

# **Watershed Development in Northeast India: Impacts, Opportunities and Problems**



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## Abstract

The Northeast region is endowed with problems of undulating topography, soil erosion, small land holdings, *jhume* (shifting) cultivation, although it has fertile lands, high and dependable rainfall and agriculturally-favourable climate which can serve as the best-bet for the development of watershed programs on a large scale. Although a number of impact assessment studies have been done in past by various researchers and organizations on the watershed development programs, no thorough study has been conducted on the impact of watershed development programs carried out in the Northeastern region. It is in this endeavor, a study was attempted to assess the impact of watershed development programs in the region. The study is based on the review of evaluation reports as well as the case studies carried out under the project. The study assessed the performance of watershed programs by employing meta-analysis of 37 watershed case studies and micro-level studies of four watersheds in the region, which were implemented by different agencies/organizations under different watershed development programs have been documented. The results of meta-analysis of 37 case studies showed that all the watersheds in Northeast region were economically remunerative with an average B:C ratio of 1.79 with the average internal rate of return of 19.4. Agricultural productivity was increased by 28.9 per cent along with increased cropping intensity of 24.67%. The watershed interventions also reduced the area under *jhume* cultivation.

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# **Watershed Development in Northeast India: Impacts, Opportunities and Problems**

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# Contents

Introduction .....	1
Role of Watersheds .....	1
Problem Specification and Methodology .....	2
History of Watershed Programs in NE Region .....	3
Benefits of Watershed Programs .....	4
Case Studies .....	7
Umpling-Umrynjah Watershed (WDPSCA) .....	7
Lyngiong Watershed (NWDPPRA) .....	11
Wah Umroi (ICAR Model Watershed) .....	13
Nongpoh Watershed (NGO) .....	14
Lessons Drawn from the Case Studies .....	16
Sound Institutions.....	16
Equity .....	17
Sustainability .....	17
Sharing Costs and Benefits .....	18
Gender Issues .....	18
Market Linkages and Infrastructure .....	19
Technical Aspects .....	19
Watershed Ownership and Management .....	19
Conclusions and Future Directions .....	20
References .....	21
Appendix I: List of Reviewed Studies .....	23



## Introduction

Northeastern region (NE) in India comprising eight states has remained far behind in the growth and development of the country. Undulating topography, vulnerability to natural calamities, insufficient road infrastructure, social unrest and insurgency had adversely affected its pace of development and economy. Agriculture, as an important economic sector in the NE region, contributes about 30 per cent to the gross domestic product (GDP) and is the main source of livelihood for a majority of rural population. However, agriculture in the region is characterized as subsistence, low input and technology laggard (BIRTHAL et al. 2006). The geophysical conditions limit horizontal expansion of cultivable land. The percentage of cultivated area to total geographical area ranges from 2.2 per cent in Arunachal Pradesh to 35.4 per cent in Assam as compared to 43.3 per cent at national level. High growth of population (varying from 2.01 to 5.22 per cent per annum, except in Assam and Tripura) with a large proportion of small and marginal farm households, traditional and low input agricultural practices coupled with the problem of insurgency have affected the agricultural economies adversely in the region. The region is bestowed with fertile lands, abundant water resources, evergreen dense forests, high and dependable rainfall, mega biodiversity and agriculturally conducive climate. Yet it has failed to convert its strengths optimally into growth opportunities for the well being of the people (Barah, 2006).

Sustained supply of irrigation water is crucial to improving the production and productivity of agricultural crops, but only about 10 per cent of the total cropped area in the region is irrigated (FAI, 2003). The region has considerable surface and groundwater resources because of its location in the high annual rainfall zone, which varies from 1400 mm to 6000 mm across the NE states, but the water resource remains untapped due to uneven topography and difficulty in the construction of reservoirs.

## Role of Watersheds

The role of watershed programs in the development of rain-fed agriculture in India is well documented (World Bank 1990; Fernandez 1994; Farrington and Lobo 1997; Hinchcliffe et al. 1999; Kerr 2002; Kerr et al. 2002; Joshi et al. 2005 Wani et al. 2008). These studies bring forth the various issues related to watershed development programs such as management of common property resources, sharing of benefits and costs, multiple and conflicting uses of common property resources within watersheds, multiple and overlapping property rights regimes in watersheds, difficulty in encouraging social groups to organize around a spatial unit defined by hydrology, upstream/downstream issues, equity and gender, besides others. There is a voluminous research on various issues of watersheds through out the country, however, not a single study has been attempted at a comprehensive scale to measure the outcomes of such programs in the Northeastern region of the country, which have unique geography and social system than rest of the country.

The NE region endowed with problems of undulating topography, soil erosion, small landholdings, *jhuming* or the prevalence of shifting agriculture coupled with fertile lands, high and dependable rainfall and agriculturally-favourable climate can serve as the best

bet for the development of watershed programs on a large scale. The region is confronted with two major technical and water-related problems (i) heavy and intense rainfall and surface run-off during south-west (June-September) monsoon, leading to soil erosion and siltation or pollution of water bodies downstream and (ii) lack of water during 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 degradation of soil and water resources, which can best be addressed by a watershed program in the region.

Rain-fed agriculture in India occupies an important place in the developmental initiative as 60 per cent of the 142 million hectare is rain-fed, and productivity is low (1 t ha<sup>-1</sup>) although potential is high (Wani et al. 2009). India achieved self-sufficiency in food through Green Revolution. Integrated watershed management programs have shown the potential of doubling the productivity of rain-fed areas (Wani et al. 2003) by maintaining self-sufficiency in food while sustaining the natural resource base.

