Impact Evaluation of Watershed Activities on Forest Conservation and Livelihood of People - A Case Study of Fakot Watershed in Uttarakhand State

National Rainfed Area Authority
Planning Commission
Government of India
New Delhi

सत्यमेव जयते

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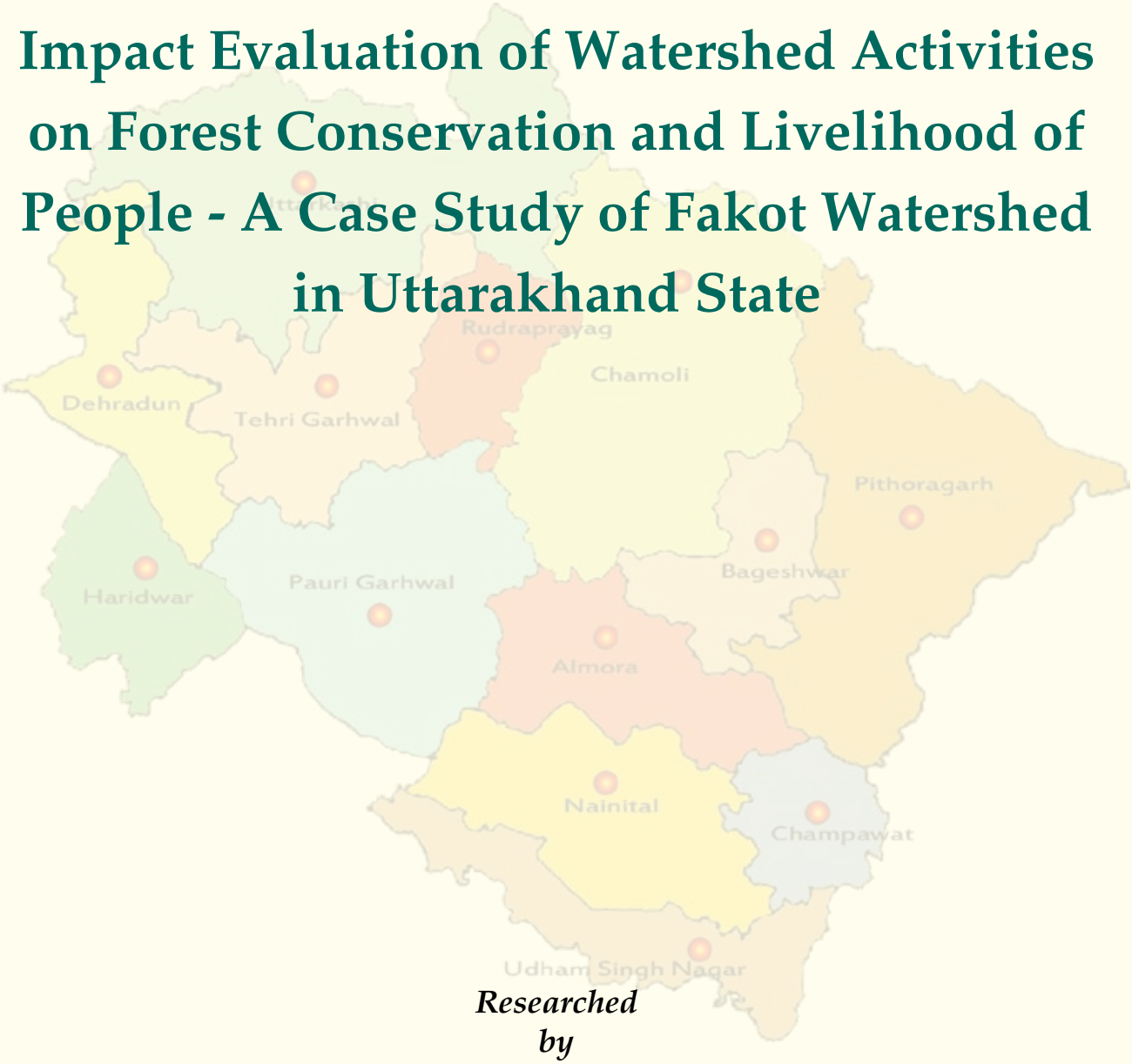

Researched by

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Foreword

I am happy to place before the resource managers, policy makers and other stakeholders, the study conducted by the National Rainfed Area Authority (NRAA) through Himalayan Action Research Centre, Dehra Dun on the impact of model watershed development programme implemented by the Central Soil and Water Conservation Research & Training Institute Dehra Dun in Fakot and Kalimati Watersheds of Uttrakhand.

2. These studies were undertaken to highlight the impact of these activities on the livelihoods of the people and also to reverse adverse environmental impact on the regeneration and the quality of the forests. The study has clearly indicated the improved condition of the forests and the reduced dependency of the people on forests due to increased productivity of agriculture, horticulture and animal husbandry, etc.

3. it is hoped that this report will promote such attempts of participatory and harmonious integrated natural resource management in the rainfed areas of the country leading to better ecological status of our forests and simultaneous improvement in the socio-economic conditions of the people living in the forest fringe areas.

(Dr. J.S. Samra)
Dated: 04.01.2012

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PREFACE

The community based watershed management has gone a long way in ensuring integrated and holistic development of natural resources for meeting the livelihood needs of the rural people. It also steps up productivity of agriculture and allied sectors significantly. However, only those watersheds have been successful in achieving their desired results where the forest and adjoining non-forestlands are treated in a sequential and simultaneous manner.

The Central Soil and Water Conservation Research & Training Institute, DehraDun had undertaken Institute Village Link Programme during 1996-98 in Fakot Watershed of Uttrakhand. The programme treated 370 hectare land belonging to six villages. The National Rainfed Area Authority (NRAA) has been mandated to find "out of box" solutions and innovative ideas for the management of natural resources. However, in many states the information on the impact of these activities on improving the conditions of the forests has not been properly documented. To bring a holistic picture before the stakeholders, the Himalayan Action Research Centre, DehraDun was awarded a study on "Impact evaluation of watershed activities on forest conservation and livelihoods of people in Fakot Watershed of Uttrakhand". The study was conceived and initiated by the then Technical Expert (Forestry) of NRAA, Dr. V.K. Bahuguna.

The study has clearly revealed that the watershed programme had improved the livelihood opportunities for the villagers due to increased productivity of agriculture and allied sectors. Due to increased income generation, the migration from the villages was reduced. A significant increase in the productivity of agriculture, horticulture and livestock was observed, resulting in enhancement of the household's income.

As far as the impact on forest is concerned, the study reveals that species richness and regeneration was significantly higher in the treated areas as compared to untreated areas. However, farmers are now experiencing adverse effect of intensive rainfall over short duration and prolonged dry spells which could be attributed to the effect of clime change. This calls for innovative strategies to reduce adverse impacts of climate change. Forest management practices need to be tailored keeping view of hydrological regime to meet the emerging challenges. It requires a holistic approach for the management of land, forest and water resources. The report is expected to help the practising natural resource Managers, Administrators and Planners in holistic management of natural resources.

(Alok K. Sikka)

EXECUTIVE SUMMARY

An Integrated Watershed Management Project (IWMP), located at Fakot representing the lower and middle Himalayas in Tehri Garhwal district of Uttarakhand, was developed and executed by Central Soil and Water Conservation Research Training Institute (CSWCRTI), Dehradun during 1975-86 on demonstrational approach. The main focus of the project, popularly known as "Fakot Watershed", was on adoption of a participatory approach for management of rain water, livestock and horticulture development, crop production and realizing gainful employment by ensuring environmental security and strengthening capacities of the local people. The project has laid significant emphasis on mobilizing local people and identifying priorities right from the stage of planning to the implementation and monitoring of the programme through a participatory approach.

With a view to assess the success of the project and its impact on the land and people, a study entitled "Impact Evaluation of Watershed Activities on Forest Conservation and Livelihood of People – A case study of Fakot Watershed in Uttarakhand" was conducted in the project area. Its main objective(s) was to learn from the experiences of the project and capture the successes for replicating in other watersheds of the country. The study covers the impact of IWPM on the social, economic and ecological aspects, mainly agriculture and horticulture development, forest conservation, income and employment opportunities and ecological security.

The socio-economic profile of watershed area reveals that most of the households depend on agriculture and animal husbandry for their livelihood. Three out of six villages are well connected by motorable road, at a reasonable distance. About 96% of the total households have electricity facility. Drinking water is available round the year in all the three sampled villages through pipeline and natural sources of water.

The most important activity of the project was the improvement and repairing of bench terraces, both in irrigated and rainfed land, and other conservation measures adopted for in-situ moisture and soil conservation. A total of 20.2 ha area was brought under irrigated terraces in the watershed during the project period. This had a positive impact and now some of the wastelands have been bench terraced for growing food and vegetable crops, particularly off season vegetables, as also for cultivating fruit trees.

Intensive interventions for improving the production and variety of crops, mainly, wheat, rice, maize, *mandua, jhangora*, pulses along with promotion of cash crops such as ginger, turmeric, french beans, onion, potato, colocasia, chillies, cucumber and cabbage have contributed to enhance the food security as well as farm income. The study reveals that wheat, rice and ginger are the main crops which contribute to 20.98%, 21.52% and 26.10% respectively, totaling 68.6% of the total crop production. Remaining crop

production comes from vegetables, pulses, spices and traditional crops like mandua, Jangora, barley etc. Maize is cultivated in 1.68% of the gross cropped area and its contribution to total crop yield is 0.84%. Ginger is the main cash crop and is being cultivated in 7.42% of the gross cropped area and its yield is 26.10% of the total crops cultivated in the area. Vegetables such as cucumber, colocasia, cabbage, bitter gourd, tomato, potato and onion are occupying 0.96 ha of land.

Though the crop production in 2009 indicates a declining trend as compared to that of in 1986-94, this trend has become noticeable only during the past 2-3 years, mainly due to climate change which is affecting rainfed agriculture to a great extent. Despite crop productivity showing a declining trend, its impact is limited on the total income. To supplement the income, as also to mitigate the risk of crop failure due to climate change, the farmers are growing short duration crops. Apart from this, the location of Fakot provides good scope for micro enterprise development as the villages are at the vicinity of the highway connecting many tourist destinations and holy places. Establishment of micro enterprises like tea stalls, provisional stores, vegetable shops, small eatery and juice centres have provided new options to villagers for income generation. About 20% households from the area have established micro enterprises along the highway.

The livestock development has also contributed significantly to the total income of the households in Fakot watershed. Due to the intervention of the project, a shift from local breed cows and goats to buffaloes is clearly visible in the area. The change in livestock composition has increased milk production and thus many individuals are selling milk in the nearby markets. This major change in livestock composition has resulted in a shift from grazing to stall feeding. This has directly reduced the pressure on forests as buffaloes are exclusively stall fed and not left for grazing due to their massive body and inability to move in hilly terrain.

