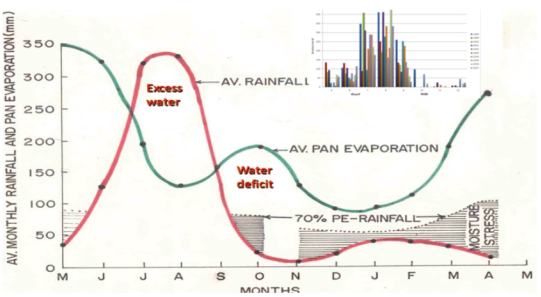

FIGURE2 Bimodal pattern of rainfall distribution in *Shivaliks* of North West India

2.3 Landscape Characteristics

The general landscape in the upper part is steeply sloping hills covered with mixed forest and high drainage density of 8-9km/km^2. The area is having vertical cliffs and landslide scars. The hill soils are generally sandy loam to loam with admixture of boulders and gravels. The middle part is moderately steep and generally divided into level terraces' industry, and ravine type cut off area by *choes.* There are lot of boulders, gravels and stones in the profile. Mostly soils are loamy sand with admixture of gravels and their pH ranged from 7.2 to 8.7 with low EC. There is no problem of salinity and alkalinity or water logging but soil erosion is a serious problem in the hilly forest area and along the choes/nalas. Stream bank erosion by *Sirsa* is a serious problem. These characteristics have been presented in detail by Grewal *et al*., 1989 and Grewal, 1995.

2.4 Review of Literature and Unpublished Reports and Documents

The perspective on the watershed development initiatives in the *Shivaliks* of north India basically drive its strength from the review of published literature, personal communications, unpublished reports and documents and large number of publications of the author starting from Sukhomajri project. The author was part of the technical support group of the World Bank funded projects in the Shivaliks. Had the opportunity of handing capacity building trainings and workshops at Regional Watershed Development Center and PAU Regional Research Station for Kandi area Ballowal for ten years. This provided access to all reports and documents of all five participating states covered under these projects and strong interaction with staff and officers of five participating states. Voluminous information was generated during the compilation of draft project reports; monitoring, evaluation, impact assessment and learning assignments related to watershed development projects (Grewal, 1995; Sagwan *et al*., 1995; Jain *et al*., 1998; Grewal *et al.*, 2002; Grewal, 2002; Grewal *et al*., 2003a,b; Dogra *et al*., 2005; Grewal and Bhushan, 2005; Dhar *et al*., 2006; Grewal, 2006; Bharat and Grewal, 2007; Grewal, 2016; Grewal, 2018.). A genesis of this information base was attempted to highlight the key lessons learnt from these watershed interventions, institutional innovations, role of community mobilization, un-addressed gaps, implementation constraints, institutional loopholes and a comparative and critical analysis of previous studies/ publications including constraints in replication are discussed. The policy implications for current and future watershed development programs are deliberated.

3. Results and Discussion

3.1 A Historical Perspective on Watershed Development in the *Shivaliks* of North India

3.1.1 Pre-Independence Work in the *Shivaliks*

L.B. Holland, the then Deputy Conservator of Forest Punjab compiled a report in 1928 titled "Denudation and Erosion in the Low Hills of the Punjab: published in Civil and Military Gazette Lahore. He traversed the foot-hill areas of Punjab and provided detailed account of degradation and reasons thereof. R, Maclagan Gorrie a Scottish Forest Officer posted in Hoshiarpur authored a classical book titled "Soil and Water Conservation in the Punjab" published in 1946 from Lahore. Gorrie attempted to lay down the details of practical field work in afforestation of catchment areas, reclamation of torrent beds and waste lands and the control of runoff and erosion processes. He highlighted the problem of soil erosion and enactment of Punjab Land Preservation (Choes) Act 1900 as modified in 1944. The problem of soil erosion and land degradation remained in focus since long. Glover, 1944 described the problem of soil erosion in the *Shivalik* foot hills and its consequences narrated in an Oxford University pamphlet.

The area affected by 'choes'(rain torrents) in Hoshiarpur district of Punjab increased from 194 km^2 in 1852 to 286 km^2 in 1886 and to 2000 km^2 in 1939. The devastation was later reported to have affected an area of 2.5 million hectare (Anonymous, 1976). As the problem assumed serious proportions, the Punjab Land Preservation (choes) Act was passed in 1902 to prevent further deterioration. The resistance by the local people to the act led to the grant of limited grazing and tree cutting rights in forest areas close to villages (Hudson, 1991). The intention was to contain their influence in a limited area of the forest called the protected forest. The areas away from the villages were completely closed and called Reserve Forests. The implementation of the law remained weak and the situation further deteriorated after independence.