## Problem Specification and Methodology

A number of impact assessment studies have been made in the past for studying the impact of watershed development programs. However, no comprehensive study has been conducted on the impact of watershed development programs in the Northeastern region. It is in this endeavor, a study was attempted to assess the impact of watershed development programs in the region. The study is based on the review of evaluation reports as well as the case studies carried out under the watershed projects. In this regard, various departmental reports were studied to draw broad conclusions from the results reported in the paper. (Table 1). The study assessed the performance of watershed

**Table 1. Net sown and irrigated area in Northeastern states.**

Name of State	Net sown area (000' ha)	% of reported area	Net irrigated area (000' ha)	NIA as % of NSA
Arunachal Pradesh	164	2.98	42	25.61
Assam	2774	35.34	172	6.20
Manipur	217	11.16	40	18.43
Meghalaya	227	10.19	60	26.43
Mizoram	98	4.70	16	16.33
Nagaland	305	19.27	67	21.97
Sikkim	110	16.37	9	8.18
Tripura	280	26.69	40	14.29
NE average		18.22		10.68
All India		46.06		39.11

programs by employing meta-analysis adopted by Joshi et al. 2005. Meta-analysis is a statistical procedure that integrates and upscales numerous spatially and temporally distributed, combinable micro-level studies to distil logical macro-level policy inferences. The inferences drawn, based on meta-analysis, are often more objective and authentic. Based on the review of 37 case studies on watershed programs in Northeast region,

this study attempted to document efficiency, equity and sustainability benefits. A similar approach was followed by Joshi et al. (2005) for watersheds in the country excluding the Northeast states. The list of these studies is provided in Appendix I. Moreover, four case studies were conducted during 2007 with four watershed projects selected from those implemented by various departments/organizations under the watershed programs. The purpose was to study the performance of different watersheds as micro-case studies and assess their effectiveness with respect to targeted objectives.

## History of Watershed Programs in NE Region

The history of watershed management in India dates back to 1880 with the Famine Commission and then with the Royal Commission of Agriculture in 1928. Both commissions laid the foundation for organized research in a watershed framework. After Independence, the Government supported program started in mid-1950s, when the focus on watershed programs was sharpened with the establishment of the Soil Conservation Research, Demonstration and Training Centres at eight different locations of the country. The center started watershed activities in 42 locations mainly at small-scale level to understand the technicalities of soil degradation and options that contribute to soil conservation (Samra, 1997).

Northeast region is characterized with the *jhum* practice or shifting cultivation problem. Shifting cultivation 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 cultivation and fallow periods with fallow cycles of 20-30 years. With increasing population pressure the *jhum* cycle has slowly reduced to 3-6 years thereby, causing serious land degradation and ecological problems. As per the report of the Task Force on Development of Shifting Cultivation Areas, constituted by Ministry of Agriculture in 1983, the total area affected by *jhum* practice was 43.57 lakh ha in the states of Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Orissa and Tripura. In the seven states of Northeast (as per ICAR Research Complex for NEH Region) a total of 14.66 lakh ha was affected with *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 Program for Shifting Cultivation Areas (WDPSCA). The WDPSCA program was taken up during the Fifth Five Year Plan as a pilot project with 100% financial assistance from the Central Government and was implemented through Ministry of Agriculture. The scheme was launched during the year 1976-77 covering the whole of Northeastern states along with the states of Andhra Pradesh and Orissa. After operating for two years, the scheme was transferred to state sector as per the decision of National Development Council (NDC).

A total of 1700 *jhumia* families benefited with an expenditure of Rs.129.71 lakh in its initial phase. During the Seventh Five Year Plan, in persuasion of the recommendation of the Task Force on Shifting Cultivation (1983), the Scheme for Control of Shifting was implemented with 100% Central assistance to the State Plan Program from 1987-88 to 1990-91 in the nine states – 7 NE states, Andhra Pradesh and Orissa. Consequent upon the decision of NDC, the scheme was again transferred to state sector and was discontinued with effect from 1991-92. During the Seventh Five Year Plan the scheme

was implemented through the Ministry of Agriculture on the basis of family development approach and 26512 *jhumia* families benefited under the program with an expenditure of Rs.60.72 crore. On a pressing demand from Northeastern states, the Planning Commission agreed for the revival of the scheme for Northeastern region only as an additional central assistance to State Plan Scheme from 1994-95. Accordingly, the scheme is continuing in the seven Northeastern states, on watershed basis with 100% additional assistance to the State Plan under the Watershed Development Projects for Shifting Cultivation Areas (WDPSCA).

The Government of India (GOI) undertook strategic investments through watershed approach for development of rain-fed areas in the country through sustainable management of natural resources in the region. The National Watershed Development Program for Rain-fed Areas (NWDPA) introduced at the national level in 1986-87 was started in NE by 1990-91. The funding pattern was 75% grant in aid and 25% as loan to the states. The NWDPA program launched in the Eighth Five Year Plan 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.

## **Benefits of Watershed Programs**

Watershed programs have specifically been launched in the rain-fed areas with the primary objective of improving the livelihoods of poor rural households that are afflicted by a disproportionate degree of risk with respect to agrarian activities. Their net income levels are low and uncertain and their plight is further compounded by acute degradation of soil and water resources (Wani et al. 2003, 2008). The Government of India aggressively intensified watershed programs in fragile and high-risk ecosystems, where farm incomes drastically declined due to excessive soil erosion and moisture stress. It was anticipated that the watershed programs would augment farm income, raise agricultural production and conserve soil and water resources in the rain-fed areas through the process of applying appropriate technical and financial support (Joshi et al. 2005).

Watershed programs 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 Northeastern states) indicate that the past investments in watershed programs 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 2.

It is worth mentioning that the watershed programs 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 analyzed. The benefit-cost ratio (BCR) and the internal rate of return (IRR) were used as proxies from efficiency gains in the watershed programs. Though, there is a whole lot of criticism about the way in which BCR ratio and the IRR are arrived at in the Indian context as all these evaluation reports have been prepared by different organizations and probably might not have adopted the same

**Table 2. Impact indicators from the sampled watershed studies. (N=37)**

Indicator	Particulars	Unit	Mean	Minimum	Maximum
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 <sup>-1</sup> yr <sup>-1</sup>	164	21	795
Sustainability	Irrigated area	Per cent	60.25	11.5	122.72
	Cropping intensity	Per cent	24.67	1	65
	Reduction in <i>jhum</i> area	Per cent	33.69	2	90
	Reduction in soil loss	Per cent	63	32	97

procedure in calculating these figures. Moreover, it is worth to mention that the watershed programs generate 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 of benefits. These include (i) increased water storage capacity, which augment irrigation; (ii) increased cropping intensity; (iii) reduced run-off leading to reduced soil loss; and (iv) abandonment of *jhumia* practice, which conserve the natural resource base and make the people of region adopt the settled farming. Similar approach was also used by Joshi et al. (2005) in the meta-analysis of watersheds and their impacts in India.