The most visible economic impact is the increased income of the beneficiaries as a result of selling their agricultural produce in local markets. Today, mangoes and off-season vegetables are major items of trade. Items worth Rs. 14,00,000 were traded in 2008 from the sampled villages. These included ginger, chillies, cabbage, colocasia, paddy and maize. Farmers have developed entrepreneurial qualities and earned good profits.

The total farm income (income from agriculture and livestock) has increased many folds in comparison to the income in 1975 and 1991-92. Similar trends are seen in the business and service sectors. The sale value of food grains is worth Rs. 4,62,590 which constitutes 25.43% of the total income from crops. Ginger as cash crops contribute Rs. 3, 60,000 and constitute 18.52% of the total income from crops. The vegetables, pulses and spices contribute Rs. 6,15,290, Rs. 3, 36,870 and Rs. 3633400 and constitute 33.82%, 18.52% and 21.63% respectively of the total income from crops.

The assessment of the present condition of the forest in Fakot watershed reveals that the average density of regeneration, recruitment and establishment in control plots is 265, 417 and 31, respectively, whereas in the case of treated forests, it has increased to 345, 453, and 174, respectively. This indicates a healthy trend. It is also seen that in treated areas, a few more species like *Bheemal, Kharik* and *Malu,* which are highly valued as fodder, have come up. Similarly, in treated areas, there are as many as 22 species of shrubs and 11 species of herbs against six species of shrubs and four species of herbs, respectively in controlled site. This clearly indicates improved biodiversity in the forest areas of the watershed. The study also shows that dependency of the local people on forest areas has reduced considerably, which is at present around 20%.

To conclude, the Fakot Integrated Watershed Development Project has not only succeeded, in improving the productivity of crops and enhancing the livelihood opportunities of local people mainly through introduction of new farming technologies and change in livestock composition but has also contributed in conserving and improving the ecology of the nearby forest areas, which has resulted in soil and water conservation in the watershed. The project has also been successful, to some extent, in changing the mindset of the people towards adopting improved technology and developing entrepreneurial qualities to undertake micro enterprises. It may be possible to replicate this treatment with suitable modifications keeping in view the local conditions, in other areas to achieve higher productivity of land, including forest areas and environmental conservation.

ACKNOWLEDGEMENTS

Himalayan Action Research Centre (HARC) is grateful to the National Rainfed Area Authority (NRAA), Planning Commission, Government of India, New Delhi, for providing financial support to conduct this study. HARC expresses a deep sense of gratitude to officers of NRAA namely Dr. J.S. Samra, CEO, Dr. V.K. Bahuguna, Technical Expert (Forestry) and Dr. Hilaluddin, Chief Consultant (Forestry) for providing their support right from the planning phase to completion of this study. This manuscript has benefited a lot with their valuable suggestions. HARC is grateful to Dr V.N. Shardha, Director, Central Soil and Water Conservation Research and Training Institute (CSWCRTI), DehraDun, for providing access to literature and official records related to Institute Village Link Programme. HARC had valuable discussions with Dr B.L. Dhyani (CSWCRTI) and Mr. A.N. Mishra (Retd. from CSWCRTI) during the course of this study. HARC expresses its sincere thanks to Mr. D.C. Khanduri, Mr. C.M. Thapliyal, Mr. Alok Mishra, Mr. Gautam Kumar, Mr. Rajneesh Verma and Mr. Vikas Jha for extending their full support in bringing out this manuscript in its present form.

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1. INTRODUCTION

The Himalayan region, well known for its rich, natural and cultural heritage, is also marked with characteristics such as inaccessibility, fragile and young ecosystems, inadequate infrastructural facilities, poverty and politically and economically marginalized. Since last four to five decades the Himalayan region and its communities, that are totally dependent on natural resources for livelihood, are facing a serious threat to their survival due to increased rate of depletion of natural wealth and degraded environment. To reverse the trend of environmental degradation and ensure sustainable livelihood to the people, the participatory integrated watershed management approach has been very effective to reverse the trend. The key thrust of this approach is to seek active and effective participation of community as a major stakeholder in conservation, regeneration and the judicious use of all the natural resources - land, water, plants and animals within a particular watershed. The participatory approaches are being recognized as a powerful and helpful tool for achieving the goals and objectives of any programme, especially in developing a sense of ownership, accountability and responsibility among the community.

1.1 Background of the Study

An Integrated Watershed Management Project (IWMP) located at Fakot watershed, in Tehri Garhwal district of Uttarakhand, representing lower and middle Himalayas was developed and executed by Central Soil and Water Conservation Research Training Institute (CSWCRTI), Dehradun during 1975-86 on demonstrational basis. This is popularly known as "Fakot Watershed" since then.

The main focus of the project was to adopt a participatory approach for management of rain water, livestock and horticulture development, crop production, realizing gainful employment, ensuring environmental security and strengthening capacities of local people. Special emphasis has been given on mobilizing and involving local people right from the stage of planning and identifying the priorities up to the implementation and monitoring of the programme through participatory approach.

In this background, a study on "Impact Evaluation of Watershed Activities on Forest Conservation and Livelihood of People – A case study of Fakot Watershed in Uttarakhand state" was conducted in the project area by a team of Himalayan Action Research Centre, Dehradun, with technical and financial support from National Rainfed Area Authority (NRAA), Planning Commission, Government of India, New Delhi. The main objectives of the study were to learn from the experiences of the project and capture the successes of the programme for replication in other watersheds of India. The study covers the impacts

of 'Integrated Watershed Management Project' on social, economic and ecological aspects mainly agriculture and horticulture development, forest conservation, ecological security and income and employment opportunities.

The study area lies in the Himalayan Mountains which are characterized as an inaccessible, resource poor, and fragile but ecologically important region. The mountain region has inadequate infrastructure and marginalized inhabitants primarily due to uncertainties associated with rainfed production system. Bhaitan, Malas and Tachla were the three villages selected for the study. The project aimed at sustainable management of natural resources, improving standard of living, increased fruit, fuel and fodder supplies, increased livestock productivity, increased forest cover, decreased surface run off, increased water conservation, improved minor irrigation and increased community participation. The components of the project may be grouped into two categories of which the first-one addressing individual household resources and other addressing common property resources.

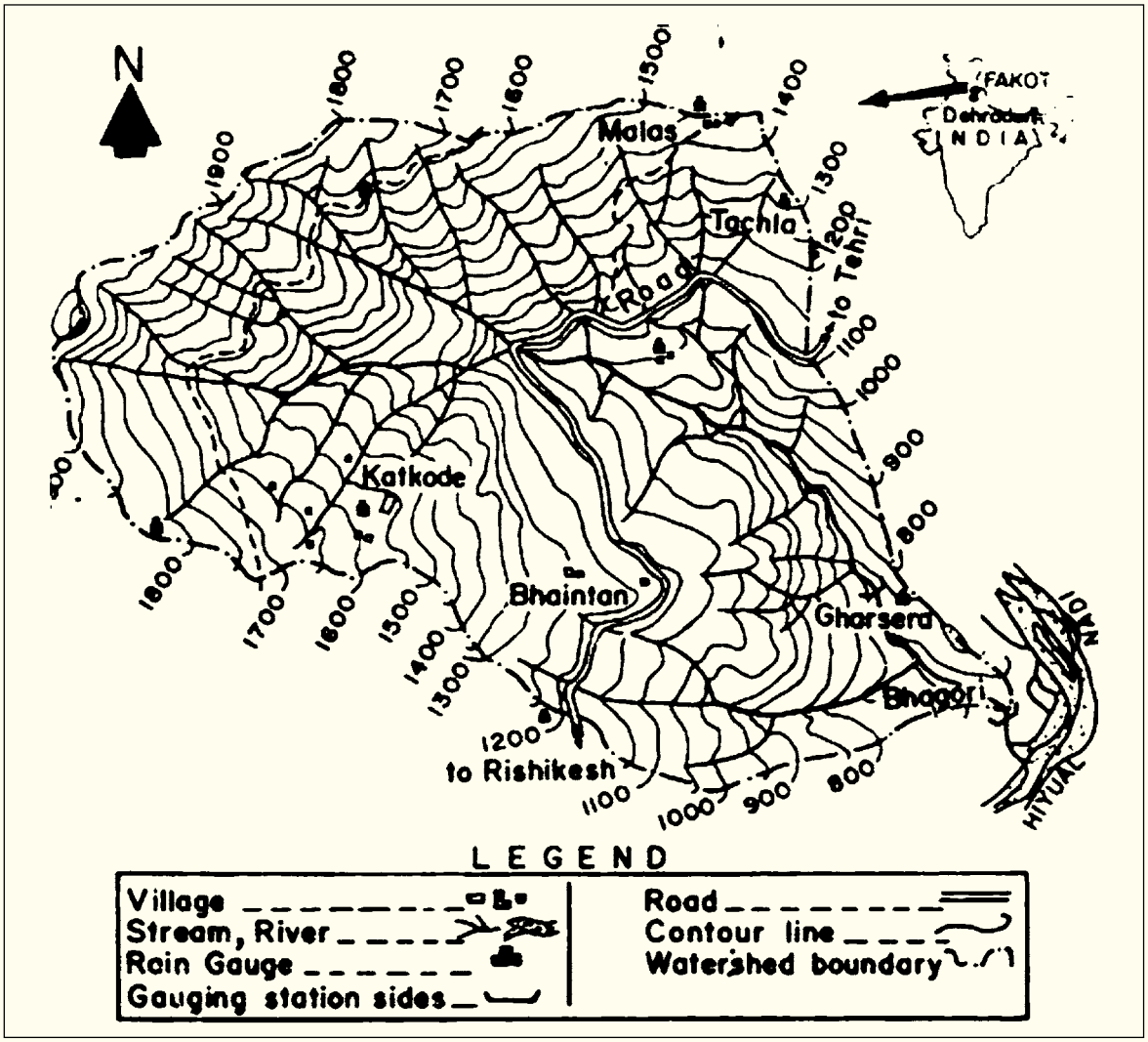

Figure 1: Location Map and Project Area of Fakot

1.2 Methodology

This case study was compiled following two methods: a literature survey and field survey. Literature survey included review of published information (scientific and popular articles appeared in journals, magazines, news papers, etc.) and unpublished information in the form of project reports and documents. The field survey comprised of a general village level survey and an in-depth household level survey. Three villages, where maximum interventions were done during the course of the programme were selected for capturing the broader picture and learning the lesson. During the selection process, it was kept in mind that households from all socio-economic classes of people are represented. Stratified Random sampling procedure was adopted in selection of households. The reports and documents on Fakot Watershed Project formed the basis for the selection of samples and preparing questionnaires. Meetings and discussions with concerned project implementing agencies were held to get an overview of the project details. Two sets of questionnaires were prepared and tested with five families for collecting data. This pilot testing identified the gaps in the questionnaires and after discussion, the questionnaires were finalized. Detailed discussion with concerned project implementing agencies were held to get an overview of the project details.