3.1.2 Early Post Independence Initiatives

A wing of soil conservation under a joint director was created in the department of agriculture Punjab in 1961. Sh. MSV Rama Rao an experienced soil conservation officer from Maharashtra was engaged as soil conservation adviser. In the Govt. of India, soil conservation was a wing of the agriculture department and a first contour bunding project at *Fauji* Colony Banur was funded by the GOI in late fifties. In this project, a patch of salt affected soil was allotted to retired army officers for reclamation. After a

detailed topographic survey, a contour bunding plan was prepared and implemented. First gauging station was established to measure runoff and soil loss from the treated area. Unfortunately, no report was generated.

Soil and Water Conservation Research and Training station was established at Dehradun under the Ministry of Agriculture and Cooperation. The Soil Conservation Research & Training Station at Chandigarh was established in 1955 with 700 acres research farm near Mansa Devi Temple of Manimajra town. A separate soil and water conservation department was created in the year 1962.

The trainings of all categories of staff in the department of soil & water conservation were compulsory. While DSCOs and ASCOs were sent for 5.5 months training at Dehradun Institute, soil conservation inspectors and JEs were sent for assistant trainings at Kota center of Dehradun institute and sub inspectors and surveyors were sent for training at Training Institute Hoshiarpur.

3.1.3 Main *activities of the department of soil and water conservation in the Punjab*

- Contour bunding on erosion prone sloping lands was the most common activities during sixties in foot hills areas. A contour bund with 6ft base, 2ft top and 3ft height was a common norm.
- Land leveling and bench terracing was introduced subsequently where soil depth was not a problem. A cut/fill method of calculation of earth work in land leveling was introduced to work out the cost of work.
- Low height masonry check dams were approved for field safe disposal of excess runoff in terrace lands.
- Similarly, two to three meter height check dams were constructed in drainage lines/gullies to break the velocity of runoff water and induce siltation of gully bed. In case of Rajgarh Project near Kurali, in the gully bed 11 check dams were constructed in series and after three years, farmers started raising sugarcane in silt deposited gully bed.
- After the success of Sukhomajri Project, the construction of earthen dams for rainwater harvesting was started in Ropar, Hoshiarpur and Pathankot areas. A provision of underground pipe lines was made to carry the harvested water for limited irrigation in designated command areas. A conflict with the state forest department was reported often where the dam sites were located in the forest area. They wanted to construct such dams themselves and wanted that the funds be transferred to the forest department. The conflict was resolved because Forest and Soil and Water Conservation were with the same minister.
- Gradually, the base flow harvesting projects got introduced after the success of Makkowal project. One of the best base flow harvesting projects was at village Ballowal in Balachaur block of Hoshiarpur district which provided gravity irrigation through two underground pipelines to about 60 acres of land of Ballowal and Takarla villages and farmers raised poplar plants along the open channels and an oasis of greenery was created in the barren landscape. The soil and water conservation department replicated the mode in number of perennial khads in the Kandi area.

3.1.4 Construction of medium height earthen dams by the Irrigation Department

In late eighties, the Irrigation Department Punjab earned a World Bank project for the construction of medium height earthen dams for rainwater harvesting and irrigation in command areas. A dozen such dams were constructed varying in height from 25 to 30 m length varying from 150 to 230m across major khads having base flow. Since catchment area treatment was not paid due attention, faster siltation gradually emerged as a serious problem.

3.1.5 Kandi Watershed *and Area Development Project (KWADP)*

The first conscientious efforts to reverse ecological degradation in the foothills of Punjab was made through the Kandi Watershed and Area Development Project (KWADP) during 1980-88 with the financial assistance of 30 million US$ from the World Bank. In this pilot project, multi-disciplinary approach of resource conservation was followed in 11 major watersheds covering one lakh hectare of farm and forest lands. One of the objectives was to harvest rainwater from the forest

catchments by the construction of medium height dams across major torrents to irrigate an area of 10,800 ha. The Irrigation and Drainage Department of the Punjab state constructed these dams on the outermost fringes of the low hills where rain-fed agricultural lands were located down below in close proximity. Such dams are 21.4 to 38.8m high and covered cultivable command area varying from 450 to 3750 ha. The experience with dams indicated that their reservoirs are silting at a much faster rate (>60 t/ha-1 yr.$^{-1}$) than originally planned (<15 t ha^{-1} yr.$^{-1}$). The funds were provided for dam construction but the catchment area was not treated with soil conservation measures. Concerted efforts were not made to close the catchment areas against grazing and fuel wood extraction. The rapid siltation reduced the functional life of the reservoirs.