The mean benefit cost ratio of watershed program was modest at 1.79, indicating that the investment in watershed programs in the Northeast region yielded almost 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 2). These results suggested that the watershed programs performed reasonably well under these fragile environments and that the investments were justified as the income levels were raised within the target domains.

A further important function of the watershed programs was to generate employment opportunities. This would have the positive impact of alleviating rural poverty and 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<sup>-1</sup> yr<sup>-1</sup>. In those watershed projects that included multiple activities, employment generation increased to 795 person days ha<sup>-1</sup> yr<sup>-1</sup>. Generation of employment opportunities within these rural communities invariably increase their purchasing power with a corresponding decline in rural poverty. Based on these observations, the watershed investments may be viewed as a poverty alleviation program in the fragile areas.

Rain-fed 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 rain-fed systems. The watershed programs are largely aimed to conserve soil and water as a means of raising farm productivity. The available evidences revealed that both these objectives

were accomplished in the watershed programs. There is a mean reduction of 63 per cent in soil loss due to watershed interventions (Table 2) minimizing land degradation due to water erosion. This has a direct impact on expanding the irrigated area and increasing the cropping intensity. On average the irrigated area increased by 60.25 per cent, while the cropping intensity increased by 24.67 per cent (Table 2).

Watershed programs launched in the Northeastern states have an important component of *jhumia* cultivation. Shifting cultivation, locally known as *jhuming* is one of the most ancient and traditional system of farming practiced by the local tribals on the hill slopes ranging from steep to very steep. The system is recorded as the first step in transition from food gathering and hunting to food production. *Jhum* cultivation in the region has become more hazardous as the process is repeated year after year and tribals move from one place to the other for *jhuming*. The *jhumias* do not own the lands as it belongs to Forest/Revenue department. Generally, areas having good forest growth or dense bamboo forest are selected for *jhuming* as they give good burn; consequently, give better yield of the crops. There is progressive degradation of the production base due to large-scale deforestation by shifting cultivation. Since the hill tops, particularly the catchment areas are the source of water, deforestation in the hills has led to the elimination of sources of water while increasing run-off water. The system is labour intensive with low technology. There are 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 degradation of the natural resources, resulting in an ecological imbalance in the area. In order to tackle the problem of *jhuming* and *jhumies*, the scheme for control of shifting cultivation was launched (WDPSCA) with 100% special central assistance to the State Plan for NE states during Seventh Five Year Plan starting from 1987-88 to 1991-92. This was continued in the subsequent five year plans due to persistent demand from the states of Northeastern region. The objective of WDPSCA Scheme aimed at mitigation of colossal ill effects of shifting cultivation caused primarily by its reduction in *jhum* cycle and a total progressive degradation of production base in the hill ecosystem, by introducing and applying improved technologies for proper treatment of land and water resources in the *jhum* areas of hill watersheds so as to improve production and productivity of crops on 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 proper scientific land use technique according to its land capability and suitability.

The basic shift in the strategy in the control of shifting cultivation in Seventh Five Year Plan to Eighth Five Year Plan focused on the conservation, management and development of land and water with village community as a whole instead of settlement and resettlement of *jhumia* families alone. The conservation of land and water aimed at integrated watershed development with scientific land use planning in an eco-friendly system, which ultimately leads to increase in productivity and employment generation. The summary results on this account reveal almost 40 per cent reduction in the area under *jhumia* cultivation under these watershed projects with a maximum of 90 per cent reduction in area. 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 results of the reviewed watersheds clearly suggest that these programs successfully met the

objectives. These benefits have far reaching implications for rural populations in the rain-fed 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).

## Case Studies

The watershed programs in the country were undertaken with multiple objectives ranging from the rehabilitation of degraded areas to conservation of the resource base and improvement of the productivity in agriculture (Joshi et al. 2004). In recent years, the watershed programs have become more focused on poverty alleviation and livelihood security (Sreedevi and Wani 2009). Though a number of studies ranging from case studies of individual watersheds to comprehensive assessment and meta-analysis studies have been conducted by different researchers, no work has so far been attempted to look into the performance of watershed programs in the NE region. In order to get an on-site assessment of the impacts of watershed programs and its benefits to the community, case studies were conducted through participatory rural appraisal (PRA) and discussions were held with the watershed committee members, SHGs, beneficiaries and landless along with the project implementing agencies (PIAs) of the watersheds. In all, four watersheds were selected, which were implemented by different agencies/organizations under different watershed development programs in the state of Meghalaya. The detailed case studies of these watersheds are documented in the following sections.

### Umpling-Umrynjah Watershed (WDPSCA)

The Umpling-Umrynjah Watershed program was done under the Watershed Development Program for Shifting Cultivation Areas (WDPSCA) sponsored by Ministry of Agriculture (MoA) Government of India and implemented by the Soil and Water Conservation Department Shillong, East Khasi Hills district, Meghalaya. The watershed development program was started in the year 1999-2000. The major objectives of the watershed development project were (i) to protect and develop hill slopes of *jhum* areas through different soil and water conservation measures on watershed basis and reduce the land degradation process, (ii) to encourage and assist *jhumia* families to develop *jhum* land for productive use with improved cultivation and suitable package of practices, (iii) to improve the socio-economic status of the people through household/land-based activities and (iv) to mitigate the ill effects of shifting cultivation by introducing appropriate land use/water management as per capability and improved technologies.

With this aim in mind, the project was formulated in the concept of watershed development and carried out in the organizational and committee set up. The watershed is located in the Northeastern direction on the Shillong Umroi Airport road at a distance of about 38 km under Myllem C&RD Block, East Khasi Hills district. The watershed lies geographically between 25° 39.6" and 25° 41.4" North Latitude and 91° 53.3" and 92° 0" East Longitude. It covers four villages: Umrynjah, Madan Mawkhar, Umphrew and Umjathang with a total number of 183 households. The total geographical area of watershed is 1300 ha with a net treatable area of 875 ha. The project cost was Rs.63.54 lakh with a project duration of five years.

In order to make the project a people's program by addressing their needs based on the priorities and available resources, the PIA did a PRA exercise using various techniques viz participatory mapping, wealth ranking, matrix ranking, Transect walk, Venn diagram with the villagers and an exercise was undertaken to understand what the people have to say on the need to practice bottom-up approach before formulating the watershed development plan.