Data pertaining to relevant parameters, both at village and household level, were collected by way of a detailed set of questionnaires containing both qualitative and quantitative questions. Information was gathered mainly on agriculture and horticulture development and production. In addition, an individual household's income from all sources like agriculture (crop, agricultural work), micro-enterprise and other sources like government and non government employment, skilled and unskilled labour was also quantified. The data regarding income was reported annually in terms of rupees. The data pertaining to expenditure of household was collected under the heads of entertainment, transportation, infrastructure development, food, education, health and treatment and social events.

The data regarding access to financial institution, public and domestic facilities such as electrification, drinking water facility, water storage tanks, telephone facility, road connectivity, sanitation and medical facility was also collected to understand the socioeconomic profile of the beneficiaries. Primary data was collected as per questionnaire from 53 randomly selected households benifited from the IWMP from three villages namely Bhaitan, Malas, Tachla in the watershed area.

The vegetation conditions in the watershed area and adjoining non-treated forest area were assessed by laying out sample plots of various sizes and shapes depending upon plant biomorph. The vegetation condition was examined along the existing trails and the selection of sample points was in accordance with random sample strategy. Circular plots of various sizes were laid at each sample point to quantify perennial woody species (tree

and shrub) populations, whereas annual herbaceous vegetation (herbs and grasses) were enumerated in square plots.

At each sample point, a 10-meter radius circle was established. Within the 10 meter radius of the central point of each sample point, all tree species were identified and their numbers were counted in three classes namely Regeneration Class (< 2 meter height), Recruitment Class (2-4 meter height) and Establishment Class (> 4 meter height). After regeneration enumeration, another circle of 5-meter radius was established at the same point. Within this circle, all shrubs were identified to species and their numbers were counted. Additionally, a square plot of 1-m x 1-m was established at the same point. Herbaceous annual plants falling within this plot were identified to species and their numbers counted. The data recorded on species with their numbers were analyzed for density (Curtis & McIntosh 1950) as follows:

$$\text{Density} = \frac{\text{Total individuals of a species in all quadrates}}{\text{Total area of all quadrates}} \times 10{,}000$$

Species diversity (H′) was calculated following Shanon-Wiener (1963), whereas species richness (H_o) was computed in accordance with Hill (1973) as follows;

$$H' = \sum_{i=1}^{S} [(Ni/N) \ln (Ni/N)]$$

Where Ni is the number of individuals belonging to the ith species in the sample and N is the total number of individuals in the sample.

$$H_0 = S$$

Where S is the total number of species in the all samples.

Equity indice (E_5) of vegetation were calculated as modified Hill's ratio (Hill 1973) as follows;

$$E_5 = \frac{1/\lambda}{e^{H'} - 1}$$

Where H′ and λ are Shanon-Wiener (1963) and Simpson (1949) diversity indices,

respectively.

$$\lambda = \sum_{i=1}^{S} \frac{Ni\ (Ni\text{-}1)}{N\ (N - 1)}$$

Where N is the total individuals in the population and Ni is the number of individuals of ith species in the population.

1.3 Organization of Report

This case study has been divided into six main chapters. The first chapter describes the background and methods of the study. The second chapter discusses the location and implementation approach of the project. The third chapter analyses the socio-economic profile of beneficiaries such as demography, literacy and occupation. Occupation of the rural population has been categorized as primary (which is the main source of livelihood) and secondary profession (other than primary). These professions have been grouped as labour, farming, micro enterprises and salaried jobs (including business) as categorical variable. Details of physical assets (land holding and houses) include the area of the irrigated and unirrigated land under cultivation and other operations available with the individual. Status of literacy, migration trend, status of access to basic facilities in the villages, status of community based institutions (CBOs) and access to financial institutions have also been discussed in this chapter. The frequency distribution was estimated for better representation of the data for those parameters, which can be logically classified.

The fourth chapter deals with the economic impact including agriculture and horticulture development, impact of land improvement, land use intensity and crop productivity. This chapter highlights the income and employment opportunities provided by the project to beneficiaries. Income from various sources includes total annual income earned from different sources like agriculture, livestock, micro enterprise, government and non government job and labour wages. It is a direct indicator of the economic status of the household.

The fifth chapter deals with the ecological impact. It describes the status of diversity and density of trees, shrubs and herbs both in treated and control areas. The chapter also deals with the analysis of the dependency of villagers on forest and their farmland for fuel and fodder. It also describes the impact of watershed activities on forest conservation efforts.

The sixth chapter mentions the negative effects of climate change on crop production, particularly, for the past 3-4 years. Rising temperature, erratic rainfall or delayed rainfall is affecting agricultural activities such as delay in sowing period, late harvesting and missing the next season for sowing. The case study ends up with major conclusions, lessons learned and ways forward for future replication of the project in similar micro climatic conditions.

2. ABOUT THE PROJECT AND ITS LOCATION

The Fakot Integrated Watershed Management Programme (IWMP) was implemented by CSWCR&TI, Dehradun during 1975-86 in Narendra Nagar Developmental Block of Tehri Garhwal district of Uttarakhand. The watershed elevation ranges from 650m to 2015m above mean sea level with annual rainfall varying from 1500 to 2600 millimeters. The general slope of watershed is 72 %. The area under this watershed is 370 hectare. Six villages namely Malas, Tachla, Katkode, Bhaitan, Gharsera and Bhagori are situated in this watershed. The area under cultivation is 80 hectare of which only 12 hectare is under irrigation. The present case study is based on the three villages namely Bhaitain, Malas and Tachla encompassing a total household of 125.

The project targeted poor and marginalized farmers with the aim of making them self-relient through their participation and identification of their immediate needs. This was done by making them realize their social responsibility by building their knowledge about land utilization in accordance with its capability and available techniques and their applications. The overall objective was to minimize the intensity of ecological degradation in the area and improvement of the living standards of the local population through afforestation and other measures to improve the productivity of soil and water resources. It involved long-term ecological rehabilitation, mainly through afforestation and soil conservation measures, check further erosion and reduce downstream flooding. It also focused on reducing the current gap between demand and supply of fuelwood and fodder for the benefit of the communities.

The major interventions carried out under the project included development of feasible irrigation facility, making of bunds, leveling of agricultural land to increase water retention and minimise soil erosion, development of canals along the fields, horticulture development, plantation of multipurpose trees, pasture development, demonstration of new methods of agriculture, etc.

The major objectives of the project were –

- Integrated planning of the area for proper land use management for higher productivity per unit area, per unit time and per unit of resource use;
- Transfer of technology developed in the field for improvement of socio-economic conditions of hill population;
- Training of local people engaged in soil and water conservation and development for land use planning in hilly terrains;
- Develop effective means to coordinate activities of research, training and developmental programme of central/state agencies and institutes;

- Monitoring the changes in environment as affected by changed land use management practices; and
- To identify constraints and suggest remedial measures.

The concept of IWMP is based on the bottom up approach for seeking active and meaningful participation of the people in planning, execution and management of resources to ensure sustainable livelihoods generation for the people. The project adopted a participatory and demand driven bottom up approach to solve farmers' problem. In the process, scientists and farmers worked hand in hand as partners for integrated development of the area.

3. SOCIO-ECONOMIC PROFILE OF THE BENEFICIARIES

The socio-economic profile of a region determines the resource use pattern and enables the developmental authorities to prioritize the needs of the stakeholders. Therefore, special emphasis was laid on the analysis of the socio-economic profile of the farmer families benefited under the project. All the three villages, selected for the case study, are located in three Gramsabhas (Civic Body) namely Bhaitan Gramsabha, Malas Gramsabha and Tachla Gramsabha. Families residing in these villages belongs to different caste groups namely Brahmin, Rajput and Scheduled Caste. However, Tachla does not have Scheduled Caste families. Most of the families in these villages are highly dependent on common property resources and allied activities for their livelihood. The average size family consists of nearly 4 to 7 members with two male and female adults and one male and female child in general. The average age of the household head range from 49.49 to 55.42 years.

The survey notes that most heads of households were males, with a few households' headed by females. Due to the poor development of the region in terms of infrastructural set up and the topography, their livelihood is difficult and revolves around agriculture and allied activities. According to the baseline survey, there were 94 households during the inception of the project who were generally poor having small land holdings and dependent on common property and livestock resources.

3.1 Demography, Literacy and Occupation

Table 1: Population statistic in the surveyed villages

Parameters		Village Name	
	Bhaitan	Malas	Tachla
No. of households	137	14	26
Total population	555	78	140
No. of Male	292	35	64
No. of Female	263	43	76
SC Population	26	7	0
No. of SC Male	14	3	0
No. of SC Female	12	4	0

Source: Census 2001

Although 2001 census puts the total number of households in the three villages 177 only, 125 households that were covered under the watershed programme from which the sample households were selected for the present study. The omitted households reside in the market area and were not the direct beneficiaries of IWMP. Table 2 depicts information on village wise sample size of the study, whereas Table 3 provide demographic statistic of the surveyed villages.