The important lesson is that dam was constructed by the Irrigation and Drainage Department but forest catchment area was under the control of Forest Department. A unified implementing agency is necessary for effective results and catchment area treatment is necessary to prolong the functional life of the reservoirs.

3.1.6 Small earthen dams

3.1.6.1 Sukhomajri Operational Research Project

The first successful attempt was made in the Sukhomajri Operational Research Project (ORP) near Kalka in the Haryana state (ICAR, Ford Foundation funded) where three earthen dams were constructed between1976-81 to store rainwater from hilly forest catchments and conveyed through gravity fed underground pipe lines to 60 acres of farm land (Grewal *et al*., 1990). This facility of limited irrigation revolutionized the rain-fed agriculture and mean crop yield increased from 2.0 to 5.7 t ha^{-1} yr.$^{-1}$. The average grass yield in forest catchment improved from 0.1 to 0.95 t ha^{-1} yr.$^{-1}$ and tree density from 64 to 464 trees/ha with simultaneous reduction in soil loss from 191 to 27 t ha^{-1} yr.$^{-1}$ (Mittal and Sud, 1982). The availability of water from the adjoining forests for thirsty farm lands encouraged farmers to become interested in catchment protection. A village co-operative emerged which took over the responsibility of protecting the degraded forest land (social fencing). Grazing was replaced by stall-feeding. Forest contractors were replaced by village co-operatives contracting for the extraction of forage and commercial grass (Mittal *et al*., 1988). Arya, 1994 evaluated the impact of Sukhomajri watershed development project and noted that there was increase in number of buffaloes and cows and decrease in number of goats. The availability of green fodder from farmlands increased by 144% and dry fodder by 56%. The hills regained the lost greenery and people regained faith in conservation and joint management of resources (Grewal *et al*., 1995).

3.1.6.2 *Dams construction in Nada Sahib Watershed*

The successful example of Sukhomajri was replicated at Nada Sahib with similar results. In a watershed of 649 ha at Nada (Haryana), six earthen dams were constructed between 1980-89having total catchment area of 138.9 ha, storage capacity of 49.29 ham, command area of 64.7 ha at a cost of Rs. 27.42 lakhs. Unlike bigger irrigation projects, the gestation period in such small projects was less than a year. Moreover, local people particularly laborers got employment near their homes (Grewal *et al*., 1995).

3.1.6.3 Earthen dam construction in Bunga watershed

The overwhelming success at Sukhomajri and Nada resulted in the selection of 47 National Watersheds under different institutes of ICAR/SAU's to give application test to this technology under varying agro-ecological conditions. Out of these, Bhunga watershed was selected in Ambala *Shiwaliks* where an earthen dam of 16m height was constructed to harvest rainwater from 154.3 ha forest catchment having

water storage capacity of 59.6 ha m, spread area of 11.7ha, command area of 243 ha and total cost was ₹ 3.55 million in 1985.

Arya and Samra, (1996) evaluated the impact of Watershed Management Program at Bunga village on animal husbandry sector and reported that milk production increased from 231 to 723 thousand litres from 1983-84 to 1991-92 and 233 percent decline in number of goats. The number of cows, buffaloes, and bullocks increased by 47,172 and 33 percent, due to increased availability of fodder and grass. Arya (2010) reported significant decline in livestock migration with substantial increase green and dry fodder availability. The increase in productivity of crops and milk and other results were identical to previous projects where the impacts of droughts were moderated through life saving irrigation and such projects provided economic and ecological security to resource poor communities (Grewal *et al*., 1989).

3.1.6.4 Earthen dam in Relmajra watershed

A similar project was selected in village Relmajra village during 1991 near Ropar in the Punjab *Shivaliks* with the financial assistance from the Ministry of Environment and Forests, Government of India. In this project, rainwater harvesting, development of marginal lands under horticulture and forage component and drainage line treatment technology was successfully demonstrated. The village society generated social funds for maintenance and to creating welfare facilities for the community (Samra *et al*., 1995).

