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Sustainable Hill Agricultural Practices through Watershed Development Programmes and their Impact in Himalayan States

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I

INTRODUCTION

The Rio conference in 1992 recognised the crucial role played by mountain ecosystems by highlighting that the livelihood of about 10 per cent of the world's population was dependent directly on mountain resources such as water, forests and agricultural products and minerals (United Nations, 2001). In addition, population living in valleys and plains depend on the mountains for water as many major rivers originate from mountain ecosystems. This aspect was also stressed in Agenda 21 which stated that about 40 per cent of the world's population lived in adjacent medium and lower watershed areas. The vulnerability of mountain areas to environmental degradation pressures placed by increasing population growth, tourism and economic development, has further accentuated the fragility of these highly sensitive ecosystems. The cultivation of marginal lands due to increasing population pressure has led to ecological degradation in the Himalayan region thereby putting a question mark on the very sustainability of mountain agriculture and its natural resource base.

The major mountain ranges in India are the Himalayas and the Western Ghats. The Himalayas are among the youngest and highest mountain systems in the world. They traverse an arc of about 2500 km between the Indus and the Brahmaputra rivers, with an average width ranging from 100 to 400 km. The Himalayas pass through eight countries: Afghanistan, Pakistan, India, China, Nepal, Bhutan, Bangladesh and Myanmar. In India, this mountain ecosystem is spread over 12 states: Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal. They are inhabited by 51 million people, covering 18 per cent of the geographical area and 6 per cent of India's population. The Himalayas have probably one of the highest hydropower potentials in the world, which includes the Indus, Ganga and Brahmaputra rivers. This hill system represents one of the richest natural heritage sites in the world. One-tenth of the world's known species of higher altitude plants and animals occur in the Himalayas (IPCC, 2001).

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II

PROLOGUE

The rich environmental heritage of the Himalayan region is under pressure from natural and human-induced stresses such as earthquakes, landslides, construction activities (roads and dams) and poaching. The impacts of these pressures is illustrated by the declining forest cover in the states of Assam, Manipur, Meghalaya, Mizoram, Nagaland and Sikkim, the loss of wildlife habitat and the loss of life and property caused due to natural disasters. Deforestation has resulted in many species of flora and fauna of the region becoming endangered.

Hill agriculture in India is confronted with the problem of uneven topography, soil erosion, small landholdings, inaccessibility with poor road infrastructure and opportunities of fertile land, high and dependable precipitation in the form of rain, snow and an agriculture friendly climate that can be the best bet for the development of watershed development programmes on a large scale (Shaheen *et al*., 2008).

In order to address the problem of mountain agriculture, two programme agenda of promoting integrated watershed development and alternative livelihood opportunities besides generating and strengthening knowledge about the ecology and sustainable development of mountain ecosystems were identified by the Agenda 21 of the United Nations.

Climate change being a global phenomenon has added another dimension to mountain agriculture. While the priority has to be given to adaptation, we are aware that the Himalayas are suffering the consequences of a global phenomenon. Unfortunately the global instruments in relation to the Kyoto Protocol do not yet benefit the mountains. There is a continuum between mitigation and adaptation, and water storage/management should be the centre-stage initiative for climate adaptation in these mountain ecosystems where other measures will revolve around it. The Watershed Development Programme (WDP) is one of the major best bet options for sustaining the mountain agriculture besides securing natural resource base and livelihood security as well as a strategy to climate adaptation. It also complements the goal of conservation agriculture in such areas by soil and water conservation through these water and land based development programmes.

In this backdrop, the paper attempts to assess the impact of watershed development programmes implemented specifically to address the problem of hill states and its broader implications. The paper is based on review of various studies and evaluation reports conducted by different organisations, the list of which is given in the reviewed studies.

Watersheds and the Hills

A majority of watershed development projects in the country are being sponsored and implemented by the Government of India with the help of various departments,

non-governmental organisations (NGOs), self-help groups (SHGs), etc. Drought-Prone Area Program (DPAP), Desert Development Program (DDP), National Watershed Development Project for Rain-fed Areas (NWDPRA), Watershed Development in Shifting Cultivation Areas (WDSCA) and Integrated Watershed Development Project (IWDP) are some of the important development programmes that plan, fund and implement watershed development projects under the aegis of Ministries of Rural Development; Agriculture; and Environment and Forestry, Government of India (Joshi *et al.,* 2008; Wani *et al.,* 2008). However, separate watershed development projects were initiated to address the problem of hill agriculture. Specifically, the IWDP in the Shiwaliks of five northern states and the WDSCA in seven north-eastern Himalayan states.

The World Bank Assisted Integrated Watershed Development Project (IWDP – Hills-II) as a follow up of IWDP-I was launched in the states of Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Uttaranchal since 15th September 1999 for a period of five years at a cost of Rs 954.60 crores covering the entire Shiwalik hill range with an area of 5.19 lakh hectares and 72 watersheds (World Bank, 2006). The primary objective of the project was to slow and reverse the degradation of the natural environment through appropriate soil and moisture conservation technology and restore the productive potential in the Shiwalik hills. To achieve this objective, thrust was laid on a participatory approach using cost effective watershed treatment technologies.

The Shiwaliks, the outermost part of the Himalayas, is one of the eight most degraded rainfed agro-ecosystems in the county (Singh *et al.,* 1992). Due to a high human and animal population density, the pressure on land and forest resources is enormous and adversely affects these resources through unscientific agricultural practices, heavy incidence of grazing, and the fast depletion of forests on account of over-exploitation for fuelwood, fodder etc. In order to set the processes of economic and environmental regeneration in operation, the Shiwaliks have been included in priority area for watershed development during the last three decades. The IWDP (Hills-II) Project was different from the earlier project in terms of having a larger geographical coverage, adopting a more participatory and integrated approach and in having additional components such as rural road rehabilitation. Different departments, which impinge on land-use and land management, viz., forestry, agriculture, horticulture, animal husbandry and soil conservation, were made partners in project implementation. More emphasis was laid on participatory approach and institutional development to achieve sustainability (TERI, 2006). The overall aims and objectives of the project were to slow and reverse the degradation of the natural environment; conserve soil and water; increase and improve the production and income from crops, horticulture, fodder, fibre, fuel wood and livestock; reduce flooding and devastation; restore the productive potential of the Shiwalik hills and assist institutional development.