Table 2: Number of households covered under project in the sampled villages

Name of village	No of household	No. of sampled household
Bhaitan	67	24
Malas	30	12
Tachhla	28	17
Total	125	53

Table 3: Demographic statistics of the sampled households

Parameters	Bhaintan n=24		Tachla n=17		Malas n=12	
	Mean	SE	Mean	SE	Mean	SE
Age of Head of Household	55.42	0.702	49.67	0.052	49.49	0.058
Family Size	5.86	0.114	7.2	0.86	4.4	0.31

3.2 Source of Income in Surveyed Households

The study reveals that all adult family members are actively involved in various household chores for survival of their family. The main occupation practiced in the study area is agriculture and animal husbandry. Livestock and cash receipt from crop yield constitutes the bulk of the income. Other minor but consistent sources of income are agricultural labour, micro enterprise, skilled and unskilled labour. The occupations prevailing in the area are shown in the Figure 2. Other income generation opportunities like driving, performing religious services in temples (local priest), contract, and government schemes like Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGA) are very popular in the area. This explains the reason of nearly 58% of surveyed population having other income generating opportunities. The agricultural labour as means of occupation implies the labourers working in other's agricultural land and earning their livelihood out of it. In addition to agriculture and animal husbandry, at least one member of more than half of the households is engaged in salaried job in the government and private secotor. About 46.15% of the population is involved in skilled and unskilled labour while nearly 20% are engaged in micro enterprise. There are many shops owned by villagers on the roadside market. The location of Fakot provides good scope for micro-enterprise development as the villages are in the vicinity of the highway connecting many tourist destination and

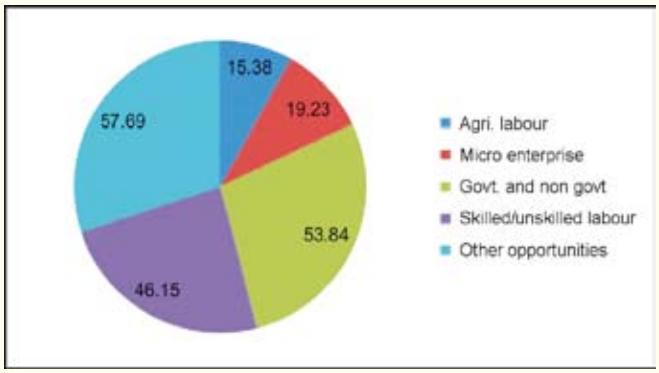

Figure 2: Proportion of secondary & teritiary occupation in the surveyed villages

holy places. These opportunities include running *dhabas* (small food joints), tea stall, juice palour, fresh vegetable shop and small hotels.

The popularly known "money order economy" of Uttrakhand also holds true to the economies of these villages as people who migrate from these villages for better work opportunities in nearby towns/cities contribute significantly to the local economic spectrum. Figure 2 shows income of villagers from various income sources.

3.3 Status of Education and Literacy

Education plays an important role in human resource development through up-gradation of technical knowledge and expertise which is interlinked with the socioeconomic improvement of the person and thereby betterment of the future generations. This study revealed that there exists at least a Primary School in each sampled village where almost all the children hailing from the village are attending school. In addition, a High School and an Intermediate School exists in Fakot. Average literacy rate in the sampled villages varies; the highest being in Bhaitan stands at (82.05%) where male literacy is 95.12%, and female literacy rate is 67.56%.

Table 4: Literacy status of the surveyed villages

Parameters		Village Name	
	Malas	Bhaitan	Tachla
Literacy rate	68.65%	82.05%	65.81%
Male Literacy rate	90%	95.12%	89.65%
Female Literacy rate	51.35%	67.56%	42.37%

Source: 2001 Census

The literacy status of the studied villages reveals that female literacy is significantly lower than the corresponding male literacy which is a matter of great concern. The literacy rates of the populations of the sampled villages are given in Table 4, whereas Table 6 shows education status of the sampled population.

Table 5: Literacy level in the sampled households

Village name	Adult men			Adult women			
	Literate	Illiterate	Write name	Literate	Illiterate	Write name	Total
Malas*	8	4	1	6	10	8	37
Bhaitan#	18	2	1	25	12	2	60
Tachla$	12	3	3	17	13	10	58
Total	38	9	5	48	35	20	155

** n=12, # n=24, $ n=17*

Table 5 shows the literacy level among adult males and females in sampled households. Llliterate male are only 9 out of 52 (17%), while the number of illiterate females are 34%. This is evident by data given in Table 6 which shows an increasing rate of literacy among young generation of girls. The trend seems to be progressive as girls are being given education. However, this increasing trend is upto secondary level only because not a single girl is pursuing higher studies at graduation or above level due to lack of professional institutions and higher academic institution in the vicinity of the villages. The nearest academic institution is located at Narendra Nagar which is 20 km away from Fakot. There are also accedemic instituions location at Chamba -40 km and at Rishikesh about 35 km. Therefore, the girls are deprived of higher education. Only in Tachla village, eight girls have joined Industrial Training Institute (ITI) for professional studies. If the girls of the present generation are given proper education, they can certainly improve the decision making environment prevalent at the household level.

Table 6: Children of the sampled households attending educational institution at various level

Village		Girls				Boys				
	Primary	Middle	Secon-dary	Pro-fessional	Primary	Middle	Secon-dary	Under-graduate	Post-graduate	Pro-fessional
Bhaintan	13	4	7	-	10	5	6	3	-	1
Tachla	6	4	3	08	7	8	0	2	1	1
Malas	4	4	1	-	6	3	1	1	-	1
Total	23	12	11	8	23	16	7	6	1	3

3.4 Details of Physical Assets (land holding and houses)

According to size of land holding, farmers are categorised as large, small, medium and landless. As agriculture is the mainstay, land is considered the most important asset and one of the main basis in determining the status of a household. About 90% of the watershed population is directly dependent on it. Most of the households fall in small and medium farmer category (Table 7).

Table 7: Distribution of the sampled households according to land holding

Village Name	Landless	Household having less than 5 Ha	Household having 5-10 Ha land	Households having more than 10 Ha
Bhaitan*	-	14 (58.3%)	06 (25%)	04 (16.7%)
Tachla#	-	10 (59%)	05 (29%)	02(12%)
Malas$	-	06 (50%)	04(33%)	02(17%)

** N-24, # N-17, $ N-12*

Note-*Figures in brackets show the percentage of the total number of sampled households in each village.*

The proportion of cemented house in the surveyed villages of Fakot Watershed is high. Nearly 75% of the households have cemented house and nearly 20% have semi *pucca* house while rest of the households have mud houses.

3.5 Status of Access to Basic Facilities in the Sampled Villages

The sampled villages are well connected by a motorable road, at a reasonable distance. Since 1960, transportation facility is available in this region. Bhaitan and Tachla are connected with the National Highway. The electrification of these villages was done in 1980. Drinking water is available round the year through pipeline but during summer season, natural sources of water and storage tanks are used by people. Most of the households own mobile phones. Health facilities have been made available to villagers since 1970. A Public Health Centre is functional in Fakot where vaccination facilities for mother and child care are available apart from distribution of medicines to treat curable diseases. The Block Development Office is 0.5 km away from the nearest village Bhaitan and Pata and 3.5 km away from the farthest hamlets (Bhagori and Kathkode). State Horticulture Department with its horticultural mobile team distributes horticultural plants and vegetable seeds among villagers besides organizing awareness campaign on plant protection measures. The proportion of access to facilities in the studied villages are shown in figure 3.

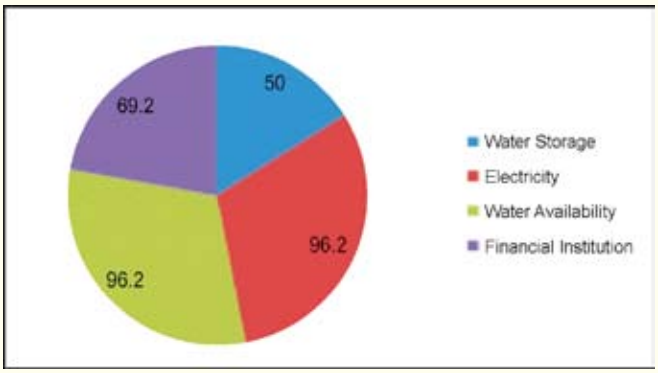

Figure 3: Proportion of access to facilities in the surveyed villages

Table 8: Market and its distance from villages

Market Location	Distance from village in Km		
	Malas	Tachla	Bhaitan
Agrakhal	10	8	5
Rishikesh	35	32	29
Chamba	33	30	27
Dehradun	89	86	75

The main markets for selling of farm yields are located at Dehradun, Chamba, Rishikesh and Agrakhal. Colocasia and ginger crops, grown in abundance in the region, are sold in Dehradun *mandi*. The local wholesale market of these crops is in Agrakhal where agricultural produce are sold in bulk. The trading of french beans, green chillies, cucumber, cabbage, cauliflower and mango are being facilitated by two autonomous cooperatives

formed at Agrakhal in 2004 at a distance of 5-km from these villages. This facility has greatly reduced the transportation cost and quality loss of seasonal perishable crops. The status of famous markets where bulk of trading of locally produced agriculture is done is given in Table 8.

3.6 Migration Trend

Like other villages of Uttarakhand, out-migration is a common practice in the study villages. The inhabitants of Fakot Watershed migrate to nearby towns/cities for better job opportunities. Although there exist good scopes of many off-farm income activities specifically tourism as study villages are located in the vicinities of National Highway, which is the main destination to many tourism and pilgrims spots. The migration trends in the sampled households of Fakot Wateshed are given in Table 9.

Table 9: Migration trend in the surveyed households

Name of village	No. of person migrated in last 10 yrs	No. of household surveyed	Engagements
Malas	8	12	Defence, private jobs, drivers, chef in hotels and industrial labor
Tachla	6	17	
Bhaitan	20	24	
Total	34	53	

3.7 Status of Community Based Institutions (CBOs)

The development of agriculture was a difficult task in Fakot Watershed due to acute shortage of irrigation facilities accentuated by erratic, scanty and delayed rainfall. These problems were further aggravated by the economic hardships due to non availability of local employment opportunities. Stories of agriculture fallow lands, economic hardships, lack of fodder availability and poor agriculture productivity were common. This caused acute hardships to locals as they were unable to produce sufficient food to cater energy needs of their families and cattle. Realizing the fallout of food and fodder needs of the people, officials of Fakot Watershed Management Project started conducting meetings with the villagers in the beginning of 1975 -76. Such meetings were followed by detailed discussions to seek co-operation of locals in the holistic development of watershed area for a win-win situation for all concerned. During the next few months, several meetings were organized in Bhaitan, Malas, Tachla and other villages of watershed area to merge the interests of the villagers in meeting their family and cattle energy needs and sustainable agriculture development. In these meetings, the officials tried their best to convey their commitment to enhance agriculture production in the rainfed area of the country with active participation of local communities. The people were told that the would contribute in improving productivity and provide livelihood security for concerned and also that

they would be entitled to increased agriculture output if they contribute in watershed development.