The construction of small earthen dams to harvest rainwater and use of the stored water for limited irrigation to increase agricultural production has since been demonstrated by the operational research programs. As a result of economic viability and social acceptance of this approach, large-scale replication in the *Shivalik* foot hills was observed. The Forest Department of Haryana and Soil and Water Conservation Department Punjab took the lead.

Large numbers of small earthen dams with impermeable care-wall of heavy soil, height varying from 6 to 16m storage capacity from 1.2 to 60 ham, forest catchments varying from 20 to 157 ha and a provision of masonry spillway made for the disposal of excess water have been constructed in the foothill areas of Haryana (180), Punjab (120) and Himachal Pradesh (60) by early nineties. The salient details of these successful watershed development projects formed the subject matter of several studies (Grewal *et al*., 1989, Grewal *et al*., 1990 and Grewal, 1995).

Some guidelines on the judicious use of harvested water were suggested:

- The first preference should be given to domestic and livestock use if quality of water is good. Water quality should in fact be tested before use.
- This water should be used for high value crops like vegetables and fruits.
- The tendency to use water for raising paddy should be discouraged.
- Fish should be reared if conditions permit to augment the income of the society.
- The reservoirs should be brought to dead storage level before the next monsoon season.
- A good amount of research work on the production gains by the supplemental irrigation has been carried out. The pre-sowing irrigation in case of wheat gives the maximum advantage followed by irrigation at CRI-stage.
- The cost of dam construction is recovered in a period of 4 to 5 years through increased crop production.

3.1.7 Govt of India supported special program

Several watershed development projects funded by the Ministry of Agriculture and Cooperation, Govt. of India were supported in the *Shivalik* region. These were River Valley Project, Flood Prone Area Program. Drought Prone Area Project operated by Agriculture/ Soil and Water Conservation Departments. Since funds were limited and areas were scattered visible impacts could not be achieved.

3.1.8 *National Watershed Development Project for Rain-fed Areas (NWDPRA)*

The Ministry of Agriculture and Cooperation, Government of India, intended to generate successful watershed development models in all the community development blocks of the country where less than 30% of arable area was under assured means of irrigation. The project was

planned to act as a pace setter for comprehensive development of dry land areas adopting farming systems approach on watershed management principles in order to conserve precious rainwater and top soil. The soil and water conservation programs using vegetative technologies were promoted including animal husbandry, agro-forestry, horticulture, fisheries, sericulture and primary agro-processing.

In the Punjab *Shivaliks,* 13 watersheds were selected under NWDPRA (1990-91) covering 19,559 ha of area with financial outlay of 63.8 million. The Department of Soil and Water Conservation was made the nodal agency for coordination of activities with the line departments. The funds for associated activities in the selected watersheds were placed at the disposal of the line departments. The program suffered from coordination problems and activities by line departments were so scattered that the real impact was hardly visible. The important lesson was that a unified agency and single window of providing goods and services is required to produce visible impacts. Hudson, 1991 evaluated the performance of the soil conservation project and brought out the reasons of their sub optimal performance.

3.1.9 *Integrated Watershed Development Project (IWDP) Hills-I*

This World Bank funded project operated in four northern states of India (Haryana, Himachal Pradesh, Jammu and Kashmir and Punjab). It was designed to address the most serious problem of degradation in fragile ecosystem of the *Shivaliks* with cost effective vegetative technology for soil and water conservation on both arable and non-arable lands. Introduction of rain-fed horticulture on marginal land, livestock improvement, forage production, drainage line treatment were other components of this project. It was aimed to adopt participatory approach involving beneficiaries (small farmers, landless people and livestock owners) to ensure sustained management of common property resources.

Adoption of a single window system with built-in mechanism of monitoring, evaluation, research and training involving state agricultural universities was an important feature of this project. The runoff and soil loss measurements and impact assessment studies were conducted for quantification of conservation and production benefits to justify investments. This was a 7-year (1990-1997) project, which was extended for two more years up to March 31, 1999. A Regional Training Center for Integrated Watershed Development was established at PAU Kandi Research Station at Ballowal under this Project.