Description of the Project Area

The project area includes the sub-tropical Shiwalik and temperate Karewas ranges of the Himalayan foothills in Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Uttaranchal. The salient features of the project in each state are provided in Table 1. The geographical area of the project in Uttaranchal was 157304 ha spread over Nainital, Udham Singh Nagar and Pauri Garhwal districts of Uttaranchal. A major part of the project area (around 94153 ha) falls in Pauri district of the Garhwal region while rest of 63151 ha, falls in the Nainital and Udham Singh Nagar. It forms the catchment of the rivers Ganga, Kali and Ramganga drained by 21 sub-watersheds and 98 micro-watersheds. The topography is highly undulating with about 80 per cent hilly area and the remaining 20 per cent in semi-plain to plain zone. The plain zone confines primarily to Haldwani, Ramnagar and Udham Singh Nagar area, and mostly are arable land but with only about 4.2 per cent under irrigation. The state has a wide range of ecological zones ranging from tropical to alpine. About 64 per cent of the areas lie within 1000 m altitude and the remaining 24 per cent in the range of 1000 to 2000 m elevation group. The Shiwalik geology and soils are typical of forest soils of the Himalayas and are primarily alluvial/residual sandy loamy soils.

TABLE 1. SALIENT FEATURES OF PROJECT AREA (IWDP-HILLS-II)

Features (1)	Punjab (2)	Uttaranchal (3)	Haryana (4)	Himachal (5)	Jammu and Kashmir (6)
Geographical area (in ha)	93938	157304	70742	103652	111080
Number of sub watersheds	17	8	16	36	4
Number of villages	282	493	219	835	187
Population (in lakhs)	3.27	1.75	1.86	2.40	1.57
Topography	Moderately undulating	Highly undulating	Moderately undulating	75 per cent higher slope, rest moderate	Undulating
Climatic zone	Semi arid monsoon type	Tropical to alpine	Semi arid monsoon type	Temperate, sub-temperate to sub-tropical	Sub-tropical in Jammu and temperate in Kashmir
Elevation (m amsl)	275 - 930	1000 - 2000	300 - 1499	1000 - 2500	1000 – 2000
Soil type	Sandy loam textured with high dispersion ratio	Forest soils, alluvial/residual sandy loam silt	Sandy loam and silty with high to moderate dispersion ratio	Light soils with high dispersion ratio	Sandy, silt and clay loam in Jammu and Karewa brown hill soils in Kashmir
Rainfall (mm)	864.8 - 1163	1000 - 2000	650 - 1000	1300	1000 – 1150
Erosion risk	Moderate to severe	Severe	Moderate	Moderate to severe	Moderate to severe

Source: Data compiled by authors using evaluation reports of the IWDP (Hills-II) Project of the states and other Digests.

The soils are slightly acidic and the depth becomes shallow with altitude. The project area has more than 8832 streams, which are mostly rainfed. The region receives annual rainfall in the range of 1000-2000 mm which quickly drains out along the steep terrain. Thus, the project area is inherently quite unstable and has a high run-off and erosion risk.

The Shiwaliks of Punjab popularly known as the Kandi belt has a length of 161 km and an average width of 10 km. The project area covers 17 sub-watersheds spread over five districts, viz., Gurdaspur, Hoshiarpur, Nawan Shahr, Ropar and Patiala. Torrents are estimated to carry a huge runoff, ranging 1.49 to 83.77 million m^3/year with the bulk of rainfall which has brought 20 per cent of the region under severe erosion and 70 per cent under moderate to slight erosion and only 10 per cent under slight to moderate erosion. The intensity of torrent led degradation is extensive and severe and has been destabilising agriculture, settlements, etc. Consequently, the areas down below are subject to flash floods, debris deposits and excessive wetness while the rest of the Kandi area faces prolonged dry seasons and shortage of water the average annual rainfall ranging from 864.8 mm to 1163 mm, is unevenly distributed within the year and also fluctuates widely over the years causing recurrent flash floods as well as water stress. The fluctuations in seasonal rainfall both in *kharif* and *rabi* make farming and other biomass production a risky proposition and serious potential of excessive run-off and high soil loss. High erodible coarse textured and low organic matter soils lying on steeper slopes further strengthen the damage caused by erosion causing factors/agents (Singh and Khera, 2008).

The Integrated Watershed Development Project (Hills-II) in Himachal Pradesh covers the ecologically fragile areas of the lower Shiwaliks in the catchments of Ghaggar, Markanda, Sirsa, Swan and Chakki rivers, located in five districts, viz., parts of Sirmour, Solan, Una, Kangra and Chamba districts. In Himachal Pradesh, during the monsoons, the tributaries of the main rivers carry a high load of silt, which causes enormous damage in the plain areas to agricultural land, buildings, dams etc. The region though receives good annual average rainfall of about 1300 mm but 80 per cent of it is received during the rainy season (mid-June to mid-September), which is preceded and followed by long dry spells of 3 to 4 months at a stretch. Most of the rainwater is wasted as surface run-off resulting in accelerated soil erosion and increased rate of siltation causing havoc and miseries to the areas down below. Below subsistence agriculture, lack of employment opportunities, large number of unproductive livestock, depleting forest and fodder resources are responsible for poor socio-economic conditions of the local population resulting in poverty, illiteracy and other associated problems (TERI, 2006).

The Shiwalik foothills of Haryana were completely denuded during the last century due to the onslaught of man and cattle as well as problems of severe soil erosion, sedimentation and floods. All the efforts made so far to rehabilitate this area have proved futile due to problems of grazing and illicit felling of trees, etc. Although this region has an average annual rainfall of about 1200 mm, most of it

goes waste as run-off during the monsoon season due to lack of availability of any conventional water harvesting structure (TERI, 2006). The problematic area of the Shiwalik belt falls in Ambala, Panchkula and Yamuna Nagar districts. The altitude of the area ranges from 300 metres to 1499 metres. The area forms the watersheds of five main streams called Sirsa, Ghaggar, Dangri, Markanda and Yamuna rivers.

The state of Jammu and Kashmir is divided into three main regions, namely, Jammu, Kashmir and Ladakh. The IWDP Hills II project area includes two sub-watersheds in the sub–tropical belt of the Shiwaliks in the Jammu region and two in the temperate Karewas in the Kashmir region, covering an area of 1,11,080 ha. The average annual rainfall in Jammu is around 1150 mm, out of which around 80 per cent is received during the monsoon months with a high degree of coefficient of variation. Apart from the broad climate variation, the micro-climatic conditions within the Shiwaliks vary drastically.