With the focus to make people understand their own project empowerment, decentralization of the decision-making process was brought in by way of identification and recognition of existing village institutions namely, Durbar Shnong (village council). As a consequent, the Umpling-Umrynjah Watershed Association (WA) was formed and registered as per the Society Registration Act, in which members were made aware of their duties and responsibilities. The president and its members head the association. All the works taken up in the project were done in consultation of the WA. With a view to empower financially, a Watershed Development (corpus) Fund has been operated with the nearest bank as a fixed deposit through public contribution. Target groups contributed 5 per cent of the project works. The corpus fund when matures will be used for the maintenance of the assets after withdrawal of the project implementation agency. The total amount deposited so far is Rs. 2,04,804.

Watershed Committee (WC) was constituted at the lowest level of the village institution by the Watershed Association (WA), comprising representatives of village elders, user groups (UGs), self help groups (SHGs), youths and women groups. All members have been imparted trainings and made aware of their role and responsibilities. The committee has a chairman, and the secretary is drawn from the PIA. When the group becomes full fledged the secretary may be withdrawn and the committee may engage its own member if it feels desirable. The WC and facilitators supervise all works and day-to-day activities.

To create a sense of belonging among the watershed communities, certain activities by village communities were identified by the committee and such activities were taken up with the participation from the people through labor contribution. Entry point activities (EPAs) such as drinking well, washing place, community water harvesting structure, repairs of community hall, school building including footpaths were taken up on priority in all the four villages falling under this watershed.

In the watershed villages, SHGs were promoted and linked with financial institutions. State institute of rural development (SIRD) has been playing a pivotal role in this area. A good number of agricultural laborers, landless persons, women and youths, have been enrolled as members of SHGs. Separate groups were organized among women as they have been found highly successful in management of credit and thrift activity. Each group has 10-15 members. Twelve SHGs were formed under the Umpling-Umrynjah Watershed among which the seven groups have already been graded by Myllem C&RD block/bank, and DRDA have granted revolving fund of Rs.25000 each.

The watershed also witnessed the convergence of several R&D schemes such as providing drinking water supply under sampoorna grameen rozgar yojana (SGRY-I), indira awaas yojana (IAY), national old age pension scheme (NOAPs), swarnjayanti gram swarozgar

yojana (SGSY), etc., through district rural development agency (DRDA). Agriculture department provided high yielding variety (HYV) seeds of paddy, maize, soybean and conducted training programs on taking up specific crop production technologies in the watershed areas. Through Horticulture department, a sum of Rs. 30,000 was granted for taking up vermi composting under Technology Mission (TM) and Rs.40,000 for green house to SHGs under Umrynjah (WDPSCA). Other departments such as veterinary, public works department (PWD), district initiative for poverty reduction (DIPR), State Council for Education and Training and ICAR were also involved in the watershed development program. Various training programs were held for different categories of farmers such as training to watershed committee members on their roles, responsibilities in watershed community development, SHGs formation, watershed volunteers etc., were conducted at SIRD campus. Field visits to developed watersheds at ICAR, regional research and training centre (RRTC), Umran, and Vocational Training Centre (VTC) were held to apprise the target groups of the new technologies used in farm production and how to replicate those activities in their respective watershed areas.

The developmental activities carried out on arable land were in the form of contour bunding, peripheral bunding, agro-horticulture, crop demonstration, improvement of existing paddy fields, etc. Non-arable land treatment mainly included afforestation program, dryland horticulture, improvement of existing natural forest, establishment of compost nursery, etc. Furthermore, drainage line treatment in form of spurs/protection walls, small dug out ponds, check dams/diversion dams, water harvesting structures were taken up under the program.

## Impact

The farmers under watershed areas have diversified their farming practices by switching over to double and mixed cropping systems instead of mono cropping system as practiced earlier. In areas with assured irrigation facility, they grow paddy as the main crop, followed by subsidiary crops like potato, tomato and French beans, while as, under rain-fed conditions, the farmers grow ginger and maize as the main crops in mixture with other subsidiary crops like yam, bitter gourd, cucumber, soybean, French beans and pumpkin (Table 3).

**Table 3. Impact of watershed development program in Umpling-Umrynjah WS.**

Particulars/Indicators	Unit	Before	After	Change (%)
1. Cropping pattern		Mono-cropping	Double and mixed cropping	
2. Cropping intensity	%	138	213	75
3. Yield				
(i) Rice	kg ha <sup>-1</sup>	1325	2225	40.0
(ii) Maize	kg ha <sup>-1</sup>	750	950	26.6
(iii) Ginger	kg ha <sup>-1</sup>	500	740	47.5
4. Change in livestock composition and yield				NO
5. Farmers practicing <i>jhum</i> cultivation	%	90	7	-92.00
6. Area under <i>jhum</i> cultivation	ha	530	28.2	-94.56
7. Reduction in soil loss erosion	%			95.00
8. Increase in household income	%			23.00

During the discussion with the group of beneficiaries and members of WC, it was revealed that all farmers who were practicing *jhum* cultivation previously have now given up shifting cultivation except 6-7 farmers after the watershed program implementation. As per farmers' own assessment, with the adoption of contour bunding, they were able to arrest about 95% of soil erosion. There has not been much change in the composition of crops, only change is that they improved the cultivation of existing crops and have adopted a settled crop cultivation system. In terms of crop productivity, there has been increase of almost 40 per cent, which might mainly be attributed to HYV seeds and better irrigation. There is an increase of 23% household income from farming. Besides this, horticultural crops got introduced in watershed development program under which a number of fruit trees were distributed among the beneficiaries. About 399 ha area was brought under agro-horticulture system, 296 ha non-arable area was brought under dry land horticulture. Varieties of fruit plants such as guava, pear, lagoon pear, Khasi lemon, Assam lemon, *mosambi*, plum, peach, papaya, jack fruit, chest nut, etc., were distributed to beneficiaries and planted in their homestead/back yard garden. It was learnt that the survival rate of these fruit plants was about 85 per cent, which is quite satisfactory. Once these fruit plants came to bearing stage, it would change the household economy of the beneficiaries.

In order to address the equity issue, the watershed program also targeted poor and landless farmers in its developmental program through activities such as bee keeping, tailoring, piggery, pisciculture, vermicomposting, etc., through the formation of SHGs. Besides these special packages, landless people also benefited through labor work provided under watershed development program. Beneficiary cards were also maintained for Rehabilitation Program of *jhumia* families containing basic information about the beneficiary, his family, current income, activities taken up, disbursement of funds, progress and benefits which was being updated from time to time and for which separate funds were earmarked (17.5% of the project cost).