Water resources development to meet the pressing demands of drinking water, livestock use and supplemental irrigation was given a very high priority after the Mid Term Review in 1995. Perennial flow from small streams was harvested by specially designed, simple and cost effective structures (Makowal). Rainwater was also harvested by constructing small earthen dams and stored water used for limited supplemental irrigation which produced green fodder (clover) for stall fed buffaloes and resulted in increased milk and manure production. A total area of 180,100 ha was treated in 75 priority watersheds of four participating states up to March 1998 benefiting more than 82,500 families at a cost of 2454.4 million rupees (GOI, 1998).

Based on the experiences of this project, Jain *et al*., 1998 emphasized guidelines for the future watershed management projects:

- Sustainability of project activities require emphasis on community-based organizations to own the responsibility of maintenance of assets created, ensure cost sharing and full commitment for post project operation.
- Cost sharing by beneficiaries should be much less in the community-based activities on common lands than the private owned lands and within the private lands it should be much higher for cultivable lands than non-cultural lands (degraded wastelands).
- While treating Government/forest lands, communities' interest in terms of benefit sharing must be ensured.
- The project components should be broad based, include income generating activities for the women self help groups.
- Institutional development in the form of community-based organizations should be given top priority and should precede the project identification and implementation.
- Complementarily should be established between

the various agencies (Government, donors, NGOs) implementing the project in the same area/district/state to avoid unhealthy competition.

As a result of seven years of operation, satisfactory results were achieved as summarized by Singh, 1998.

3.1.10 *Integrated Watershed Development Project Phase II*

The community participation in project planning, implementation and subsequent maintenance remained a weak link in IWDP-I. This was then made the pre-requisite along with cost and benefit sharing arrangements in IWDP Phase II started from April 1999 in five states (UP included) with financial assistance of about ₹ 9000 million from the World Bank. Directors were appointed in all the five participating states. The components of soil and water conservation, forestry, horticulture and animal husbandry were integrated in a single window system and services of experts in these disciples were placed on board. Silt observation posts were established at representative watersheds for impact assessment. The areas of operations were also enlarged. For example, in the Himachal Pradesh, the operational area was shifted from the *Shivaliks* to mid Himalayas. This project concluded in March 2005 with a comprehensive review carried out by the World Bank from an independent agency and was rated as satisfactory achievements against objectives.

3.1.11 *Integrated Watershed Management Programme*

Integrated Watershed Management Program (IWMP) of the Government of India was supported by the Ministry of Rural Development, Directorate of Land Resources after revised guidelines issued in 2011. Five districts of Kandi area were first prioritized but due to serious groundwater depletion and soil health problems, this program was extended to 11 district of Punjab in 2012-13. However in 2015, the program was redesigned as Pardhan Mantri Krishi Sinchai Yojna (Watershed-2). The focus was to provide access to irrigation by different technological options. *Har khet ko pani*, more crop per drop was made the slogan. The program was shifted to the Ministry of Jal Shakti.

In this perspective on watershed development initiatives in the *Shivaliks* of north India, the first introductory part of the paper covered the basic information about geological setting, major problems, socio-economic consequences, and climate and water scarcity in the *Shivalik* ecosystem. In the results and discussion section, a historical perspective starting from pre independence to the detail of programs, institutional strengthening and different watershed development projects taken up to reverse the trend of degradation have been described in detail. What emerged from the implementation experiences of these initiatives is now presented in this section of the paper.

3.2 Analysis of issues and concerns emerged from implementation of programs and projects taken up for ecological restoration of the degraded Shivalik ecosystem

3.2.1 *Key lessons learnt from the past watershed interventions*

- The rigid modules of treatment (like vetiver as contour barrier) should not be imposed. Native grasses are far superior to vetiver. Flexibility must be introduced to accommodate experience-dictated changes adopting bottom up and not top down approach.
- Five years is too short a period for effective implementation of watershed development projects where all preparatory, implementation and withdrawal phases has to be consolidated where new infrastructure has to be created and plantations to be raised and nursed.
- Amelioration of highly degraded forests is difficult to achieve at low cost without effective closure/social fencing and without optimum mix of biological and mechanical measures. Thinly spread resources seldom produce good results.
- Single window system of administration is more efficient in which all disciplines work under one watershed team leader. Subject matter specialists of each discipline should be placed on board to provide blue prints and technical support.
- The institutional and implementation capacity building of all stakeholders including exposure visits must lead rather than follow project

implementation.