Methodology Adopted

The comparative methodology adopted by the evaluating agencies is depicted in Table 2. The watershed project was evaluated by different agencies using two approaches in the participating states - 'with project and without project' approach and 'ex-ante and ex-post' approach. The above analysis indicates that the impact evaluation of four states adopted the approach of "with-without" project and "before and after" project (Uttaranchal, Punjab, Haryana and Jammu and Kashmir). In Himachal Pradesh only one approach of evaluation was adopted, i.e., before and after the project. In Himachal Pradesh, control villages were not taken into account, since as stated by the state evaluation report, there was not even a single village which was not covered under the project. The study of "control" villages helps to assess as to what quantum of the impact was due to project influence and how much of it was due to the wider changes happening in the state. In Jammu and Kashmir, four control villages were selected on the basis of social stratification. The Punjab evaluation had five control villages (one in each district) selected in consultation with the project authorities. The control villages were located near the project villages. The Uttaranchal evaluation included 10 control villages. The size of sample is the same in all the states with regard to the project villages, which is 10 per cent of the total project villages. With regard to the number of households in the sample, all states except Haryana followed a uniform size, i.e., 20 per cent of the households in the project villages. A sample of 96 and 164 families was drawn from the sampled villages of the upper and lower project areas, respectively in Haryana; whereas, 62 villages and 605 households were selected for evaluation in Himachal Pradesh covering 15 MWS, were selected in five project watersheds representing 10 per cent of the total 129 MWS in the project area. Based on geographical location and proximity to market centres, 21 sample villages were selected in Jammu and Kashmir for evaluation with a total number of 765 households including 50 households from

TABLE 2. METHODOLOGICAL APPROACH ADOPTED BY EVALUATING AGENCIES

(per cent)

State (1)	Evaluating agency (2)	Project implementing agency (3)	Approach (4)	Sample size		Type of sample (7)	Tools and techniques (8)
				Village (5)	House-holds (6)		
Uttaranchal	Consulting Engineering Services, India Pvt. Ltd.	State Forest Department	With – Without and Before -After	10	20	Stratified random sampling	Participatory Rural Appraisal, Household Survey, Participatory Village Transect Survey (PVTS) Direct measurement
Punjab	Consulting Engineering Services, India Pvt Ltd	State Forest Department	With – Without and Before -After	10	20	Stratified random sampling	Village profile and semi-structured PRA, household survey, biometric survey
Himachal Pradesh	Consulting Engineering Services, India Pvt. Ltd.	State Forest Department	Before -After	10	20	Stratified random sampling	Semi-structured pre-devised format questionnaire, Group discussions
Jammu and Kashmir	Chaudhry Charan Singh Haryana Agricultural University, Hissar	State Forest Department	With – Without and Before -After	10	20	Stratified random sampling	Questionnaires, Interactive workshops, Participatory Village Transect Survey (PVTS)
Haryana	DHV Consultants Pvt. Ltd., New Delhi	State Agricultural Department	With -without and Before –After	10	10	Stratified random sampling	Survey method, Pre tested schedules.

Source: Information compiled by the authors using evaluation reports of the IWDP (Hills-II) Project of the states and TERI Report, 2006.

control villages. Likewise, in Punjab and Uttaranchal, 540 and 577 sample households were selected, respectively with 67 households in 10 control villages in Uttaranchal.

Project Interventions and Impact

The Integrated Watershed Development Project (IWDP) Hills-II was unique in nature as it was not only confined to water management but a holistic approach was adopted to sustain the resource base of Shiwaliks and increase its productive capacity. So all sectors were targeted under this programme in collaboration with the line departments, viz., agriculture, horticulture, forestry, animal husbandry and soil conservation. The interventions were made on all fronts in the project villages with emphasis on the participatory approach and institutional development to achieve sustainability.

Institutional Development

Strong and pro-active institutions play an important role in the smooth conduct and development of any area. The motivation for institutional reforms in case of natural resource management (NRM) has arisen from the emerging resource scarcity and the need to overcome the tragedy of common property resources (CPRs) and greater competition for rights of access and exploitation. Institutional reforms are now widespread and are transforming the local institutional infrastructure for NRM (Sudan, 2004). Almost all developing countries are undertaking institutional reforms and many are decentralising some aspects of NRM (Dillinger, 1994; Totemeyer, 2000; Therkildsen, 1993). Development agents, natural resource managers and many environmentalists believe that decentralisation can be a way of increasing both efficiency and equity in NRM (Smoke, 2000; World Bank, 2000, Conyers, 2000). The participatory approach was the main strategy followed in implementing the Integrated Watershed Development Project (IWDP-II) to overcome the lacunae of the non-existence of watershed institutions in the first phase of the IWDP project. The various types of institutions formed and their functioning as well as performance is tabulated (Table 3) and described in the section. As an essential component of the participatory approach, three main institutions were created: Village Development Committees (VDC), Self Help Groups (SHGs) and User Groups. Strong and proactive village institutions are the main fulcrum around which the success of all future strategies and interventions of the project depends. Therefore, the focus of the project in all the five project states has been on institution building mechanisms. Village Development Committees (VDC) were formed to act as an umbrella institution under IWDP. The formation of VDC generally began with the formation of general houses which comprise one male and one female member from each household in the project village. The VDC executives are elected which usually

TABLE 3. INSTITUTIONAL DEVELOPMENT AND CAPACITY BUILDING

State	VDCs				SHGs			Capacity building	
	No.	Percentage of SC/ST/OBC as EC members	Percentage of women as EC members	Revolving fund (lakh Rs.)	No.	Inter-loaning (per cent)	User groups (No.)	Persons trained (all)	Vocational trainings
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Himachal Pradesh	143	30	50	42.58	254	55	319	131744	6673
Uttaranchal	505	19	39	157.11	497	67	924	68000	30840
Punjab	270	20	40	122.31	329	68	N.A.	120249	78899
Jammu and Kashmir	200	20	28	26.16	195	45	237	21000	8700
Haryana	174	20	40	12.80	129	60	N.A.	7000	1983
Total	1292			360.96	1404			347993	127095

Source: Data compiled by the authors using evaluation reports of the IWDP (Hills-II) Project of the states.

comprise 7 to 15 members depending upon the population size. The executive represents all sections of the society so that the interests of all segments of population get due representation. Byelaws were developed by VDCs to facilitate strong and viable institutions. The main role of VDCs was in planning for village development and execution of works. The VDCs prepared the plans for implementation with the help of PRA based micro planning techniques. The PRA plan contained information on social and natural resources, a detailed report on the interventions required to conserve and manage land, water and forests and to increase biomass production. So a bottom up - demand driven approach was followed in a decentralised mode. The concept of 'cost sharing' was introduced in VDCs to ensure a feeling of ownership among the beneficiaries and to improve sustainability aspects. In the IWDP villages, the villagers were convinced that by becoming a member and contributing to the VDC fund, they would gain rights to participate in decision making processes. Each VDC has a revolving fund and a savings account in a bank to meet future expenses on management and maintenance of the assets created through the project. Inter loaning takes place among the members of VDCs for different needs.