In an effort to make the project sustainable, community participation and contribution to the tune of 5% was made mandatory and this was achieved through participatory approach. The fund generated through labor contributions, calculated in terms of monetary value was deposited in the fixed deposit with RRB, Mawlai Branch and the same is to be jointly operated by president of WA and chairman of WC after the end of project for maintenance of assets created during the project period. The four WAs of four villages have a corpus fund of Rs.2, 04,804. Besides this, they have planned to collect a fixed amount from individual beneficiaries to maintain corpus fund for watershed activities. The respective WAs duly adopted a resolution that every household shall contribute 5% each time for every development activity to WDF, which will be maintained by the Executive Committee (Durbar Shnong). Fund may also be used to provide loans to SHGs at nominal interest besides helping the poor and needy in times of emergencies or natural calamities. Moreover, they have community forests from which they can generate the funds for maintenance of watershed structures after project withdrawal, which is scheduled in a short time period. The impact indicators of the Umpling-Umrynjah watershed are shown in Table 3.

## **Lyngiong Watershed (NWDPR)**

The Lyngiong Watershed was implemented by the State Agriculture Department under NWDPR (Tenth Five Year Plan). There were 78 watersheds under NWDPR in Meghalaya state, which were completed by September, 2007. The Lyngiong Watershed was chosen for case study as almost 95% of the interventions were already over. It is located on Shillong-Mawsynram road about 36 km from capital city Shillong. The total geographical area of watershed is 515 hectares with 292 hectares arable area and 207 ha non-arable area. The total project cost was Rs.16.50 lakhs. It covered six villages.

Before implementation of the WS program, the PIAs made a meeting with the *durbar shnong* (village council) in which they were made aware of the proposed project. After a few meetings, WC was formed which was selected by the general *durbar* committee members. With the formation and registration of WC, actual layout for developmental works was sorted out in consultation with the members. WAs were formed at village levels. Each WA comprised 7-10 members. There were three women members in six WAs, however, with a fair number of six in WC out of total 15 members. Besides this, there were six women SHGs in the watershed area.

The developmental works were done in terms of check dams, stream bank stabilization at upper watershed area in form of brush wood structures and boulders. There was considerable land reclamation in upper watershed area due to the developmental activities carried under watershed program. Besides this, a number of fishery ponds were constructed on private lands as well as community land. In case of private lands, the beneficiary for making the fishery ponds shared 20 per cent of the cost and rest came from the watershed program. The other activities include piggery, poultry, goat rearing, vermicomposting, etc.

### **Impact**

There is a shift from growing of traditional crops to high-value vegetable crops in the area due to increase in water availability and other inputs provided under the watershed program. The watershed villages were predominantly potato-growing areas with little paddy cultivation too. Under the watershed development program, pea cultivation was started by the farmers and better quality seeds were provided by the department. Pea cultivation had given good results to farmers with better incomes. Over all, there was an increase of 18-20 per cent in the yield of the various crops. The success story of piggery rearing and poultry farming under the watershed development program is documented (Box 1).

## Box 1

### Micro-enterprises to Enhance Family Incomes

Mr. Pranshon Jala was supplied 10 cross-bred piglets by the PIA under watershed program worth Rs.10, 000 on full subsidy in February, 2006. He started with these piglets and sold them after every 7 months. These were exclusively reared for pork purpose. Their litter has been used as farm yard manure for vegetable cultivation. He enhanced his piggery rearing scale and sold three batches of pigs every year. He made three pig sheds and is planning to construct additional sheds. As per his own assessment, he has been getting a net income of Rs 65,000 per annum from the piggery farming. Observing Mr Jala's success, more farmers plan to take up pig rearing.

Mrs Maygreen Kharbteng started poultry two years back with her own resources. She constructed a low-cost poultry shed with an initial investment of Rs.6, 500. The PIA under watershed program supplied her 200 broiler chicks to start her poultry farming. She has been selling five poultry batches in a year with 150-160 number of broilers per batch. One broiler on an average fetches Rs.120-130. She buys chicks at a rate of Rs.14 per chick. She is very happy with her new enterprise and has been planning to expand her poultry farming business.

Other success stories were also observed in the case of goat rearing and fisheries. Good number of fish ponds have been constructed under the watershed program, which would boost the economy after two-three harvests.

The impact indicators for Lyngiong watershed are given in Table 4. These indicators clearly show an improvement in the livelihood opportunities for the community.

**Table 4. Watershed performance in Lyngiong WS.**

Particulars/Indicators	Unit	Before	After	Change (%)
1. Cropping pattern		Mono-cropping	Double and mixed cropping	
2. Cropping intensity	%	122	187	65
3. Yield				
(i) Winter paddy	kg ha <sup>-1</sup>	1945	2493	28.17
(ii) Spring paddy	kg ha <sup>-1</sup>	3450	4000	16.00
(iii) Autumn paddy	kg ha <sup>-1</sup>	1170	1482	26.77
(iv) Maize	kg ha <sup>-1</sup>	1465	1550	5.80
(v) Pineapple	t ha <sup>-1</sup>	4	6	50.00
(vi) Ginger	q ha <sup>-1</sup>	4.2	6	45.00
4. Change in livestock composition and yield			Piggery, goat, fishery, poultry	
5. Reduction in soil loss erosion	%			17
6. Increase in household income	%			20

## **Wah Umroi (ICAR Model Watershed)**

Development of model watersheds in Northeastern region under the NWDPRA scheme was entrusted to Engineering Division of ICAR Research Complex for Northeast Hilly (NEH) Region, Barapani, Meghalaya. These model watersheds were taken up in Meghalaya (Wah Umroi WS), Nagaland (Peren-Jalukie WS) and Sikkim (Sajung WS).

The geographical location of Wah Umroi watershed is at 25° 41.5' N and 25° 45' N longitude and 91.5° 5.5' E to 91.5° 9.7' E latitude in Ri-Bhoi district. The total geographical area of the watershed is about 1612.5 ha out of which 532.5 ha area was selected at five different locations for the watershed development program. The watershed covers five villages namely, Umroi, Mawthai, Umeit, Mawpun-I and Mawpun-II. Umroi model watershed project was started during 2003-04 for a period of five years. Out of the total selected 532.5 ha, an area of 179.69 ha was developed until 2005-06.