- Local experience, expertise and indigenous technical knowledge be effectively internalize for effective need based and demand driven packages of watershed treatment. The choice and preferences of farmers must be accommodated to ensure sustainability.
- A practice which promises returns after 3-5 years (long generation period) with no visible impact and does not take into account the immediate needs is not accepted by the beneficiaries. Interventions which provide direct, visible and immediate returns motivate communities for participation and cost sharing. Water resource development is one such most preferred intervention.
- Adopting an inclusive growth model, the involvement of landless, weaker sections, women need to be involved in equitable sharing of resources created. The cost sharing norms should also be designed accordingly.
- The non-transparency in accounts, favoritism, leadership and caste conflicts, political interference and social and economic disparities in communities, strongly influence project achievement, result in delays and sub optimal performance.
- The social dimensions of watershed development approach are becoming increasingly important but staff is not well attuned to democratized set of operations and needs a lot of training and orientation. The NGOs should be activated to share such responsibilities.
- Convergence with line departments and use of MNREGA funds remained a low key affair in spite of guidelines.
- The course of action both in research and development must attempt on a thorough and objective quantification of resource base and problems, undertake research to refine science and technology relevant to restoration and find ways and means to motivate people to understand the problems, their far reaching consequences and make them to stand on their own feet rather than look for support and subsidies. In such an endeavor, creating an enabling environment with a onetime investment would, however, be necessary.

3.2.2 *Institutional innovations and their role in improving watershed governance and program effectiveness*

- The soil and water conservation (SWC) research carried out by the central research institutions and the state agricultural universities (SAU's) have helped in characterization of resource base, better understanding of cause and effect relationships and development of useful technologies for resource conservation.
- The Chandigarh based Research Center of the Central Soil and Water Conservation Research and Training Institute Dehradun successfully implemented the Operational Research Project Sukhomajri and generated technological package for integrated watershed development with sharp focus to community partnership and resource sharing. The concept was replicated on large scale and was considered the foster mother of watershed development in the *Shivaliks* of north India.
- The watershed development projects were approved using the nomenclature of Sukhomajri Pattern. The effectiveness of this package was demonstrated in term of improvement of crop and milk production in Bunga and many other such projects.
- Simultaneously, the Punjab Agricultural University, Ludhiana, with the support from the World Bank under the National Agricultural Research Project (NARP) took a bold initiative to establish a full-fledged Regional Research Station for foothill areas of the state in 1983 to develop and disseminate technologies for rain-fed agriculture, horticulture, agro forestry, forage production, soil and water conservation and watershed management. The micro-watershed hydrology studies were initiated at Saleran (Hoshiarpur) and Patiala-ki-Rao (Ropar) watersheds to generate research information on rainfall-runoff relationships and sediment loss. Studies on runoff harvesting and efficient use of limited water were initiated in Karoran, Ballowal Saunkhri and Takarla watersheds. Experiments were also conducted to evaluate the effect of different vegetative barriers on runoff, soil loss and crop yields. This research station generated very useful information and package of practices which were disseminated through various means including the Krishi Vigyan Kendras and Farm Advisory Services operating in the *Shivalik* region. The region specific and research supported packages of practices for integrated natural resource management started supporting

the watershed development projects in this region.

- In the World Bank funded IWDP (Hills) project, A Regional Training Center for Watershed Development was established in 1992 at the Regional research Station Ballowal for capacity building of all categories of professional staff of all the four participating states. In a period of ten years, 112 training courses were organized on various facets of watershed development where 2200 staff members were trained. The impact assessment indicated that there were improvements in designs of earthen dams and soil conservation structures.
- Similarly, the watershed development Bunga project in Haryana was planned, and designed by the scientists of CS&WCR&TI, Research Center Chandigarh and implemented by the state agriculture department. So was the case of Relmajra project in Punjab *Shivaliks*. The hydrological norms used in structural designs were followed in similar project.
- Lot of research information was generated on the implementation experience, success and failures by large number of impact assessment studies by ICAR and SAUs. The trainings and experiences of operation research project demonstrated by impact assessment studies played a significant role in improving watershed governance and program effectiveness.