Self-help groups (SHG) were formed around specific issues confronting the poor or specific production activities. The SHGs were constituted in the project villages by a group of 10-20 village women generally poor, who were motivated by the project staff to come together for pooling savings as a common fund. This small savings fund made credit easily available at reasonable rates of interest, in times of emergencies. Inter loaning was found common among all SHGs which varied from 45 per cent to 68 per cent across the states. The loan was provided to meet consumption and production needs. These groups were linked with banks on completion of six months of their account opening in the bank. This linkage with bank provided them with the facility of taking additional loans.

User Groups formed were component specific comprising households that derived benefits from a particular community asset. Broadly these were groups of forestry, soil conservation, irrigation, horticulture, animal husbandry, common resources, agriculture, etc. At a later stage, to increase involvement of the community, the project initiated formation of user groups for the services or activities undertaken by the project or VDCs. They generally kept a fee for the facility availed and the same fund was utilised for repair, maintenance and upkeep of that asset.

Capacity building pertains to strengthening of social development processes through trainings, workshops, exposure visits through knowledge and skill building interventions. The project has been continuously involved in facilitating local level, unit level and state level trainings on various technical and management issues. Capacity building was given high priority among all the project states. Himachal Pradesh occupied top position followed by Punjab, Uttaranchal Jammu and Kashmir and Haryana. With regard to vocational trainings, Punjab conducted maximum trainings and exposure visits for the project beneficiaries. Uttaranchal, Jammu and Kashmir, Himachal Pradesh and Haryana followed the same. In Himachal Pradesh

different trainings were conducted for SHG members on relevant topics and skill upgradation. These institutions were expected to sustain the project initiatives after the project withdrawal which needs to be studied by the researchers so that effective suggestions and outcomes in the form of policies can come as a guiding principle in future development and implementation of such programmes.

The representation of SC, ST and OBC as executive committee members was found fair across the states which ranged from 19 to 30 per cent. Similarly, the gender composition in the executive committee was encouraging as women membership ranged between 28 to 50 per cent across the states. Jammu and Kashmir has relatively less participation of 28 per cent, much below the expected norm of 33 per cent which may be attributed to the socio-political situation in the state. Though there has been a paradigm shift in soil and water conservation measures from an isolated approach to an integrated watershed development programme with active involvement of the farming community, particularly the weaker sections and women. However, women's participation in watershed development projects should not merely be judged by the number of women working as labour or by their 'proxy presence' in meetings but by making them an integral part in the decision making process and instilling a sense of belonging in the development programmes (Arya, 2007).

Improving Productive Potential and Sustaining Resource Base

There is ample evidence and research in India and abroad that with an increase in the productive potential of agricultural systems, there has been a dwindling natural resource base which primarily includes land/soil, water resources, biodiversity etc. Singh *et al.* (1992) attempted to prepare a country-wide map of soil erosion rates for land use planning which revealed severe erosion areas with more than 20 mg/ha/year (9 tonnes/acre/year) in the Shiwalik hills, north-western Himalayan region and the shifting cultivation regions. So it was imperative to reverse the trend and the central motive of the IWDP (Hills-II) project was to improve the productive potential through a sustaining resource base with evolving watershed technology and participatory approach mechanisms. Various interventions were made by the project implementing agencies to improve the productive capacity in conformity to sustain the resource base of the Shiwaliks. These interventions include the development of arable lands under agriculture and horticulture for improved productivity; development of non-arable land under forests, pastures/grazing for enhancing green cover and productivity; drainage line treatment for the stabilisation of gully systems, the control of stream bank erosion with a reduction in run-off and sediment outflow; water resource development through various water harvesting structures and systems, renovation of ponds and tanks with a view to create a potential for irrigation and increased availability of water for live stock and domestic uses; live stock development through stock upgradation, improved health care, enhanced facilities and services, helping nomads, etc.; rural infrastructural development, such

as strengthening roads and focal points, improving the availability of potable drinking water, water harvesting for domestic uses, etc.

The impact of these interventions is summarised in Table 4 as Performance Indicators. A variety of soil conservation measures to counter the inherent as well as induced hazards of erosion and land degradation were undertaken by the project implementing agencies in these areas. Soil and water conservation measures were taken up with a vegetative treatment and the construction of water harvesting structures were undertaken in down stream. Minor engineering measures such as vegetative check dams, dry stone check dams, crate wire check dams, river bank protections and landslide treatment works were also taken up in the project areas. As a result of these measures the run-off has decreased substantially in the project areas. Jammu and Kashmir and Punjab were successful in containing the soil loss whereas, Uttaranchal, Himachal Pradesh and Haryana had also shown significant progress in this direction. A large percentage of farmers adopted soil conservation practices on their fields which primarily included terracing and bunding besides vegetative measures.

Due to project interventions water harvesting structures were constructed and extended to many villages in order to tap this additional water for growing vegetables and high value crops as well as for irrigating traditional crops like wheat and paddy. An additional area of 12254 hectares was brought under irrigation. As a result, the area under irrigation and irrigation intensity had improved, which was reflected in higher crop yields and more production due to the area expansion. However, the most important factor for this achievement is the quantitative and qualitative improvements in irrigation facilities which enabled the farmers not only to increase the yields of their crops but also to take more number of crops from the same plot in a year which is reflected by an increase in cropping intensity. Uttaranchal has experienced the maximum percentage of an increase in irrigation due to project interventions. Punjab and Jammu and Kashmir also showed good improvement followed by Himachal Pradesh. Haryana witnessed a relatively less increase. Productivity has shown a remarkable achievement in all states with an average increase in wheat yield by 0.79 tonnes per hectare and that of maize by 0.45 tonnes per hectare. The percentage increase was found to be maximum in Uttaranchal in both crops followed by Jammu and Kashmir in the case of wheat.

Livestock is an important component of hill agriculture. It occupies a major position in the rural economy due to difficult terrain, small-sized land holdings, climatic condition and food habits. It provides organic manure as fertiliser, dung as fuel, draught power to farmers for cultivation, milk as a balanced diet component for household consumption and also for sale. The strategies and project interventions undertaken included upgrading of local livestock and increasing milk yield, promoting stall feeding, rendering improved healthcare, increasing the nutrient availability of animals by fodder minikits, silvipasture, fodder grass, etc.; diversifying livelihood through other income generating activities like goatery, sheep, piggery,