The developmental works carried were in the form of entry point activity of constructing water storage tank by tapping spring water at Umeit village (upper reach). Drainage line treatments were made at upper, middle and lower reaches of watershed area. Activities on natural resource management have been carried out at Mawpun-I where 2 ha of land were taken up under soil and moisture conservation activities and other 7 hectares of land were developed for horticulture and agro-forestry. Construction of diversion wall, spillway, rectangular weir of drainage line treatment works were also carried in this village.

Since the inception of the program, different activities were implemented for developing the model watersheds. To ensure people participation in the planning and developmental activities of the watershed, SHGs approach was adopted and action plans were developed accordingly after a series of discussions for developing the model watersheds. A total of 11 SHGs are functioning at present in the watersheds. SHG meetings are generally held once in a month to collect the funds from the members and deposit in their respective bank accounts. The SHG members also discuss their common problems and needs that are recorded and brought for discussion in the Watershed Development Committee meetings. During the work season of the watershed development activities, the WC meetings are held monthly otherwise meetings are held every quarter.

The interview with the chairman of one of the women SHG revealed the activities undertaken for ginger cultivation. They have been imparted training in processing, embroidery, etc. The members take small loans in the case of domestic needs like illness or to meet other social obligations. No members till now had taken loan for starting any productive venture. Members make weekly contribution, which is deposited in the bank.

Initially the private landowners were hesitant in allowing watershed development interventions on their lands due to certain apprehensions, which was addressed by the implementing agency through involvement of the secretary of the Durbar Raj. After realizing the true motive of the implementing agency, every farmer now wants to have watershed interventions on his/her field. So it is realized that the formation of institutions or involving the village/local institutions is a pre-requisite for a successful implementation of watershed development programs, which can also help maintain the system after the project withdrawal.

## Impact

By now, only 34 per cent of the proposed area has been treated by the implementing agency. The watershed development program lasts until 2008 end. The changes in the cropping pattern, crop yield and production are in the transition phase. There are a number of enterprises that are emerging for which physical infrastructure has already been created. These enterprises relate to fish culture, vermi composting, mushroom cultivation and small processing unit. Once these enterprises start more tangible benefits would be generated under this program. There is enough social capital formation as SHGs, WDC, etc (Table 5).

**Table 5. Watershed interventions and its impact in Wah Umroi WS.**

Particulars/Indicators	Unit	Before	After	Change (%)
1. Cropping pattern		Mono-cropping	Double and mixed cropping	
2. Cropping intensity	%	120	172	52
3. Yield				
(i) Rice	kg ha <sup>-1</sup>	630	850	34.5
(ii) Maize	kg ha <sup>-1</sup>	290	370	28.22
(iii) Ginger	kg ha <sup>-1</sup>	220	305	36.16
4. Change in livestock composition and yield				NO
5. Reduction in soil loss erosion	%			32
6. Increase in household income	%			60

## Nongpoh Watershed (NGO)

Nongpoh watershed is a micro watershed located at the border between Meghalaya and Assam. The watershed area consists of 12.5 ha out of which 3.5 ha have been treated. The whole area belongs to a missionary NGO known as the Mozarello Orphanage cum Training Centre. The center is basically an orphanage boarding school in which the orphan girl students from primary to high school level study. There are a total of 45 students from class-I to high school level. These orphan students work in the field, besides studying. Many pass out students of the orphanage have now joined the Ri-Bhoi College. Sister Linda who is a well-qualified and dedicated to her mission runs the NGO.

The watershed interventions were started in 2003 under the technical guidance of ICAR, Barapani. The funds came partly from the ICAR institute and partly from externally funded schemes. A total investment of Rs.4.85 lakh was made out of which 75 per cent was contributed by the ICAR Barapani institute. The rest was contributed by the NGO in terms of labour component. Only one acre of land was under paddy cultivation before the watershed interventions. With watershed interventions, farmers have started piggery, poultry, fishery, duckery and cattle rearing. Besides introduction of livestock enterprises, a lot of plantations were done on steep slopy areas. These plantations mostly consist of fruit trees of pineapple, banana, beetle nut, pepper, guava, peach, etc. The results of the watershed interventions are discussed enterprise-wise.

**Fishery intervention:** Fishery seeds of seven different species of more than 6000 fingerlings were supplied by the ICAR, Barapani in August, 2004. They sold them in April-May, 2006 of worth Rs.33, 000. The average weight per fish was 3-4 kgs, which they sold at a very low rate of Rs.150 per fish due to market failure problem. Besides selling, they had also used 50-60 kgs of fish for their own consumption. This year, they are again going to harvest the fish.

**Piggery:** Initially, the ICAR institute supplied eight piglets to start with. Till now in these two years, they have sold 37 pigs. They have earned a sum of Rs.50, 000 from the sale of these pigs. The pork is very much famous in the area and is highly valued animal product. On an average, they have incurred Rs.20, 000 to rear these 37 piglets on feed and the leaves, collected by girls from farms to feed them.

**Poultry:** Special poultry birds of Banraja were again supplied by ICAR institute at subsidized rates. Hundred birds were supplied out of which 50-60 were sold of worth Rs.30, 000. Rest were used within orphanage center. They are now going to start with broiler chicks.

**Duckery:** Ducks are reared in the water pond from last three years. They had made about Rs.8000 from duckery. Mostly they use it for orphanage consumption.

**Milk production:** Orphanage has two jersey cows yielding about 20-24 kg/day out of which they sell 10 Kg of milk at the rate of Rs.20/Kg. Rest of milk is used for orphanage consumption.

**Rabbits:** ICAR institute supplied the orphanage 3 rabbits (2 female and one male) in January 2007. After 4-5 months, they increased the number to eight. Yet they did not sell any rabbit. They first wanted to increase their population as well as size. After getting a good number, they want to sell them in the market. The average price of rabbit was Rs.150.

**Goats:** The orphanage started with a pair of goats in year 2004. At present, they have 16 goats. They sold them at rate of Rs.1600 per goat for large sized and Rs.700 per goat for small ones.

