

**IMPACT OF WATERSHED DEVELOPMENT PROGRAMME  
ON RURAL LIVELIHOOD IN COOCH BEHAR DISTRICT OF  
WEST BENGAL**

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Submitted to the  
Uttar Banga Krishi Viswavidyalaya  
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**By  
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A close-up photograph of several roses in shades of pink and white, with green leaves visible. The text is overlaid in a black, elegant script font.

*Dedicated  
To My  
Beloved Parents  
&  
Sisters*

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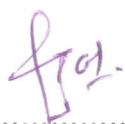




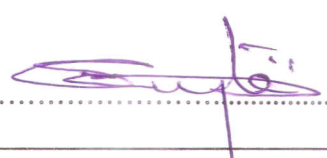
**CERTIFICATE**

This is to certify that the work recorded in the thesis entitled “**IMPACT OF WATERSHED DEVELOPMENT PROGRAMME ON RURAL LIVELIHOOD IN COOCH BEHAR DISTRICT OF WEST BENGAL**” submitted by Shri Bablu Ganguly [Reg. No. A-2012-3-M] in partial fulfilment of the requirements for the degree of Master of Science (Agriculture) in Agricultural Extension of the **Uttar Banga Krishi Viswavidyalaya**, is the faithful and bonafied work carried out under my personal supervision and guidance. The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received from various sources during the course of investigation have been duly acknowledged.

.....  
( Prabhat Kr. Pal )  
Chairman,  
Advisory Committee

**APPROVAL OF EXAMINERS FOR THE AWARD OF THE  
DEGREE OF MASTER OF SCIENCE (AGRICULTURE) IN  
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We, the undersigned, having been satisfied with the performance of Shri Bablu Ganguly [Reg. No. A-2012-3-M], in the viva-voce examination of the thesis, conducted today, the... Aug. 18 ....., 2014, recommended that the thesis would be accepted for the award of the degree of Master of Science (Agriculture) in Agricultural Extension.

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Date: 08.08.14

Pundibari, Cooch Behar

Bablu Ganguly

(Bablu Ganguly)

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In many countries watershed approaches have increasingly becoming a holistic approach to natural resource management and rural development instead of focusing only on 'water' through improved land management and rainfed crop production. To most people from the water sector, watershed management is essentially to do with better water resources management. However, watershed management as a paradigm is not, however, restricted to the water sector only but it offers a chance to deal holistically with a range of resource issues, also carries the risk of potential confusion in application.

Indian watershed management is heavily backed (through subsidy) by government as part of rural development strategy. Although there are great differences in the level of application between states it has been estimated that starting in the mid-1990s the Indian government has spent approximately \$500million per year on watershed management projects (Turton and Farrington, 1998). Andhra Pradesh is one of the states where watershed approaches have been most extensively adopted. The rain-fed agriculture contributes 58 per cent to world's food basket from 80 per cent agriculture lands (Raju et al. 2008). As a consequence of global population increase, water for food production is becoming an increasingly scarce resource, and the situation is further aggravated by climate change (Molden, 2007). The rain-fed areas are the hotspots of poverty, malnutrition, food insecurity, prone to severe land degradation, water security and poor social and institutional infrastructure (Rockstorm et al. 2007; Wani et al. 2007). Watershed development program is, therefore, considered as an effective tool for addressing many of these problems and recognized as potential engine for agriculture growth and development in fragile and marginal rain-fed areas (Joshi et al. 2005; Ahluwalia and Wani et al. 2006). Management of natural resources at watershed scale produces multiple benefits in terms of increasing food production, improving livelihoods, protecting environment, addressing gender and equity issues along with biodiversity concerns (Sharma, 2002; Wani et al. 2003a,b; Joshi et al. 2005; and Rockstorm et al. 2007).

## **Concept of Watershed**

Watershed development is a holistic approach to build and strengthen the basic resources, so as to enable the establishment of sustainable life support. This is an integrated approach on a natural hydrological unit, “a watershed”.

Watershed is a natural hydrological entity that covers a specific area expanded on land surface, within whose boundaries the entire rainfall run-off ultimately passes through a specifically defined stream. So, it is a unit of land on which all water that falls collects by force of gravity, runs via common outlet. It is thus an area of land that contributes run-off to a common point and is separated from adjoining areas by a natural ridgeline (Oswal, 1999).