TABLE 4. IMPACT INDICATORS OF IWDP (HILLS-II) PROJECT IN SHIWALIK STATES OF INDIA

Indicator (1)	Himachal Pradesh			Haryana			Uttaranchal			Jammu and Kashmir			Punjab		
	Baseline (2)	Final (3)	Percentage change (4)	Baseline (5)	Final (6)	Percentage change (7)	Baseline (8)	Final (9)	Percentage change (10)	Baseline (11)	Final (12)	Percentage change (13)	Baseline (14)	Final (15)	Percentage change (16)
Run-off (SOP) (per cent)	32	24.8	-7.2	6.74	0.97	-5.43	60.5	56	- 4.5	37	19	-18	45	28	-17
Percentage of farmers adopted soil conservation measures		67			90			95			80			90	
Irrigation intensity (per cent)	140	149	+9	143.39	145.61	+2.22	150.29	176.36	+26.07	144	157	+13	155.07	168.39	+13.32
Area brought under irrigation (ha)		3597			2538			4226			311			1582	
Cropping Intensity (per cent)	170.49	178.80	+8.31	148	153	+5	184.3	191	+6.7	129	167	+38	160	183.01	+23.01
Crop yield wheat (t/ha)	1.18	1.66	+40.67	2.07	2.70	+30.43	1.50	2.85	+90	1.10	1.80	+63.63	1.54	2.30	+49.35
Crop yield maize (t/ha)	1.28	1.58	+23.43	1.41	1.60	+13.47	1.53	2.61	+70.58	2.40	2.60	+8.33	1.09	1.58	+44.95
Forage yield (pvt. land) (t/ha)	1.16	7.0	+503	1.73	5.93	+243	3.30	4.72	+43	0.4	1.72	+330	0	5.00	
Forage yield (RF) (t/ha)	0.42	4.4	+947	1.41	2.97	+110	3.30	4.72	+43	0	0		0	0	
Horticulture plantation (ha)	-	3348		-	812		-	2602		-	4314		-	907	
Horticulture plantation survival (per cent)	-	57		-	58		-	93		-	75		-	65	
Forest plantation (ha)	-	20790		-	9632		-	19489		-	11292		-	20358	
Forest plantation survival (per cent)	-	72		-	85		-	70		-	71		-	78	
Milk yield (Cow Local) (litres/day)	1.69	2.56	+51.47	1.6	3.37	+110.6	1.70	3	+76.47	2.80	4.3	+53.57	2.10	3.50	+66.66
Milk Yield (Buffalo) (litres/day)	3.5	5.12	+46.28	2.7	4.7	+74	3.64	5.17	+42	3.50	5.3	+51.42	3.50	5.50	+57.14
Employment generated (in lakh man-days)		3.85			61.53			106			9.93			66	
Internal Rate of Return (IRR)		26.8			27			24			-			25.9	
Benefit-Cost Ratio (BCR)		1.6			1.5			1.72			-			1.7	

Source: Data compiled and calculations done by authors using evaluation reports of the IWDP (Hills-II) Project of the states and TERI Report, 2006.

poultry, integrated fishery-cum-piggery-cum-poultry, integrated fishery-cum-duckery and thus helped in improving the economic conditions of the population in the project area. The performance indicator of increase in milk yield after project interventions shows a major improvement in yield. However, the percentage increase in milk yield was experienced more in the case of cow than that of the buffalo across all states. The quality of livestock was upgraded by breed improvement through NBC services, artificial insemination and reduction of poor quality unproductive heads through castration. This has helped in increased population of improved cows and oxen.

Development of horticulture in hill agriculture is very crucial for sustaining the economy of such regions. Large scale plantation of horticulture plants over an additional area of 11983 hectare was brought under cultivation. This has led to an increase in green cover, vegetation and an increase in the income of stakeholders. Jammu and Kashmir has undertaken maximum horticultural plantations followed by Himachal Pradesh and Uttaranchal. Uttaranchal has recorded very high survival rate (93 per cent) followed by Jammu and Kashmir (75 per cent) and Punjab (65 per cent). Large size of horticulture plantations developed in Jammu and Kashmir and Uttaranchal coupled with high survival rates showed a positive impact of the IWDP-II project. Likewise, an area of 81556 hectares of non-arable land was brought under forest plantations. The basic objective of forestry activities in the project was to ensure soil and water conservation through rehabilitation of degraded community, private and government land. Land use imbalances or ecological alienation has been substantially neutralised by enlarging areas under perennial cover through afforestation, agro forestry and horticulture planting. This has helped to enhance the composite indicator namely effective Watershed Eco Index (WEI) from 29 per cent in pre-project period to 40 per cent after the project implementation (TERI, 2006).

The total net benefits for the project as a whole were worked out and the internal rate of return (IRR) was estimated from the net incremental benefits derived from various project components under arable and non-arable lands. These benefits were aggregated to work out the net incremental benefits with projections for a period of 30 years. The IRR ranged between 24 to 26.8 per cent across the states which showed the viability of the project. Sensitivity analysis was carried out for changes in benefits and it was found that even if the benefits are reduced by 10 per cent, the IRR works out to be 22.6 per cent for both Punjab and Himachal Pradesh and 20.3 per cent for Uttaranchal. Thus the project is viable even if sensitive to changes in the net benefits. The project is viable in both Himachal Pradesh and Punjab since the IRR exceeds 12 per cent (discount rate). The B-C ratio at 12 per cent worked out to be 1.6 for the project in Himachal Pradesh; 1.5; 1.72 in Uttaranchal and 1.7 in Punjab which exceeds one.

Adoption of Sustainable Agricultural Practices

The highly input-intensive conventional agricultural production systems seem to be becoming unsustainable. Organic farming is a major alternative because of the

increasing realisation that accumulation of chemical residues in the soil, water and plants as a consequence of continued and inefficient use of chemical fertilisers and pesticides can result in severe human and animal health problems. Though organically managed farms produce lower yields in the initial years than conventional chemical based farming, farm-produce through the use of organic manure fetches a higher price in the market. Moreover, advances in technology for efficient organic management of soil fertility is making it possible to raise the productivity and profitability of organic farms and the conservation of agro ecosystem. Keeping these advantages and sustainability of farming in Shiwaliks, initiatives to form bio-villages or organic villages were undertaken in the project areas. Uttaranchal took a lead role with the active support of government agencies to form these bio-villages under which organic agricultural production took place and also formed an example for other villages. In Haryana for the improvement of soil fertility and to minimise the effect of chemicals on soil and human beings, demonstration on vermin-compost making were given at about 100 places. The use of bio-pesticides was also started. Trainings were imparted to the staff and farmers to create awareness about the bad effect of chemicals on humans and animals.

In Himachal Pradesh 164 villages of 76 VDCs were selected as bio-villages for the complete use of bio pesticides to provide organic farming. About 1778 farmers were benefited so far. Besides, in the Parwanoo (HP) unit, 168 farmers of 11 organic village groups covering 10 VDCs had formed a federation for marketing the organic produce. Farmers' training camps have been organised for imparting training to the farmers to stop the use of insecticides and pesticides by inviting resource personnel from Krishi Vigyan Kendras (KVKs).