**Pineapple:** This intervention was done under watershed by ICAR in which they spent almost Rs.10, 000. Till now they had two harvests. In first harvest, they sold for Rs.7000 and second harvest for Rs.11, 000. They had planted more than 2500 plants on hill slopes. Apart from sale, children also consume these fruits. Besides pineapple, other fruit plants such as banana (100 numbers), beetlenut (200), pepper (50), guava (20), and peach (20 numbers) were also planted on steep slopes. Once these fruit tress come in full bearing stage, it will generate a huge income for orphanage besides controlling the soil erosion.

The orphanage also runs Vocational Training Centre in which they impart training on tailoring, embroidery and knitting to the orphan girls. They have three sewing machines, three knitting machines and two embroidery machines. The impact assessment (Table 6) of Nongpoh watershed shows 1100% increase in the income generated post watershed intervention from mere Rs.17,000 to Rs.2,04,000. Full benefits from the watershed interventions are yet to be realized, particularly from the horticultural plantation crops.

**Table 6. Impact of watershed interventions on the Nongpoh micro-WS**

Particulars/indicators	Unit	Before	After	Change (%)
1. Cropping pattern		Mono-cropping	Double and mixed cropping	
2. Crops grown		Rice only	Pineapple Beetlenut Pepper Guava Peach	
3. Change in livestock composition and yield		Nil	Fishery, duckery, piggery, poultry, goats, cows, rabbits etc.	
4. Reduction in soil loss erosion	%			100
5. Increase in income	%	Rs.17,000	Rs. 2,04,000	1100%

The overall performance ranking of these four watershed case studies are summarized in (Table 7). It is revealed that the Nongpoh micro-watershed performed superbly, followed by Umpling-Umrynjah and Lyngiong watersheds. The Wah-Umroi ICAR Model Watershed has not realized yet its full potential benefits and the activities and interventions are still on-going and will take more time to realize tangible benefits.

**Table 7. Performance ranking of watershed indicators.**

Indicator	Parameters	Umpling-Umrynjah WS	Lyngiong WS	Wah Umroi WS	Nongpoh micro-WS
Efficiency	Agricultural productivity	****	****	***	*****
	Returns to investment	****	****	***	*****
Equity	Employment				
	Benefits to landless	****			
Sustainability	Corpus fund generation	****	***	**	
	Soil & water conservation	****	***	***	****
	Institutional development	****	****	****	
	Diversification of activities and enterprises	*****	*****	****	*****
Over all rank		****	****	***	*****
Very Good *****, Good ****, Fair ***, Poor **					

## Lessons Drawn from the Case Studies

The case studies on four watersheds were implemented by different agencies under different watershed development programs. The lessons drawn in the successful implementation of the watershed development program and its up-scaling is discussed under different sections.

### Sound Institutions

Traditionally, the society in the Northeast is close knit one. These groups were formed basically for security from external invasion, but with the passage of time they have

established themselves to take decisions pertaining to other social activities. In the entire region, a number of institutions exist, which have substantial impact on the decision-making process in the society. Peoples' participation is facilitated by the executive agencies only when they get direct benefit or develop a feeling of deriving better means of livelihoods and improve their socio-economic conditions through the implementation of watershed projects. Institutions play an important role in the success of watershed development programs and its sustainability after the project withdrawal. Merely the formation of watershed development committees and their registration doesn't work without a strong inbuilt force to work for the collective good. Awareness generation among the watershed community, project formulation with in-built mechanism for yielding benefits to individual families are, therefore, implicitly required in any watershed management program. In these case studies, it was found that the existing traditional village institutions, locally known as, *Durbar Shnong*, had played a great role in motivating the villagers and in the initiation of the watershed development program, besides reducing the transaction costs. These traditional village institutions formed the social base for the implementing agencies to mobilize the people under these programs who were initially reluctant to give their lands for any watershed related treatment due to various apprehensions. The institutions of *Durbar Shnong* (village councils) have an important place in the social set-up of Northeast region. All the studied watersheds except Nongpoh Watershed have WCs at the apex level with WAs at the village level, besides SHGs and voluntary groups. These institutions were found successful in working together and bringing 'collective action' among the participants to sustain the watershed activities. There has been social capital formation under these selected watersheds whose role now would be tested after the project withdrawal, which is in the offing.

## **Equity**

As watershed development programs are generally land-and water-based interventions, the benefits get restricted to only land owners, ignoring the land less poor class of the society. Though, there are examples of watershed programs (Sukhomajri WS) in which land less people of the watershed community were also given due rights to harvest the benefits from the watershed programs. In the present case studies, it was observed that the landless people benefited from employment generated under the watershed development programs. Though the number of landless families in these watersheds was low, efforts have not been made by the PIAs in targeting this group except in the case of the Umpling-Umrinaj Watershed under WDPSCA in which the poor and landless families benefited from activities such as bee keeping, tailoring, piggery, pisciculture, vermicomposting, etc., especially among the women SHGs who were provided with training support. Furthermore, the favouritism in the watershed interventions on private lands cannot be ruled out among the landowners as a result of local village politics in these traditional institutions from which watershed institutions have been carved out.

## **Sustainability**

The World Bank has defined project's sustainability as the probability of its (project's) maintaining the outputs generated or expected to be generated in relation to its objective over the economic life of the project (WB, 2004). Sustainable development is about

future and about leaving for the next generation a better livelihood and natural resource base than the present one. Sustainability, be it institutional, social or financial, is sought to be achieved through participatory approach in development by involvement of village institutions (village development committees) at all stages of project – planning, implementation and management of assets created. The sustainability of the watershed project may be judged by identifying the activities and their outcome in (i) protecting the natural resource base, specially land and soil from the environmental/ecological hazard (ii) improving availability of water in watersheds (iii) improving the biomass production (iv) development and strengthening of the local institutions and (v) developing the mechanism for the maintenance of assets created during the watershed program and its management in a sustainable manner after the project withdrawal.

All these indicators were at a satisfactory level in all the watersheds under case study. However, some works carried out with locally available material like stream bank stabilization by brush wood treatment in the case of Lyngiong Watershed at the upper catchment, are unlikely to last long due to heavy rainfall area of the watershed. Such fragile and prone spots need to be treated by concrete structures. For the maintenance of assets after the project withdrawal, the Umpling-Umrynjah and Lyngiong Watersheds have created corpus fund and also developed mechanism to generate the resources for the maintenance of these structures after project withdrawal. Such mechanism had not yet been developed in the case of Wah-Umroi Watershed implemented by the ICAR, Barapani.