These ideas, however, had to be popularized and needed campaigning to spread the message of community participation and to help set up village institutions. The project implementing agencies took the help of District Developmental Agencies and Village Panchayats. All these efforts paved rich dividends and led people to become willing partner in resource management. In the process, Self Help Groups (SHGs) and Mahila Mangal Dals (Women Welfare Groups) were formed as part of the watershed development programme. These Community Based Organizations (CBOs) have their defined rules and regulation for smooth functioning. In Bhaitan, four SHGs are operational namely as Pragati, Dudhia Narsing and Mahila Mangal Dal. Pragati, Dudhia and Narsing SHGs are saving and credit-oriented self help groups mainly taking care of financial needs of the villagers through inter-loaning activities, whereas Mahila Mangal Dal focuses on social, cultural and religious activities in the villages. The members contribute equal amount in the group corpus. It would be worthwhile to mention the functioning of the Gram Vikas Samiti of Malas village whose members contribute 10 rupees monthly in the corpus of the committee. The funds collected so have been utilized for buying utensils for functions (e.g. marriages, religious ceremonies, etc.) as well as for other public welfare activities. The saving and inter-loaning records are well maintained by the office bearers of the SHGs. The decisions are being taken in the monthly meetings of the institutions. The grievance redressal and conflict resolution mechanism is done in the general body meetings. These institutions primarily support the members by providing loans for crop production and animal husbandry. They are linked with the nationalized and co-operative banks from where they obtain loans to disburse among the members. Table 10 provides information on status of CBOs in the sampled villages and their activities.

Table 10: Status of Self Help Groups in the study area

Name of organization	Name of village	Main activity
Pragati SHG	Bhaitain	Vegetable cultivation
Dudhiya SHG	Bhaitain	Milk Production
Mahila Mangal Dal	Bhaitain	Social work
Village Development committee	Malas	Services of catering, tent etc.
SHG	Tachala	Vegetable cultivation

3.8 Access to Financial Institutions for Saving and Credit Facilities

The inhabitants of the sampled villages have access to various financial sources. Several formal banking institutions have issued Kisan Credit Card (KCC) to the farmers. Self help groups are also playing crucial roles in lending money to members on nominal interest rates. Several formal banks also lend money to SHGs for onwards lending among

members. The status of saving accounts of the inhabitants of the sampled villages is given in Table 11. The important banks located in the close proximity of the sampled villages are State Bank of India, District Cooperative Bank and Uttarakhand Gramin Bank.

Table 11: No of person having saving accounts in financial institution

Name of village		No. of persons having accounts		
	Government bank	Cooperative banks	Post office	SHG's
Malas	15	-	30	-
Tachla	-	28	-	15
Bhaitan	67	7	67	33

4. ECONOMIC IMPACT

One of the major objectives of the Fakot watershed development project was to uplift the economic status of farmers through enhanced crop production and access to better livelihood opportunities and income on a sustainable basis. This study tried to capture the holistic impact of such interventions (e.g. agriculture and horticulture development, livestock improvement, and other employment opportunities provided by the project) on the lives of the people. For the purpose, status of incomes of the sampled families has been reviewed during and at post programme stage. The income of the households has been calculated from cash value of crops, dairy development, micro and medium enterprises and from other income sources. The total income, inclusive of all economic activities works out to be Rs 1,09,764.09 for Bhutan, Rs 72,001.02 for Tachla and Rs 1,08,375.63 for Malas. The breakup of economic benefits in terms of money is given in Table 19. As a result of sustained vegetable and milk production on commercial scales, several micro and medium enterprises have been established.

4.1 Agriculture and Horticulture Development and Their Impact on Livelihood

Enhancing production potential and income generation from arable land was the top priority of the programme to meet the basic needs of the farmers. Before the inception of the project, the income of the farmers were low due to undulated field, lack of perennial irrigation facilities, non-availability of quality seeds and high cost of inputs. This was further aggravated by lack of resourcefulness of farmers, small and fragmented land holdings, lack of awareness and absence of advanced technical knowledge.

Table 12 A: Land use patterns in Fakot Watershed

Total Area of Watershed Villages	675 (ha)
Total Agricultural Area	238 (ha)
Total forest Area	250 (ha)

Source: Watershed Management Directorate, Dehradun, Uttarakhand

Considering these problems, most of the technological interventions that were carried out targeted changes in land use patterns, improved soil conditions, conservation and managmenting water judiciously and upgraded technical skills of the farmers. In addition, farm planning, introduction of inter cropping, crop rotations, use of hybrid seeds were also undertaken. At present, crops sush as wheat, rice, maize, *mandua* and *jhangora* are grown in Fakot watershed area along with vegetables (e.g. onion, ginger, green chillies, cucumber, cabbage, garlic, etc.) pulses (e.g. black beans, masoor, etc.) and beans (e.g. French bean). Promotion of high income generating cash crops was considered important to encourage

market oriented agribusiness for the farmers. High yielding and high return crops were introduced for enhancing agriculture production as part of income generation activities. Existing land use patterns in Fakot Watershed area are summarized in Table 12a.

4.2 Impact of Technological Interventions on Land Improvement

The technical interventions carried out during the course of the project were mainly soil testing, promoting applications of balanced use of fertilizers, use of pesticides and introduction of integrated plant nutrients. The proportion of various intervention shows that maximum interventions 70-80% were done in the field of fertilizer application, soil testing and integrated plant nutrient management (figure 4). The most important intervention was construction of contour trenching in the wastelands. This has resulted in increased productivity of wastelands which were largely converted to orchards. In addition, the focus of the programme was on bringing non-irrigated land under irrigation.

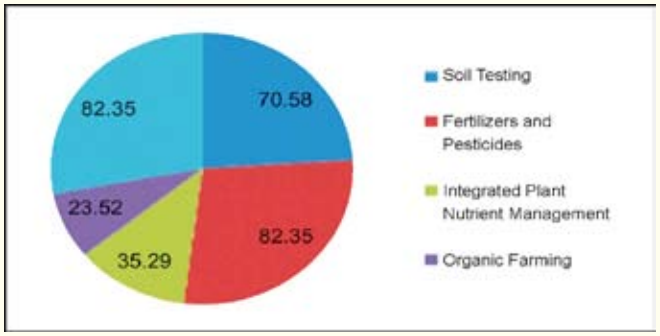

Figure 4: Proportion of land improvement in the surveyed households Note: The reason for exceeding 100 is due to land improvement intervention in more than one aspect in the same household.

The impact of interventions done for land improvement and productivity is clearly visible in terms of many positive trends on production system and livelihoods of local people. The success of the project is determined by the level of confidence generated among the stakeholders for recognizing the fact that optimum utilization and adoption of new technology can improve the agriculture productivity and increase diversity of crops. The involvement of farmers was intense as there was a sense of ownership and the cost incurred was shared between farmers and the developmental authorities. The second most important observation was the increase in food production. Earlier people were taking only one crop in a year but now 2-3 crops a year is grown. Further, horticulture development in the area has increased fruit availability to 6 to 7 months as compared to previous situations of 1 to 2 months of availability as reported by the beneficiary households.

4.3 Crop Diversification and its Impact on Agriculture Productivity

Different trends of crop production were observed in the study villages. In Bhaitan, major stress is on cucumber, green chillies, rajma, onion and ginger production probably due to the increased market demand and economic returns. In Tachla, majorities of the people

Figure 5: Ginger and Colocasia being marketed by villagers.

are growing staple crops like wheat and rice. The diversification of crop is praiseworthy despite small and fragmented land holdings. The yields of important crops cultivated by the sampled household are summarized in Table 12b.

The most significant contribution of the project is promotion of staple food crops as well as cash crops in the project area for ensuring the food security. This has helped in maintaining the sustainability of production and a good balance is made between staple crops and cash crops.

Table 12 B: Productivity of important crops in the sampled households

Crops	Yield in quintal		Area in ha		Sampled household = 53
		%		%	Production Quintals/ Ha
Mandua	12.9	1.87	1.26	4.06	10.24
Rajma	8.25	1.20	1.04	3.35	7.93
Jhangora	24.01	3.48	2.45	7.90	9.8
Ginger	180	26.10	2.3	7.42	78.26
Maize	5.81	0.84	0.52	1.68	11.17
Green chili	3.35	0.49	0.46	1.48	7.28
Rice	148.4	21.52	7.39	23.83	20.08
Wheat	144.7	20.98	8.86	28.57	16.33
Barley	14.85	2.15	1.56	5.03	9.52
Arhar	1.45	0.21	0.3	0.97	4.83
Mustard	3.7	0.54	0.28	0.90	13.21
Urd	2.55	0.37	0.36	1.16	7.08
Gram	2.4	0.35	0.8	2.58	3
Onion	7.5	1.09	0.19	0.61	39.47
Potato	0.8	0.12	0.04	0.13	20
Pea	1.2	0.17	0.24	0.77	5
Turmeric	4.8	0.70	0.08	0.26	60
Masoor	1.85	0.27	0.32	1.03	5.78
Soyabean	0.6	0.09	0.06	0.19	10
Colocasia	3.2	0.46	0.13	0.42	24.62
Tomato	2	0.29	0.02	0.06	100
Bitter gourd	7.5	1.09	0.02	0.06	37.5
Cabbage	20	2.90	0.04	0.13	50
Garlic	0.2	0.03	0.01	0.03	20
Cucumber	37.7	5.47	0.28	0.90	134.64
Fruits (Mango, Lemon, Malta & Walnut)	50	7.25	2	6.45	
Total	689.72	100.00	31.01	100.00	-

Figure 6: Vegetable cultivartion in Fakot

Figure 7: Rajma cultivation in Fakot watershed

It is clear from the perusal of Table 12a that wheat covers 28.57% of gross sown area and its contribution to the total production spectrum is 20.98%. Rice contributes 21.52% into the spectrum with 23.83% of gross sown area. Maize is cultivated in 1.68% of the total land under gross sown area with 0.84% contribution to the total production. Ginger contributes 26.10% to the total production with 7.42% contribution to the gross sown area. Vegetables such as cucumber, colocasia, cabbage, bitter gourd, tomato, potato and onion are occupying 0.96 ha of land. Fruit trees occupy 6.45% of total gross sown area. The productivity of various crops since the inception of the programme till last year are given in table 12c.

Table 12 C: Yearwise yield of crops in the Fakot Watershed

Crops	1974-75	1986-94	2009
Maize	5.0	32.3	11.17
Manduwa	4.5	8.9	10.24
Jhingora	4.0	8.4	9.80
Paddy	6.5	39.5	20.08
Wheat (rain fed)	4.5	16.4	16.33
Gram	Not Cultivated	16.8	3.0
Chillies	1.5	7.6	7.28
Ginger	35.0	114.6	78.26

Source: Data for 1974-75 and 1986-94 is from table no. 4.5 (Avg. yield of major crops), project report of CSWCRTI.

Figure 8: Supply of red chilli to market

Not surprisingly, there has been a decline in productivity of maize, paddy, gram and ginger in 2009 as compared with their production in 1986-94. Group discussion held with the respondents revealed that this declining trend was mainly due to severe drought condition that prevaled throughout the country during 2009. Although the productivity of crop has shown

a declining trend, its impact had insignificant impact on income of the households from agriculture. As an alternative, farmers have adopted cultivation of short duration crops to mitigate the risk of crop failure. On the other hand, crops like *mandua* and *jhangora* have maintained the average level of production in spite of scanty and erratic rainfall.