Watersheds in North-East Himalayan States and Its Impact

The North-Eastern Region (NER) comprising eight states has remained far behind in the growth and development of the country. Undulating topography, vulnerability to natural calamities, road infrastructure, social unrest and insurgency had severely affected its pace of development. Agriculture being as an important economic sector in the NE region contributes about 30 per cent to gross domestic product and is the main source of livelihood for a majority of the rural population. However, agriculture in the region is characterised as subsistence, low input and technology laggard (Birthal *et al.*, 2006). On the other hand, the region has several unique features in the form of fertile land, abundant water resources, evergreen dense forests, high and dependable rainfall, mega biodiversity and an agriculture friendly climate. Yet it has failed to convert its strengths optimally into growth opportunities for the well being of the people (Barah, 2006).

The salient features of the North-eastern hill states are given in Table 5. The topography of the region is highly rugged with an altitudinal variation from 500 to 8585 metres above mean sea level (amsl). The climate of the region ranges from sub-

tropical in the plains to temperate in the hills with an average annual rainfall varying from 1000 to 4000 mm and temperature ranges from sub zero to above 30 degrees Celsius. The various soil groups found in the region are alfisols, entisols, inseptisols, moililisols and ultisols (Mishra, 2004). The percentage of net sown area (NSA) ranges from as low as 2.98 per cent in Arunachal Pradesh to 35.34 per cent in Assam. The population density seems to have close relation with the percentage of net sown area across the NE states which clearly shows that biotic pressure from human beings and livestock increase the pressure for cultivation of these fragile lands. The percentage of net irrigated area (NIA) varied from 8.18 per cent in Sikkim to 26.43 per cent in Meghalaya. A major area of irrigated area in Meghalaya is served by watershed projects.

The NER region endowed with problems of; uneven topography, soil erosion, small landholdings, *jhuming* practice, and opportunities of; fertile land, high and dependable rainfall and agricultural friendly climate can be a best bet for the development of watershed programs on large scale. The region is confronted with two major technical and water related problems (i) heavy and intense rainfall and surface run-off during monsoons leading to soil erosion and siltation or pollution of water bodies downstream and (ii) drought situation in the months of February to April, leading to acute scarcity of water for spring season crops. These two extreme eventualities need to be managed for enhancing agricultural productivity, augmenting income and preventing the degradation of soil and water, which can be best addressed by watershed programs (Shaheen *et al.*, 2008).

The North-East Region is characterised by the *jhum* practice or shifting cultivation problem. Shifting cultivation, regarded as the primitive step in transition from food gathering to hunting and food production, is a primitive practice of cultivation. In the days when this system of food production emerged, it worked well and there was a balance between fallow cycles of 20-30 years. With increasing population pressure the *jhum* cycle has slowly reduced to 3-6 years thereby, causing a serious threat to land degradation and ecological problems. As per the report of the Task Force on the Development of Shifting Cultivation Areas, constituted by the Ministry of Agriculture in 1983, the total area affected by the *jhum* practice was 43.57 lakh hectares in the States of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Orissa and Tripura. In the seven states of the North-East (As per ICAR Research Complex for NEH Region) a total of 14.66 lakh ha was affected with the *jhum* problem involving 4.433 lakh *jhumia* families. In order to address the problem of Shifting Cultivation, the Government of India took a major initiative by launching the Watershed Development Programme for Shifting Cultivation Areas (WDPSCA). The WDPSCA programme was taken up during the Fifth Five Year Plan as a pilot project with 100 per cent financial assistance from the Central Government and was implemented through the Ministry of Agriculture. The scheme was launched during the year 1976-77 covering the whole of the North Eastern States along with the States of Andhra

Pradesh and Orissa. After an operation of 2 years, the scheme was transferred to the state sector as per the decision of the National Development Council (NDC).

A total of 1700 *jhumia* families were benefited with an expenditure of Rs.129.71 lakhs in its initial phase. During the VII Plan, in persuasion of the recommendation of the Task Force on Shifting Cultivation (1983), the Scheme for the control of Shifting was implemented with 100 per cent central assistance to the State Plan Program from 1987-88 to 1990-91 in nine States covering 7 North-Eastern States, Andhra Pradesh and Orissa. Consequent to the decision of NDC, the scheme was again transferred to the State Sector and was discontinued w.e.f. 1991-92. During the VII Plan also the scheme was implemented through the Ministry of Agriculture on the basis of the family development approach and 26512 *jhumia* families were benefitted under the programme with an expenditure of Rs. 60.72 crores. On pressing demand from the North Eastern States, the Planning Commission agreed for revival of the scheme for the North-Eastern Region only as an Additional Central Assistance to State Plan Scheme from 1994-95 onwards. Accordingly, the scheme is being continued in seven North Eastern States, on a watershed basis with 100 per cent additional assistance to the State Plan in the name of Watershed Development Projects for Shifting Cultivation Areas (WDPSCA).

The Government of India (GOI) undertook strategic investments through the watershed approach for the development of rainfed areas in the country and for the sustainable management of natural resources in the region. The National Watershed Development Programme for Rainfed Areas (NWDPRA) introduced at national level in 1986-87 was started in NER lately by 1990-91. The funding pattern was 75 per cent grant in aid and 25 per cent as loan to the states. The NWDPRA programme launched in the VIII Plan was further continued in Ninth and Tenth Five Year Plans. Apart from these, the Integrated Wasteland Development Project Scheme (IWDP) taken up by the National Wasteland Development Board also aimed at developing wastelands on a watershed basis in the region.

Watershed programmes were initiated over a wide range of “agro-ecoregions” and were planned, developed and implemented by various government agencies. A review of the available reports (37 in number for North Eastern States) indicate that the past investment in watershed programmes yielded positive results like raising the incomes, generating employment opportunities and conserving the natural resource base. A summary of the multiple benefits derived from these programs is presented in Table 5.