3.2.3 Role of community mobilization, participatory approaches and local institutions in watershed management

In case the local communities were not mobilized to actively participate in the planning and implementation of programs related to management of common property resources and as a result SWC works done at a great expense mainly by the Government initiatives were seldom maintained by the beneficiaries. This led to serious doubts about the viability and suitability of the technological packages. Eckholm, 1976 emphatically held that the application of technical answers to the ecological problems seldom turns out to be simple. He felt that social dimensions of SWC were largely ignored. Hudson, 1991 felt that low level of success in SWC is caused to some extent by attempts to use unsuitable technology for a particular set of conditions. The technology, which is based on the development of an existing practice stand better chances of adoption than something, which is new to the area. It must be considered necessary to appreciate the positive points of the traditional production and land-use systems and strengthen them through science and technology inputs so as to enhance their value and efficiency (GBPIHED, 1993). This is better than advocating changes involving the replacement of traditional systems by new one's found suitable elsewhere. The explicit role of common interest groups, women self help groups, water user associations must be inbuilt at project planning.

3.2.4 Major un-addressed gaps, implementation constraints, institutional loopholes and regional disparities within existing watershed programs

About 30 years research and development work on watershed development have solved many questions but many remain unsolved or answers need more debate.

- Use of remote sensing interventions in the study of small watershed hydrology and micro-planning of watershed/water resource development could not reach to the operational stage.
- The sedimentation of reservoirs without adequate catchment area treatment has reduced the operational life of large number of reservoirs. Catchment treatment before the construction of dams is advised but seldom done. There is seldom convergence between agriculture/soil conservation departments with forest department when catchments are located in the territory of forest department.
- In view of denudation of catchment areas, how to get more water but much less sediment remains an issue. More work on filter vegetation is needed. Water yield tend to decrease when catchment is well protected. How to maintain water yield to reservoirs upon watershed rehabilitation by manipulating the vegetative cover is yet an unanswered question.
- How to control seepage from leaky reservoirs.
- Spread of limited water over large commands at low cost.
- Effective control of landslides in highly erodible catchment soils.
- Share benefit with landless, labourers and poorer

farmers.

- Enlisting active community participation and enforcing cost sharing norms.
- Activate research and training to support expansion of programmes and coordination between research institutions located in Kandi area of all five states.
- The rural communities in general and resource poor in particular must be involved effectively in the decision making process.
- Lastly, it is not important that how many trees have been planted or how many hectares have been irrigated but most important is that how many poor, landless, deprived families have been given gainful employment, access to common property resources and avenues of livelihood security.
- Regional disparities- the per hectare cost of treatment is higher in Himachal Pradesh as compared to Haryana because of higher material transport costs on difficult terrain. The implementation arrangements varied across states. While watershed development projects in Haryana was operated by the agriculture department but in HP and J and K by forest department.

3.2.5 *A comparative and critical analysis of previous studies publications*

The watershed development related research work largely emerged from CS&WC R& Training Institute Dehradun and its Research Centre Chandigarh. Simultaneously, research input was also added from Ballowal and Daulakuan Regional Research Station of Palampur Agriculture University.

Samra, J.S., Singh, R.P. and Mohan, A.N. 2000 compiled an annotated document of publication of the Central Soil and Water Conservation Research and Training Institute, Dehradun providing summaries of published papers by the Institute Scientists from 1954 to 1998. The abstracts of 1388 papers and bulletins were included in the form of a book. These publications were divided into seven area of research. The analysis of these previous studies indicated that the rate of publications gradually started from 1954-58 but remained at low key up to 1974-78. However, the rate of publication suddenly increased in 1979-83 and 1984-88 when watershed development research starting from Sukhomajri expanding to other 47 operational research project across all the nine centers of the institute. In case of Watershed Development Research in *Shivaliks*, the publications started from Sukhomajri and out of 69 publications covered by Samra *et al*., 2000, the maximum are on various facets of Sukhomajri watershed project, followed by Bunga, Nada, Tibbi in Haryana, Relmajra in Punjab and Behdali in Una district of Himachal Pradesh. Lot of research information was added after this publication. An effort was made to catalogue watershed based research and development in *Shivaliks* of North India and lessons learnt.

3.2.6 *Constraints in replication and lack of community participation*

The local communities were not made to actively participate in the planning and implementation of programmes related to management of individual and common property resources and as a result SWC works done at a great expense mainly by the Government initiatives were seldom maintained by the beneficiaries. This led to serious doubts about the viability of technological packages. The failures in SWC and lack of community participation became a common problem.