One of the most important visible impacts of project intervention is crop diversification in the area. The major components of crop production are vegetables, pulses, spices, fruits and cereals. The water harvesting techniques and increased irrigation facilities through canals (*guhls)* and tanks resulted in production of different types of vegetables such as green vegetables, cauliflower, onion, cucumber, colocasia, potato, tomato and peas. Irrigation facilities supported by other interventions favoured cultivation of seasonal vegetable which added income into household economy.

The climatic condition of the watershed area is suitable to horticultural crop production. As focus of the programme was to make best use of existing land, thus wastelands, *nala* bank and abandoned fields were used for horticulture development. Approximately, 12 hectare of rainfed agriculture land has been converted into horticulture land as part of the programme. As on today, 382 mango, 39 lemon, 21 walnut, 22 malta and 10 guava trees are under the ownership of 53 households. Approximately 50 quintals of production is calculated from fruit trees. The production of mangoes has increased many folds which resulted in selling of surplus produce to the nearby market and contributing to income.

The field observation buttressed by group discussion held with the locals revealed that locals have given high priority to food security and are growing staple crops in ample quantity. The production of commonly grown crops and income fetched thereof by the sampled households are depicted in Table 13.

Table 13: Price of different crops grown by the sampled households

Crops	Sampled household (N=53)		
	Yield in Quintal	Price /quintal in Rupees	Total Income in (Rs.)
Madua	12.9	1000	12900
Jhangora	24.01	1000	24010
Maize	5.81	2000	11620
Rice	148.4	1500	222600
Wheat	144.7	*1200*	173640
Barley	14.85	*1200*	17820
Vegetables & fruits	130	4733	615290
Spices (chili, garlic & Turmeric)	8.35	4000	33400
Ginger	180	2000	360000
Pulses	17.1	19700	336870
Oilseeds (Mustard)	3.7	3000	11100
Total	689.82		1819250

The cash income from cereal is Rs 462,590 which constitutes 25.43% of the total income from crops. Vegetables and fruits constitute 33.82% of the total income from crops and fetch about Rs. 6,15,290. The cash income from spices is Rs. 3633400, which constitutes 21.63% of the total income. On the other hand, monetary value of pulses is Rs. 3,36,870, which constitutes 18.52% of the total income from crops. The cash value of oilseeds is Rs. 11,100 and constitutes 0.61% of the total income from crops. This study estimates average annual income of a family from crop production to the tune of Rs. 34325.47 in the sampled villages.

Figure 9: Supply of frenchbean to maarket

Major Items Traded

The most important factor that has fetched better price to farmers is direct marketing of agriculture produce by the growers to the market avenues. As part of the programme, intensive awareness was created by the project implementing agencies aiming at sensitizing the farmers to sell their produce in the whole sale markets for better profits. To quote an example, the farmers marketed french beans, ginger, chillies, mango, cabbage, colocasia, paddy and maize amounting to Rs 14,00,000 in 2008-09.

4.4 Impact of Bio-engineering Measures Adopted for Soil Conservation and Improving Irrigation Sources

Before inception of the project, farmers of Fakot watershed had severe constraints with regard to agriculture production owing to prevalent rainfed conditions. To overcome the problem, soil and moisture conservation work such as repairing of bench terraces, construction of stone riser, gully plugging, nala bunding and contour trenching was done at massive scale as part of the programme. In addition, water storage and harvesting structures and vegetative barriers were constructed besides development of irrigation channel network to harness maximum benefits of available water resources in increasing agricultural production.

A total of 20.2 hectare area was brought under irrigated terracing in the watershed area as part

Improved Bench Terraces augments production

Bench terracing in the Fakot watershed program have raised new hopes in this region. During the project period, the land with steep slopes was leveled. Contour trenching techniques were adopted for soil and moisture conservation which led to the augmentation in net sown area. One of the most significant impacts of this intervention was the development of a new cluster of land which was earlier not considered fit for cultivation. At present, cash crops are being grown in these clusters of land. According to the villagers more than Rs 3 lakh is earned from the land areas, which were once considered wastelands.

of the project activities. This was a great beginning for agriculture and horticulture development in the region. Apart from this, contour trenches were dug to control the velocity of surface runoff. Water retention structures (e.g. gabion structure) were constructed and road side erosion control measures were taken in collaboration with Directorate of Border Roads Organization, State Soil Conservation Department and Department of Rural Development. The combined impact of the measures taken resulted in reduced soil erosion and increased ground water recharge. The impact of availability of water resulted in conversion of significant wasteland into arable land and as a consequence many farmers started cultivating fruit and vegetable crops in these lands.

Figure 10: Improved terrace in Fakot

Figure 11: Water tank constructyed during the project

The second most important achievement in the study areas was the development of small irrigation channels locally known as *guhls* to distribute water from small perennial springs to the fields. To check the seepage losses, cement lined *guhls* were constructed along the canals. Cement masonary tanks with storage capacity of 10-30 cubic meters were constructed at suitable sites to augment irrigation water supply. As the construction cost was high, farmers were subsidized by way of providing cement and wages for mason works from the projects funds. The stakeholders contributed for earthwork and construction materials, which amounted to about half of the cost of the structure. Table 14 provides details of the area under irrigation in Fakot Watershed, whereas land use patterns of the sampled villages as part of the present study are given in Table 15.

Table 14: Irrigation statistic of Fakot Watershed

Year	1975-76	1994-95
Area (Ha.)	11.84	25.10

Project Report – 1997, CSWCRTI, Dehradun

Table 15: Area of irrigated and non irrigated land in the sampled households

Name of village	Total Land area (in ha)	Cultivated land (in ha)	
		Irrigated land	Non -Irrigated land, land/ rainfed
Malas	20	1	19
Tachla	20	4	16
Bhaitan	28.9	2.89	26.01
Total	68.9	7.89	61.01

Total land area is 68.9 ha out of which 61.01ha land is unirrigated.

The introduction of low density polythene (LDP) tank as an alternative to cemented tank was an important intervention during the project period. Such tanks (lined with LDP) were often seen in the project area during field visits. Today, 15 families in Bhaintan are using water from these tanks for agriculture purposes. Establishment of vegetative barrier of non palatable plant species helped not only in arresting soil erosion but also increased water recharge.

Polythene tank as a source of livelihood

Bharat Singh, a marginal farmer from Bhaitan village, has become a source of inspiration for other farmers by adopting low density polythene (LDP) tank technique for growing vegetables. During IWMP, Bharat Singh constructed a polythene tank having a dimension of 15x8x5 feet on his own land. He fills this tank with water by linking it with the main water storage tank which is further linked with guhls improved under the project. The stored water is used for growing vegetable and fruit crops. The vegetable crops include french beans, cucumber, cauliflower and cabbage and he is getting a good harvest. In the words of Mr. Bharat Singh, "my earning has increased many fold after constructing polythene tank. Today, I earn approximately Rs. 20,000-25,000 from my 5 Nali land. I own 100 mango trees which have been raised under bench terracing system. I sell mangoes in the local market and earn significantly.

Figure 12: Canal constructed during the project

Today, availability of water for irrigation through tanks, *guhls* and wells in the surveyed villages has improved as compared to project inception year. All families of Malas village have access to tanks for irrigation purposes. In Tachla, 10 families have access to tanks for irrigation purpose, 28 families have access to *guhl* irrigation while wells are used for irrigation purpose by 20 families. In Bhaitan, 15 families are using river water for irrigation and an equal number are using tanks. Nearly 30 families are using *guhls* and wells for irrigation.

4.5 Income and Employment Opportunities

The most important indicator which determines the success of any developmental programme is the better access to income avenues created as part of the programme and increased income of the people thereof. A number of income and employment opportunities were made available as part of the programme. These included crop production, livestock development, micro and medium enterprise development, forest conservation and development, etc.

4.5.1 Livestock Development as a Major Source of Income

Today, villagers keep cows, buffaloes and oxen in the sampled villages. They hardly rear goats, sheep and poultry. In the beginning of the project, total livestock population was 553 including 66 cows, 128 bullocks, 92 buffaloes, 158 sheep and goats. The average milk yield was 112 liters and 734 liters per lactation for cows and buffaloes, respectively (Source Project Report). Today, average number of cows, buffaloes and oxen per household are 0.20, 1.0 and 0.26, respectively. The livestock populations in the sampled villages are given in Table 16. A major portion of household income is drawn from selling of milk @ Rs. 13 per liter in peak season. The major shift that the programme has brought in livestock holding pattern in the watershed area is adoption of improved breeds of buffaloes from cows, goats and sheep. This has resulted in increased milk production. The milk production by the sampled households is summarized in Table 17. The increment in milk production has generated ample scope for dairy business in this region.

In case of veterinary service, there is low preference for artificial insemination but regular vaccination camps for livestock diseases like foot and mouth disease are being organized by the government department.

Table 16: Livestock composition in the sampled households:

Livestock		Village Name		
	Bhaintan (N=24)	Tachla (N=17)	Malas (N=12)	Overall (N=53)
Cow	6	4	1	11
Buffalo	24	16	13	53
Ox	2	6	6	14

Villagers earns considerably by selling milk and milk by products such as curd, ghee and buttermilk. One of the important contributions of livestock is the production of manure, being used in agriculture production, has not been accounted in income. The total income earned from livestock rearing in Bhaitan, Tachla and Malas amount to Rs. 482185.44, Rs. 310437.34 and Rs. 215784.36, respectively. Table 18 provides information on average milk production by cattle in the sampled villages.

Table 17: Monthly milk production of cows and buffaloes in the sampled households

Village	Cow	Buffalo	Total cow milk/month (litres)	Total buffalo milk/month (litres)
Malas (12)	1	13	78.75	1596.88
Tachala(17)	4	16	384.45	2080.42
Bhaitan (24)	6	24	819.21	3053.75
Total (53)	11	53	1282.42	6731.04

Table 18: Average milk production in the sampled area.

Average milk per cow /day	3.8
Average milk per buffalo /day	4.23

4.6 Income Sources

Income determines the economic status of a household which ultimately is linked with the social status of the family in a typical Indian scenario. The villagers of the sampled villages have various income sources such as agricultural, micro and medium enterprises, government and private jobs, etc. This study revealed that a farmer's income mainly revolves around agriculture, although she/he has other sources of income which only supplement his/her main income source. As part of the project intervention, increased fodder production and changed livestock holding pattern has attributed to significant increase in milk production and resultant increased income. This has led people to think grabbing other employment opportunities such as running small business enterprises in the form of tea stalls, provisional stores, vegetable shops, small dhabas (food corner), juice centres etc. Table 19 provides information of income earned by the people during past year in the sampled villages, whereas comparative statement of incomes from various sources before and after project intervention is given in Table 20.