It is worth mentioning that the watershed programmes were launched in the region with four principal objectives, namely, improving production efficiency, equity, sustainability and abandonment of *jhumia* (shifting cultivation) practice in the NE region. To document these benefits proxy indicators were chosen and analysed. The benefit-cost ratio (BCR) and the internal rate of return (IRR) were used as proxies from efficiency gains from the watershed programmes, though, there is whole lot of criticism about the way in which BC ratio and the IRR are arrived at in the

TABLE 5. SALIENT FEATURES OF NORTH EAST HILL STATES

State/Parameters (1)	Geographical area (sq. km) (2)	Population density (3)	Climatic zone (4)	Rainfall (mm) (5)	Elevation (metre amsl) (6)	Net sown area (000' ha) (7)	Per cent of reported Area (8)	Net irrigated area (000' ha) (9)	NIA as percentage of NSA (10)
Assam	78438	340	Tropical monsoon climate with high humidity	2818	1000-1200	2774	35.34	172	6.20
Arunachal Pradesh	83743	13	Alpine-temperate-subtropical	2000 – 4100	530 - 3568	164	2.98	42	25.61
Manipur	22327	103	Temperate to subtropical	1467.5	790 – 2994	217	11.16	40	18.43
Meghalaya	22429	103	Subtropical to temperate alpine	3000	780 – 1961	227	10.19	60	26.43
Mizoram	21081	42	Temperate with mild climate	2540	1000 – 2000	98	4.70	16	16.33
Nagaland	16579	120	Tropical to subtropical	1800 – 2500	610 – 1800	305	19.27	67	21.97
Sikkim	7096	76	Subtropical to temperate	2739	3210 – 8585	110	16.37	9	8.18
Tripura	10486	305	Subtropical to temperate	1881	500 – 940	280	26.69	40	14.29
NE State (Total)	262179	148			500 - 8585	4175		446	
NE State (Avg.)				1000 - 4000			18.22		10.68
All India							46.06		39.11

Indian context. All these evaluation reports have been prepared by different organisations and most probably may not have adopted the same procedure in calculating these figures. Moreover, it is worth mentioning that the watershed programmes generate a substantial amount of 'non-market benefits and costs' which cannot be quantified easily in monetary terms. Additional employment generation in agriculture as a consequence of watershed activities was assessed as an equity benefit. Four important indicators were identified to demonstrate the sustainability benefits. These include (i) increased water storage capacity, which augment irrigation; (ii) increased cropping intensity; (iii) reduced run-off leading to a reduced soil loss; and (iv) abandonment of the *jhumia* practice, which conserve the natural resource base and made the people of region settle on farming. A similar approach was also used by the Joshi *et al.,* (2005 and 2008) in the meta analysis of watersheds and their impacts in India.

The mean benefit cost ratio of the watershed programme was modest at 1.79 indicating that the investment in watershed programmes in the North East region yielded nearly double the initial investment. Similarly, the mean internal rate of return on watershed investments was approximately 19.40 per cent, with a maximum of 39.25 per cent (Table 6). These results suggested that the watershed programmes performed reasonably well under these fragile and uncertain environments and that the investments were justified as income levels were raised within the target domains.

TABLE 6. IMPACT INDICATORS FROM THE REVIEWED WATERSHED STUDIES IN NORTH-EASTERN STATES (N=37)

Indicator (1)	Particulars (2)	Unit (3)	Mean (4)	Minimum (5)	Maximum (6)
Efficiency	B/C ratio	Ratio	1.79	1	4.04
	IRR	Per cent	19.40	10.5	39.25
	Agricultural Productivity	Per cent	28.89	1.75	73
Equity	Employment	Person days/ha/year	164	21	795
Sustainability	Irrigated area	Per cent	60.25	11.5	122.72
	Cropping intensity	Per cent	24.67	1	65
	Reduction in *jhum* area	Per cent	33.69	2	90
	Reduction in soil loss	Per cent	63	32	97

Source: Shaheen *et al.,* 2008.

A further important function of watershed programmes was to generate employment opportunities. This would have positive impact of alleviating rural poverty and in reducing income disparities among households. The mean additional annual employment generation in the watershed area on various activities and operation was 164 person days/ha/year. In those watershed projects that included multiple activities, employment generation increased to 795 person days/ha/year. The generation of employment opportunities within these rural communities will invariably increase their purchasing power with a corresponding decline in rural

poverty. Based on these observations, watershed investments may be viewed as a poverty alleviation programme in fragile areas.

Rainfed areas are confronted with acute problems of land degradation through soil erosion, and high levels of risk associated with agriculture due to variable rainfall. Technological interventions through soil and water conservation can greatly reduce the risk in rainfed degraded systems. The watershed programmes are largely aimed to conserve soil and water as a means of raising farm productivity. The available evidence revealed that both these objectives were accomplished in the watershed programmes. There is a mean reduction of 63 per cent in soil loss due to watershed interventions (Table 6). This has a direct impact on expanding the irrigated area and increasing the cropping intensity. On an average the irrigated area increased by 60.25 per cent, while the cropping intensity increased by 24.67 per cent as depicted in Table 6.

Watershed programmes launched in the North Eastern states had an important component of *jhumia* cultivation. *Jhum* cultivation in the region has become more hazardous as the process is repeated year after year and tribals move from one place to other for *jhuming*. There is progressive degradation of the production base due to large-scale deforestation by shifting cultivation with negative externalities in terms of severe soil erosion; low crop production; and elimination of important tree species as well as genetic resources of the region; thereby causing a total degradation on the natural resources resulting in the ecological imbalance in the area. In order to tackle the problem of *jhuming* and *jhumies*, the scheme for the control of shifting cultivation was launched (WDPSCA) with 100 per cent Special Central Assistance to the State Plan for NE States during VIIth Plan for five years starting from 1987-88 to 1991-92. This was continued in the subsequent Five Year Plans due to a persistent demand from the States of the North- eastern region. The major objective of these watershed Schemes in the region were aimed at the mitigation of the colossal ill effects of shifting cultivation caused primarily by its reduction in the *jhum* cycle and a total progressive degradation of production base in the hill ecosystem, by introducing and applying improved technologies for the proper treatment of land and water resources in the *jhum* areas of hill watersheds so as to improve production and productivity of crops on a sustainable basis. The ultimate objective of the scheme was to combat the problems of *jhuming* and *jhumies* in a befitting way taking watersheds as unit of development in order to lead the *jhumias* to be guided by the principles of a proper scientific land use technique according to its land capability and suitability.

The basic shift in strategy in the control of shifting cultivation in the VII plan to VIII Plan was focused on conservation, management and development of land and water with the village community as a whole on a watershed basis instead of settlement and resettlement of *jhumia* families alone. The conservation of land and water was aimed at integrated watershed development with scientific land use planning in an eco-friendly system which ultimately led to an increase in productivity and employment generation. The summary results on this account reveal almost 40

percent reduction in the area under *jhumia* cultivation under these watershed projects with a maximum of 90 per cent in area reduction. These benefits confirm that the watershed programs are a viable strategy to overcome several externalities arising from the degradation of soil and water resources. The above summary results of the reviewed watersheds clearly suggest that these programs successfully meted the objectives. These benefits have far reaching implications for rural populations in the rainfed environments. However, the benefits often vary depending upon the location, size, type, rainfall, implementing agency, and people's participation, among others (Joshi *et al.*, 2005).