### **Sharing Costs and Benefits**

One of the key determinants for the success of watershed activities in the past was that the expected private benefits exceeded the expected private costs (Joshi et al. 2004). The costs of works carried on the private individual lands were shared between the PIAs and the beneficiary as per the ratio given in the guidelines for different programs. The cost shared by the beneficiaries was mostly in terms of labour component. It was found that the proper consensus needed among the community members or villagers in carrying out the watershed works on community lands. This consensus is mainly required to workout the sharing of benefits generated by the community lands. However, in most cases, it has been planned by the members of watershed committees that the revenue generated through these community lands will be used to maintain corpus fund that may in turn be used to maintain assets after the project withdrawal.

### **Gender Issues**

More impetus is now put on the role of women in the watershed development programs. Meghalaya state, which is dominated by the Khasi tribe, has a custom of matrilineal system of property right. Women have an active role in the overall agricultural activities. In the watershed case studies, , an effective number of women were members of the watershed committees. Furthermore, a number of women SHGs performed various activities under these watershed programs. Women were also entrepreneurs of new enterprises created under the watershed programs.

## **Market Linkages and Infrastructure**

The real incentives of any agricultural development program get harvested when there are proper markets for remuneration of the products generated under the program system. Due to poor road infrastructure and lack of means of communication, the markets are not closely linked with these watersheds. It was found during the discussion that the farmers are not getting the real worth of their produce and also they have to invest a lot to sell the produce in far off markets in cities and towns. Most of the watersheds in NE are located with poor connectivity. So there is problem in the timely availability of inputs; and the market linkages to sell the produce need to be addressed through the formation of village market cooperatives. Small-scale village processing industries may also help in overcoming the problem of market failures and price fluctuations, besides value addition of the produce. It will also be useful in considerable employment generation.

## **Technical Aspects**

The guidelines provided under different watershed development programs have its limitation in case of hilly areas of Northeast region. NE has a tough terrain, poor road infrastructure and comes under high rainfall zone. Most of the works carried out for treating the prone areas have been done by locally available material as per guidelines. For example, brush wood treatment for stream bank stabilization in these watersheds is not going to last because of steep slope and high intensity of rainfall that will create havoc with these structures during monsoon season. Furthermore, the development cost per hectare as per guidelines should be more in case of hill regions where they have to transport the masonry material by head load or by employing ponies, which exacerbate the costs. It was also observed that there should be enough flexibility in the development component of watershed programs and activities should not be restricted as per guidelines but more demand driven as per local needs as well as suitable to biophysical base of the area. In fact, there is a need for a separate nation wide watershed development program for hill regions and guidelines need to be developed separately for such programs. Timely availability of funds was also mentioned by the PIAs as a constraint in effective implementation of watershed programs.

## **Watershed Ownership and Management**

One important lesson drawn from the present case studies is that the programs carried at micro level and under one management protocol produce quick and more desired results, as was observed in case of Nongpoh Watershed. This is due to the fact that the benefits derived goes to an individual or institution and decisions are taken at one end. So incentives generated under such situations are owe-fully quick and tangible.

## **Conclusions and Future Directions**

Watershed development projects have been taken up from time to time under different programs launched by the Government of India in the Northeastern region. The study concludes that the watershed programs have contributed in raising income, generating employment and conserving natural resource base as well as motivating people for abandonment of jhum practice. It is suggested that the watershed program would be a vehicle of development to alleviate poverty by raising farm productivity and generating employment opportunities in marginal and fragile environments. The peculiar nature of region and its problems and opportunities signifies a further greater scope of watershed programs at a larger scale in the region with due modifications in the programs and guidelines.

Watershed programs have demonstrated the potential to stabilise agriculture, increase crop yields, cropping intensity, reduce soil erosion, and most importantly increase family incomes and reduce the Jhuming practice in the Northeast region of India. However, these studies also indicated a strong need to develop suitable watershed development policies for hilly areas and considering distinct social structure in the Northeast region.

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## **Appendix I: List of Reviewed Studies**

1. Final report on impact evaluation study of Darugre Chikama Watershed in East Garo Hills district, Meghalaya, 2006, GOI, Ministry of Water Resources, Brahmaputra Board.
2. Evaluation study of Lozu Watershed in Phek district of Nagaland under WDPSCA Scheme, 2001, sponsored by Department of Agriculture and Cooperation, NRM Division, Ministry of Agriculture, GOI and conducted by Agricultural Finance Corporation Ltd. Mumbai.
3. Report on impact evaluation of watershed development project for Phijo Watershed, Nagaland, submitted to Department of Agriculture and Cooperation, Ministry of Agriculture, GOI, prepared by National Productivity Council.
4. Report on impact evaluation of watershed development project for Andharcherra (UC) Watershed, Tripura, submitted to Department of Agriculture and Cooperation, Ministry of Agriculture, GOI, prepared by National Productivity Council.
5. Final report on impact evaluation study of Jendra-Ringi Watershed in Jaintia Hill district, Meghalaya, 2006, GOI, Ministry of Water Resources, Brahmaputra Board.
6. Final report on impact evaluation study of Kupli Micro Watershed in Jaintia Hill district, Meghalaya, 2006, GOI, Ministry of Water Resources, Brahmaputra Board.
7. Evaluation of NWDPRP program implemented during Ninth Five Year Plan in Mizoram in Nghavawklui Watershed, submitted to RFS Division, Department of Agriculture and Cooperation, Ministry of Agriculture, GOI, prepared by Northeastern Regional Institute of Water and Land Management, Tezpur.
8. Evaluation of NWDPRP program implemented during Ninth Five Year Plan in Mizoram in Saihapui Watershed, submitted to RFS Division, Department of Agriculture and Cooperation, Ministry of Agriculture, GOI, prepared by Northeastern Regional Institute of Water and Land Management, Tezpur.
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10. Evaluation of NWDPRP program implemented during Ninth Five Year Plan in Mizoram in Liemakhong Watershed, submitted to RFS Division, Department of Agriculture and Cooperation, Ministry of Agriculture, GOI, prepared by Northeastern Regional Institute of Water and Land Management, Tezpur.
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## About ICRISAT



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