Milk production as a means of livelihood

Milk production in Bhaintan village is slowly but gradually developing as an important source of livelihood for the villagers. The demand of milk in the local market is about 200 liters per day majority of which is being fulfilled from Bhaintan village. The reason for this success is fodder development scheme and change in livestock composition by increasing the number of buffaloes during the course of watershed development. In the project intervention area, nearly half of the families are engaged in milk production at commercial level. Among the many beneficiaries are Dilip Singh, Sanjay Singh Negi, Kuwar Singh, Bharat Singh, Jontari Devi and Pushpa Devi. As a result of surplus milk production, the youths of the village have opened tea stalls in Fakot market and the milk is supplied to them from the village.

Table 19: Income of the beneficiary households from various sources

Annual Income (in Rs)	Average		
	Bhaintan (N=24)	Tachla (N=17)	Malas (N=12)
Agri. Labour	4357.14	2940	2700
Micro enterprise	2885.71	1000	1942.8
Income from crops	32681.89	36781.89	34132.69
Income from Livestock	20091.06	18261.02	17982 .03
Govt. and non govt.	32571.4	9400	46200
Skilled /unskilled labour	5623.08	1942.86	400
Other opportunities	10735.7	857.14	4200
Total income	108945.9843	71182.91434	89575.49434

Table 20: Comparison of Income at different Intervals

Sources of Income	Annual income (Rs./family)		Annual income (Rs./ family)
	Pre project	During 1991-92	At present (2009)
Farm	249(6.7)	12894(51.5)	53352.02 (55.61)
Business	2187(59.0)	3545(14.3)	13194.81 (13.75)
Service	1274(34.3)	8542(34.2)	29390.48 (30.64)
Total annual income	3710(100)	24981(100)	95937.31 (100)

From the review of Table 20, it is clear that the augmentation to household income from farm, business and service have increased when compared with the incomes of the households from these sources before project intervention. Similar, trends are seen in incomes from business and service sector. At present, farm, business and service sectors contributes 55.61%, 13.75% and 30.64%, respectively in the household economy in the region.

5. ECOLOGICAL IMPACT

Though the focus of the project was on transfer of technology in watershed management to field conditions, thereby increasing the farm production and providing livelihood opportunities to the population, yet the aim of the present study is, *inter alia*, to find out the residual effect of the project on environmental conservation - soil and moisture not only on the farm lands where the project was implemented but in village common lands and adjoining forest lands as well. The idea is to test the utility and effectiveness of watershed management practices on conservation of adjoining forest areas. Needless to mention that forest conservation leads to conservation of soil and moisture, which ultimately results in increasing the productivity of the landscape.

5.1 Forest regeneration patterns and crop composition

The Integrated Watershed Management programme gave much emphasis on increasing the availability of fodder and fuel within the villages. In the process, soil and moisture conservation work was carried out on village common lands, which was enriched with plantations of multi-purpose trees. This study tried to look into the availability of fodder in sampled villages, peoples' dependency on forest for fodder and fuel and the present condition of the forest in the micro watershed area.

Tree regeneration patterns in the treated and non-treated forests are given in Table 21a and 21b, respectively. As is evident from table 21a, tree species richness in Regeneration, Recruitment and Establishment Classes of treated forests are 7, 15 and 26, respectively. Species, specifically *Asain, Bahera, Baroda, Bheemal, Laundua, Mahua, Malu, Mandara, Saken, Semal, Silver Oak, Sinsaru, Thatriya* and *Tumli* have shown their presence in Establishment Class only. On the other hand, species such as Baanjh, Buras, Kaaphal, Khagsi, Payan and Samara were present in all classes, whereas species like Devri, Dhaura, Khakra, Kuri, Mango, Rohini, Timla and Tungla have shown their presence in Recruitment and/ or Establishment Class(s). The overall densities in Regeneration Class (345.29 mean ± 153.11 S.E.) was almost double than its corresponding value in Recruitment Class (174.08 mean ± 57.45 S.E.) but significantly lower than Establishment Class (453.70 mean ± 84.99 S.E.). A bird's eye view of Table 21b reveals that only *Kalabansa* was present in Regeneration class in non-treated forest when compared with its corresponding class values in treated forests where seven species have shown their meaningful densities. Similarly, there are two species namely Devri and Rohini in Recruitment Class of non-treated forests against 15 species in the Recruitment Class in treated forests. Likewise, Establishment Class of non-treated forest area is represented by 17 species as compared with 26 species of trees in the Establishment Class of the treated forest. Further, overall tree density in Regeneration Class of non-treated forest (265.86 mean ± 167.65 S.E.) is significantly lower than its corresponding value in the treated forest (345.29 mean ± 153.11 S.E.). Similarly, there are fewer trees per hectare in the Recruitment Class of non-treated forest

Table 21 A: Tree regeneration patterns in the treated forests

Species	Regeneration (plants/ hectare)		Recruitment (plants/ hectare)		Establishment (plants/ hectare)	
	Mean	SE	Mean	SE	Mean	SE
Asian	0	0	0	0	25.32	16.88
Baanjh	18.99	18.99	25.32	25.32	151.92	69.47
Bahera	0	0	0	0	3.17	3.16
Baroda	0	0	0	0	3.17	3.16
Bheemal	0	0	0	0	31.65	16.34
Buras	0.20	0.20	9.50	9.49	12.66	12.66
Devri	0	0	22.16	12.53	0	0
Dhaura	0	0	22.16	14.96	19.79	12.55
Kalabansa	303.84	140.29	0	0	0	0
Kaphal	0.10	0.10	6.33	6.33	12.66	9.67
Kaula	0	0	0	0	3.17	3.16
Khagsi	9.50	9.49	12.66	12.66	18.99	18.99
Khakra	0	0	15.83	15.82	0	0
Kuri	0	0	3.17	3.16	0	0
Laundua	0	0	0	0	50.64	25.05
Mahua	0	0	0	0	9.50	6.76
Malu	0	0	0	0	12.66	9.67
Mandara	0	0	0	0	25.32	14.77
Mango	0	0	6.33	6.33	0	0
Payan	9.50	9.49	12.66	12.66	9.50	9.49
Rohini	0	0	18.99	12.66	0.30	0.30
Saken	0	0	0	0	3.17	3.16
Samara	3.17	3.16	3.17	3.16	6.33	6.33
Semal	0	0	0	0	6.33	6.33
Silver Oak	0	0	0	0	12.66	12.66
Sinsaru	0	0	0	0	3.17	3.16
Thatriya	0	0	0	0	3.17	3.16
Timla	0	0	3.17	3.16	9.50	6.76
Tumli	0	0	0	0	3.17	3.16
Tungla	0	0	22.16	18.90	3.17	3.16

Table 21 B: Tree regeneration patterns in the control forest

Species	Regeneration (plants/ hectare)		Recruitment (plants/hectare)		Establishment (plants/ hectare)	
	Mean	SE	Mean	SE	Mean	SE
Aola	0	0	0	0	6.33	6.33
Asen	0	0	0	0	37.98	30.69
Bahera	0	0	0	0	6.33	6.33
Banjh	0	0	0	0	63.30	63.30
Buras	0	0	0	0	31.65	31.65
Chena	0	0	0	0	25.32	18.45
Devri	0	0	12.66	12.66	0	0
Dhakna	0	0	0	0	25.32	25.32
Gald	0	0	0	0	12.66	12.66
Ghaiti	0	0	0	0	37.98	37.98
Kaaphal	0	0	0	0	25.32	25.32
Kalabansa	265.86	167.65	0	0	0	0
Laundua	0	0	0	0	31.65	24.52
Mandara	0	0	0	0	12.66	7.75
Rohini	0	0	18.99	12.66	12.66	12.66
Samara	0	0	0	0	6.33	6.33
Semal	0	0	0	0	6.33	6.33
Tun	0	0	0	0	18.99	18.99
Tungla	0	0	0	0	31.65	24.52

(31.65 mean ± 24.52 S.E.) as compared with its corresponding value in the treated forests (174.08 mean ± 57.45 S.E.). Likewise, tree density in the establishment class of treated forests (453.70 mean ± 84.99 S.E.) is higher than trees per hectare in the non-treated forest (417.78 mean ± 108.90 S.E.). Higher tree regeneration and recruitment densities and richness in the treated forests as compared with the non-treated forests implies remarkable improvement in the forest condition as a result of protection and regeneration measures taken as part of the watershed development activities. Special mention needs to be made about *Bheemal, Kharik* and *Malu* - highly valued fodder species. Their presence indicates that comprehensive efforts have been made for pasture development in the region which in turn is a boost to dairy development which is one of the most important sources of local economy. The overall density of shrubs in the treated area (4205.78 mean ± 850.70 S.E.) is significantly higher than its corresponding value in the non-treated forests (3550.25 mean ± 1199.40 S.E.). Presence of 22 species of shrubs and 11 species of herbs in the treated forest (table 21c) against 6 species of shrubs and 4 species of herbs in the non-treated forest (table 21c)

Table 21 C: Shrub densities (plants per hectare) in Fakot Watershed

Species	Treated forest		Non-treated forest	
	Mean	S.E.	Mean	S.E.
Aakh	25.64	25.64	0	0
Atmaru	102.56	89.23	0	0
Baskera	128.21	128.21	80.00	73.03
Bhel	0	0		
Chirolaz	141.03	141.02	0	0
Karyapatta	538.46	204.77	496.40	192.72
Kingora	0	0	51.28	46.81
Gojla	102.56	89.23	0	0
Hinsara	51.28	51.28	0	0
Hisra	102.56	102.56	0	0
Kaplia	76.92	76.92	0	0
Karonda	12.82	12.82	25.64	23.41
Khagsa	76.92	76.92	0	0
Kingora	141.83	98.16	0	0
Kuja	128.21	128.21	0	0
Kukar Dari	128.21	128.21	0	0
Kura	64.10	64.10	0	0
Kurenja	500.00	292.63	0	0
Lantana	1320.51	495.07	2871.29	840.03
Lonia	76.92	76.92	0	0
Mendasingha	12.82	12.82	0	0
Musola	230.77	230.76	0	0
Phuli	192.31	192.30	0	0
Runia	51.28	51.28	0	0

is an indication that forest floor is gaining moisture which is making favorable conditions for regeneration of intermediate and climax species in the ecosystem. However, dominance of Lantana – a weed species in the non-treated forest which is forming bulk of the under storey biomass require immediate attention. Although it adds to overall diversity of the ecosystem but its proportional composition into plant life-form spectrum is a matter of serious concern. Higher overall herb density has been observed in the treated forest (346001 mean ± 79806.25 S.E.) as compared to its corresponding value in the non-treated forests (1290.80 mean ± 375.84 S.E.). Interestingly, individual densities of fodder grass species (e.g.