Eckholm, 1976 emphatically held that the application of technical answers to the ecological problems seldom turns out to be simple. He felt that social dimensions of SWC were largely ignored. Hudson, 1991 felt that low level of success in SWC is caused to some extent by attempts to use unsuitable technology for a particular set of conditions. The technology, which is based on the development of an existing practice stand better chances of adoption than something, which is new to the area. It must be considered necessary to appreciate the positive points of the traditional production and land-use systems and strengthen them through science and technology inputs so as to enhance their value and efficiency (GBPIHED, 1993). This is better than advocating changes involving the replacement of traditional systems by new one's found suitable elsewhere.

3.2.7 *Policy implications for current and future watershed development programs*

Remote sensing based appraisal and monitoring of resource base need serious push through participatory, de-centralized watershed development in the Shivaliks. Attempting farming system approach, small farm based hill agriculture should integrate local fruits, vegetables, floriculture and high value crops like ginger, turmeric and garlic. The impending labour shortage, provisions for machinery, tools and plants for small farms and generation of small farm technologies are challenges which has to be addressed. Water scarcity, diminishing supplies, drying of natural springs, and dilapidated condition of irrigation Kuhuls against climate change mitigation challenges, water security remains a challenge waiting for innovation and financial support. Promotion of bio fertilizers and pesticides, processing, value addition and marketing needs a strong push. Skill improvements through capacity building, easy credit and crop insurance and agriculture and industry partnership are one of the priority areas. Funding support to research and extension is equally important. Only salient issues generally debated have been flagged but many more could be added.

Conclusions

The genesis emerging from the discussion part of the paper clearly indicates that the sustainability of the watershed interventions shall strongly depend upon institutional capacity building, strengthening of community organizations and continuity of funding support. The communities shall have to be brought at the central stage of decision making and bottom-up approaches shall have to be adopted for the success of the projects. Taking a historical perspective, the detail of programs and watershed development projects taken up to reverse the trend of degradation has been presented starting from pre independence to Pardhan Mantri Krishi Sinchai Yojna covered 11 sections. Key lessons learnt from these watershed interventions, institutional innovations, role of community mobilization have been described. Major un-addressed gaps, implementation constraints, institutional loopholes and a comparative and critical analysis of previous studies/ publications including constraints in replication are discussed. The policy implications for current and future watershed development programs are deliberated.

Watershed management as a tool for environmental rehabilitation of degraded ecosystems is now well recognized all over the country. Common guidelines for systematic implementation of participatory watershed development were prepared at the national level and were made the pre-requisite along with cost and benefit sharing arrangements. It was suggested that integrated watershed development be undertaken systematically with GIS support in demand driven and participatory approaches by strengthening social institutions (VLDC's, Panchayats), focusing to local flora and immediate community needs giving due priority to water resource development for drinking, irrigation, improving moisture regime and ground water recharge. The strengthening of data base by systematic studies can lay strong foundation not only for rehabilitation of degraded *Shiwaliks* but also for ensuring sustainability of biological production systems. It is, therefore, recommended that all out efforts should be made for an integrated approach to rainwater harvesting in *Shiwaliks* with national and international financial support. There is an urgent need to prepare a holistic perspective plan for this purpose. The conclusions of this paper are briefly summarized as under:

- Large scope with basket of options is well demonstrated. However, sufficient data support and continuity of efforts is required, with national and international funding support.
- Possibilities to tie up forest protection, livestock improvement, horticulture, fish nearing, employment generation and economic development should be further explored by adding high value crops, processing and marketing.
- There is a need for integrated/holistic perspective plan to garland *Shiwaliks* with water bodies with committed financial support. Punjab needs to float proposals for foreign funding support like Himachal Pradesh.
- Continued research and training to refine technologies is necessary. There is a scope to reduce failures, economize on cost and build in sustainability concerns more seriously.
- Experiences are building up which need compilation for the benefit of user groups and managers of future projects.
- Efforts must be harmonized with poverty alleviation, environmental rehabilitation welfare

of women, landless, weaker sections which needs to be targeted more seriously.

Moreover, it must be clearly understood that land cannot be reclaimed or conserved through sporadic efforts and short term projects and by a thin spread of monetary resources. Long-term programs backed by sound land use policies and strategies by involving local communities are urgently needed. We must not only internalize the double shift in research paradigm but must also absolutely couple it with sound policies, tireless extension and effective natural resource management so that benefits reach to those who failed to get them before (Ismail, 1998).

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