CONCLUSIONS AND POLICY SUGGESTIONS

Increasing water scarcity is a serious threat arising from climate change and the Himalayas are facing its brunt through glacier retreat. The current water storage capacity for countries in the Hindu Kush-Himalayan region is much below the estimated needs for food security. For adaptation to climate change there is an urgent need for the potential utilisation of water harvesting structures through initiatives such as watershed management. The watershed interventions and their sustainability in the entire Himalayan states become more important as it sustains the livelihoods of millions of people in the entire Indo-Gangetic plains through the rivers which originate from them. The vulnerability of these hill eco-systems have been further accentuated by the increasing biotic pressure which in turn have put pressure on the productive potential of the region. So a proper balance needs to be maintained in sustaining the resource base vis-a-vis exploiting the productive potential of these areas. Hill agriculture in India is confronted with the problem of uneven topography, soil erosion, small landholdings, inaccessibility with poor road infrastructure and opportunities of; fertile land, high and dependable precipitation in the form of rain, snow and an agriculture friendly climate that can be the best bet for the development of watershed development programmes on a large scale. The reviews of the studies reveal significant achievement of these land and water based programmes in the hill states of India. Emphasis was put on institutional building, however, further improvements and successful models of institutional development need to be upscaled which can maintain, operate and govern the watersheds effectively on a sustained basis. Furthermore, these watersheds need to be connected with effective market linkages in order to get good returns out of the produce from these units which in turn will strengthen the belief and importance of such programmes as well as re-investment by the community people or beneficiaries in such interventions. A separate policy and guideline for watershed development programmes needs to be developed at a national level for hill states looking at the specific nature of the problems confronted by these states. The development cost per hectare as per guidelines should be more in the case of the hill regions where they have to transport

the masonry material by head load or by employing ponies to higher elevations and through difficult terrains which exacerbate the costs.

REFERENCES

Agenda 21, United Nations (2001); http://www.un.org/esa/sustdev.

Arya, Swarn Lata (2007), "Women and Watershed Development Programs in India: Issues and Strategies", *Indian Journal of Gender Studies*, Vol. 14, No.2, pp. 199-230.

Barah, B.C. (2006), *Agricultural Development in North-East India: Challenges and Opportunities*, National Centre for Agricultural Economics and Policy Research, Brief No. 25, New Delhi.

Birthal, P.S; A.K. Jha, P.K. Joshi and D.K. Singh (2006), "Agricultural Diversification in North Eastern Region of India: Implications for Growth and Equity", *Indian Journal of Agricultural Economics*, Vol. 61, No.3, July-September, pp. 328-340.

Conyers, D. (2000), *Decentralisation: A Conceptual Analysis*, *Local Government Perspectives: News and Views on Local Government in Sub-Saharan Africa*, Vol.7, No.1, pp. 8-17.

Dillinger, W. (1994), *Decentralisation and Its Implications for Urban Service Delivery*, Discussion Paper No. 16, p.8, Urban Management Program, The World Bank, Washington, D.C., U.S.A.

IPCC (2001), "Climate Change 2001: Impacts, Adaptation and Vulnerability", Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.

Joshi, P.K., A.K. Jha, S. P. Wani, Laxmi Joshi and R.L. Shiyani (2005), "Meta-Analysis to Assess Impact of Watershed Program and People's Participation", Comprehensive Assessment Research Report 8. Colombo, Sri Lanka: Comprehensive Assessment Secretariat.

Joshi, P.K., A.K. Jha, S.P. Wani, T.K. Sreedevi Joshi and F.A. Shaheen (2008), *Impact of Watershed Programs and Conditions for Success; A Meta Analysis Approach*, Global Theme on Agro-ecosystems Report No. 46, International Crops Research Institute for Semi-Arid Tropics, Patancheru (Andhra Pradesh).

Mishra, A.K. (2004), "Ensuring Resource Sustainability Through Efficient Management for Enhanced Rice Productivity in Watersheds of High Rainfall Hill Zones of North-East Himalayas", *Himalayan Ecology*, Vol .13, No.2.

Shaheen, F. A., P.K. Joshi and S.P. Wani (2008), "Watershed Development in North-East: Problems and Opportunities", Paper presented and published (full length) in the Conference Compendium of International Water Management Institute's 7th Annual Conference on 'Managing Water in Face of Growing Water Scarcity, Inequity and Declining Returns: Exploring Fresh Approaches', 2-4 April, 2008, International Crops Research Institute for Semi-Arid Tropics, Patancheru, Hyderabad.

Singh, M.J. and K.L. Khera (2008), "Soil Erodibility Indices Under Different Land Use in Lower Shiwaliks", *Tropical Ecology*, Vol.49, No.2, pp. 113-119.

Singh G., R. Babu, P. Narain, L.S. Bhushan and I.P. Abrol (1992), "Soil Erosion Rates in India", *Journal of Soil and Water Conservation*, Vol.47, No.1, pp. 97-99.

Smoke, P. (2000), "Fiscal Decentralisation in Developing Countries: Review of Current Concepts and Practice, Paper prepared for the United Nations Research Council for Social Development, Geneva.

Sudan, F.K. (2004), "Institutional and Transaction Costs in Natural Resource Management: A Study from Jammu and Kashmir", *Resources, Energy and Development*, Vol.1, pp. 55-74.

TERI (2006), "Overall Impact Evaluation Study of the World Bank Assisted Inetgrated Watershed Development Project (Hills-II) in the States of Punjab, Harayana, Uttaranchal, Himachal Pradesh and Jammu and Kashmir", prepared for Department of Agriculture and Co-operation, RFS Division, Ministry of Agriculture, Government of India, prepared by the Energy and Resource Institute, India Habitat Centre, New Delhi.

Totemeyer, G.K.H. (2000), "Decentralisation for Empowerment of all Units of Governance and Society: A Critical Analysis of Namibian Case", *Regional Development Dialogue*, Vol.5, No.1, pp.95-104.

Therkildsen, O. (1993), "Legitimacy, Local Governments and Natural Resource Management in Sub Saharan Africa", in S. Marcussen (Ed.) (1993), "Institutional Issues in Natural Resource Management "(Occasional Paper No 9), p.83.

Wani, Suhas P., P.K. Joshi, K.V. Raju, T.K. Sreedevi, J.M. Wilson, Amita Shah, P.G. Diwakar, K. Palanasami, S. Marimuthu, A.K. Jha, Y.S. Ramakrishna, S.S. Meenakashi Sundaram and Marcella D'Souza (2008), "Community Watersheds as a Growth Engine for Development of Dryland Areas: A Comprehensive Assessment of Watershed Programs in India", Global Theme on Agro-ecosystems Report No. 47, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Hyderabad.

World Bank, (2000), *Entering the 21st Century, World Development Report, 2000*, Oxford University Press, Oxford, p.108.

World Bank (2006), "Project Appraisal Documents: Integrated Watershed Development Project (Hills – II)", http://www.worldbank.org.