Table 21 D: Herb densities (plants per hectare) in Fakot Watershed

Species	Treated forest		Non-treated forest	
	Mean	S.E.	Mean	S.E.
Atmari	0.70	0.70	0	0
Bugia	4000.00	3999.93	0	0
Dubbar Ghas	0	0	1120.00	260.76
Ghas Padanina	0.70	0.70	0	0
Golda Ghas	106000.00	34870.55	8.20	3.36
Hathi Ghas	0	0	160.00	109.54
Kalnhisar	7000.00	6999.87	0	0
Khadu	8000.00	7999.85	0	0
Lonia	79000.00	44582.44	0	0
Paanch Patta	12000.00	9164.98	0	0
Phulni	18000.00	17999.67	0	0
Siroli	1000.00	999.98	0	0
Tachla	111000.00	57084.66	2.60	2.17

Table 21 E: Vegetation diversity indices in the treated forest

Diversity	Tree		Shrubs		Herbs	
	Mean	SE	Mean	SE	Mean	SE
H’	0.63	0.04	0.48	0.05	0.34	0.04
H_0	5.80	0.51	4.00	0.49	2.40	0.22
E_5	0.18	0.06	0.27	0.08	0.16	0.04

Table 21 F: Vegetation diversity indices in the control forest

Diversity	Tree		Shrubs		Herbs	
	Mean	SE	Mean	SE	Mean	SE
H’	0.63	0.03	0.27	0.07	0.32	0.03
H_0	5.20	0.37	2.60	0.51	2.60	0.40
E_5	0.04	0.04	0.01	0.00	0.02	0.01

[2] *Source:* project base line

Golda Ghas, Tachla Ghas, Lonia Ghas, etc.) are significantly higher in the treated forest as compared to non-treated forest (Table 21d). Similarly, diversity indices are remarkably higher in the treated forests (Table 21e) as compared with non-treated forest (Table 21f).

5.2 Decreased Dependency on Forest for Fuel and Fodder

Before the inception of the project, the dependency of people on forest for fodder, fuel and fiber was about 80%. Earlier the villagers used to meet about 42% of their requirement from government forest and about 13% from civil soyam land[2]. The community land was under excessive pressure of grazing and had no effective and economic vegetation. Therefore, efforts were made to propagate multipurpose trees and grasses in the watershed. Since this was a pilot project on watershed development, basically implemented on farmlands, there was much emphasis on planting forest tree species on community land. Reserve forests, which are at the periphery of the villages in the watershed, were not taken up for plantation under the project. However, efforts were made for plantation of preferred multipurpose tree species such as Bheemal (*Gweta optwa*), Kachnar (*Bauhinia purpuria*), Toon (*Toona ciliata*) Timla (*Ficus roxburghii*), Asin (*Terminalia tomentosa*) , Sandan (*Ougenia dalbergoids*), Sesam (*Dalbergia Sisoo*) on rainfed agriculture and community land to increase biomass production, which would fulfill the requirement of fuel and fodder of the villagers. According to project documents, more than 20,000 saplings of various multipurpose trees were planted in the watershed. Of these more than 5,000 trees are surviving and providing substantial quantity of fodder and fuel. Plantation of elephant grass and local grasses was taken up in a big way which is successful attempt to a great extent. The fringe forests were benefited by the project since there was an increase in biomass production and pressure on forest was considerably reduced. The villagers were already practicing farm forestry in their farmlands, which is evident from Table 22, which gives availability of fuel and fodder in the villages.

Table 22: Status of trees in the villages and its annual yield

Species	No.	Av Ht (in Mts)	Ac Dia (in cms)	Annual Yield per tree		
				Fodder (HL)	Fuel-wood (HL)	NTFP (Kg)
Bhimal	700	10	30	14-17	3-5	-
Asheen	250	8	25	8-10	1-2	-
Sandan	300	8	25	8-10	-	-
Gural	600	7	20	6-8	-	-
Semal	150	8	25	-	-	-
Khirak	300	9	27	8-10	-	-
Elephant Grass/ local grass	2000 tufts	1.5	-	4-6	-	-

Though villagers were not having recorded rights in the reserved forests, yet forest products were being taken wherever and whenever possible. Now after the implementation of the project, the biomass production in the private lands has increased to a greater extent and consequently removal from the forest areas has been reduced considerably. Now, most of the requirements of fodder and fuel-wood are being met from private lands of the villagers which is evident from data given in Table 23.

Table 23: Availability of plant biomass in private, common and forest land.

Item	Percentage of requirement being fulfilled by type of land %		
	Private Land	Common Land	Forest Land
Fodder	80	10	10
Fuel-wood	65	15	20
Grass	70	20	10
NTFP	70	10	20

The baseline data reveals that the dependency of farmers for fuel and fodder on forest was 60%, which came down to 40% in 1985-86. The present case study shows that the dependency on forest has declined further to the level of 10%-20%.

6. CLIMATE CHANGE - AFFECTING THE LIVELIHOOD AND FOOD

It is an established reality now that climate change is a global challenge and its effects are going to impact the whole universe in various ways. Infact, the adverse effects of the climate change are already visible on our environment, weather, agriculture, water availability, and sea-levels. Those most vulnerable to climate change are the communities living in rural areas and depending on agriculture and allied activities as a main source of their livelihood. The present study also depicts the negative effects of climate change on crop production, particularly, during 2009. Rising temperature, erratic rainfall or delayed rainfall is affecting agricultural activities such as delay in sowing period, late harvesting and missing the next season for sowing. As per the perceptions of villagers and data on production and productivity, it can be stated that the negative impact of climate change are visible in studied villages also.

According to a United Nations backed report, climate change is posing a serious threat to communities in the Hindukush Himalayan region. The temperature increase in the Himalayas seems to be more alarming than the global average, increasing at a rate of 0.6 degree centigrade per decade compared to the worldwide average of 0.74 degree centigrade over the past century. The new report found that extreme climatic events are destroying crops, depleting water resources, depleting livestock and cropland, and giving a blow to agricultural productivity (UN 2009). Table 24 shows the decline in yields of wheat, maize paddy and gram in project area due to change.

Table 24: Comparative chart of crop yield (quital/hectare) in the Fakot Watershed

Crops	1974-75	1986-94	2009
Maize	5.0	32.3	11.17
Manduwa	4.5	8.9	10.24
Jhingora	4.0	8.4	9.80
Paddy	6.5	39.5	20.08
Wheat (rain fed)	4.5	16.4	16.33
Gram	Not Cultivated	16.8	3.0
Chillies	1.5	7.6	7.28

Source: Data for 1974-75 and 1986-94 is from table no. 4.5, project report of CSWCRTI.

The declining trend in 2009 is mainly due to the change in climate, which has seriously affected the rainfed agriculture of the project area.

Interestingly, the impact of climate change on traditional crops (e.g. *mandua, jhangora, caulai, etc.*) of the mountainous region is less than on the other crops. These crops are

more resistant to draught and are less affected by the same. The crop production of wheat, rice, maize and vegetables are more affected due to climate change impacts. This is a strong indication towards promoting traditional crops on a large-scale in order to meet the challenges of climate change.

In the present situation where, the climate change is seriously affecting the agriculture of Fakot Watershed, it is strongly recommended to adopt and promote the production of traditional cereals and horticultural crops in order to achieve better food and economic security.

MAJOR CONCLUSIONS AND LESSONS LEARNED

1. The most significant contribution of the project, which is clearly visible today, is an improvement in agricultural production and environment conservation. This can be elaborated as knowledge building of farmers in engineering measures which were so effective that in spite of steep slope and difficult undulating topography, bench terracing has made possible the use of otherwise wasteland for agricultural and horticultural use. Several orchards have been developed after bench terracing. The intervention under engineering measures has resulted in the conversion of wastelands into fruit orchards, which was totally absent before the inception of the project. Now horticulture has become a permanent source (mainly mangoes) of income for the project beneficiaries.

2. The manifestation of dairy as a commercial source of income due to the change in composition of livestock by increasing the number of buffaloes was an intervention which has changed lives. Now, nearly half of the families are practicing dairy as a major source of income.

3. A marked increase has been seen in the production of biomass, particularly from the privately-owned farm-lands of the villagers. This has been possible due to large-scale planting of mulberry and improved grasses during the project period.

4. As a result of increased biomass production, the villagers have become almost self-sufficient for their requirement of fuel and fodder. This in turn has resulted in improving the condition of the nearby forest by minimizing the removal of forest products.

5. Distribution of high-yielding varieties of seeds, fertilizers and chemicals in the form of insecticides and pesticides was also a major contribution. A number of varieties of crops introduced during the project has resulted in increased crop diversity as well as diverse options for income generation. The production of a variety of vegetables, fruits, cereals, pulses and oilseeds strengthened the food and economic security of the project beneficiaries.

6. The scope of irrigation was increased through construction of economical tanks having Low Density Polythene (LDP) film instead of cement. This was a major breakthrough as there was limited resource for irrigation and most of the water sources were located at a lower elevation than the fields.

7. People of the study area are having a poor socio-economic condition, hence they

have a less risk taking capacity and have limited scope for use of inputs. In spite of subsistence nature of agriculture with limited availability of improved seeds, other inputs and crop diversification, the tendency to channelise the production to the market is really appreciable.

8. It was observed that a long duration project should be undertaken and during the withdrawal phase follow-up activities should be linked with the ongoing schemes of various department of the Government so that the continuity of development is not disturbed.

THE WAY FORWARD

Fakot Integrated Watershed Development Project was successful to a great extent in improving the productivity of crops and enhancing the livelihood opportunities of local people mainly by the change in livestock composition pattern and new farming technologies. The encouraging results of this innovative project lies in the fact that the people themselves are practicing bench terracing and a positive mindset has been developed for off-seasonal vegetable cultivations selling the excess production in the nearby market to earn profit. The encouraging results of this project shows the way forward for adopting a similar approach with proper follow-ups in other watersheds covering a larger area for a longer period of time to achieve a long-term impact and bigger extrapolation.

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LIST OF ABBREVIATION

CSWCR&TI	-	Central Soil and Water Conservation Research and Training Institute
CBOs	-	Community Based Organizations
IWMP	-	Integrated Watershed Management Programme
KCC	-	Kisan Credit Card
NRAA	-	National Rainfed Area Authority
SBI	-	State Bank of India
SHG	-	Self Help Group

National Rainfed Area Authority
Planning Commission
Government of India
New Delhi