Singh (2000) has defined watershed as a geographic area drained by stream of connecting streams such that all precipitation in this area leaves the area in a concentrated flow through a single outlet.

Watershed, as a natural unit of ecosystem planning and development, is widely used in most of the countries. It has a wide spectrum of characteristics like watershed topography consist of mountains, hills, plains, gullies, valleys and so on. Each is characterized by variable slope and the area, from one location in the watershed to the other location; land mass includes land use, soil type and underlying geology; meteorological factors contain rain, evaporation, radiation, wind, temperature etc.; vegetation involves agriculture, forestry and agro-forestry.

These resources are interdependent and ultimately management of these factors is determined with the proper consideration of ecological and socio-economic factors.

Watershed development project is aimed at conservation of natural resources and maintaining the ecological development of the area by using the simple soil and water conservation techniques.

The process of watershed development involves co-ordinated multidisciplinary activities and expertise from several departments. To sustain the assets created under the programme, the participation of the people community as well as Panchayati Raj institutions is also essential. In Karnataka, various bodies and Departments implementing

watershed development programmes needed greater co-ordination in planning, implementation and supervision necessitating a concerted thrust on watershed management.

A watershed, also called a drainage basin or catchment area, is defined as an area in which all water flowing into it goes to a common outlet. People and livestock are the integral part of watershed and their activities affect the productive status of watersheds and vice versa. From the hydrological point of view, the different phases of hydrological cycle in a watershed are dependent on the various natural features and human activities. Watershed is not simply the hydrological unit but also socio- political-ecological entity which plays crucial role in determining food, social, and economical security and provides life support services to rural people (Wani et al.2008).

Watershed management is a landscape-based strategy that aims to implement improved natural resource management systems for improving livelihoods and promoting beneficial conservation, sustainable use, and management of natural resources. Integrated watershed management (IWM) has been promoted in many countries as a suitable strategy for improving productivity and sustainable intensification of agriculture.

In India, most watershed projects are implemented with the twin objectives of soil and water conservation and enhancing the livelihoods of the rural poor (Sharma and Scott, 2005). Different types of treatment activities carried out in a watershed include soil and moisture conservation measures in agricultural lands (contour/ field bunding and summer ploughing), drainage line treatment measures (loose boulder check dam, minor check dam, major check dam, and retaining walls), water resource development/management (percolation pond, farm pond, and drip and sprinkler irrigation), crop demonstration, horticulture plantation and afforestation (Palanisami and Suresh Kumar, 2005). The aim has been to ensure the availability of drinking water, fuel wood and fodder and raise income and employment for farmers and landless labourers through improvement in agricultural production and productivity (Rao, 2000).

Watershed Development can open up new opportunities for households to both intensify and extensify production, for example through:

- Increasing the frequency of cultivation – increased groundwater recharge often permits cultivation of a second crop, or ‘life-saving’ irrigation of a main crop; and
- Adopting new technologies, such as improved varieties of staple crops, higher levels of input use and higher yields; shifts to the cultivation of higher value crops in some areas;
- Expansion of cultivated areas – soil and water conservation and irrigation structures can bring new land into production.

All of the above tend to generate increased demands for labour. These may be provided initially from farm family sources and subsequently by hired labour. Beyond pilot projects, however it is not known, for instance, how far intensification/extensification generates employment opportunities for households – often poor and the landless – which depend on labouring for their livelihoods.

### **The problem statement**

Recognising the importance of watershed development programme in the state, Cooch Behar district also implemented 6 nos. of micro watershed project during XI- five year plan (2007-08 to 2011-12) of which Rangamati watershed project has executed at Mathabhanga-II Block. It is a project among 48 nos. Micro watershed project in West Bengal during XI- five year plan period. The project comprised of Rangamati (Part), Ruidanga (Part), Mukuldanga (Part) mouzas of Ruidanga and Barsoulmari Gram Panchayat. The Rangamati micro watershed is a region of depression resulting in few physiographic problems which largely contribute to deteriorate other socio-economic situation. The major problems of this micro watershed were soil erosion (sheet erosion, rill erosion, gully erosion and stream bank erosion); high rainfall causes occurrence of flood, deposition of sand in the cultivable area and converts the land uncultivable or unculturable; the surface of the watershed is slightly sloppy causing excessive run-off of down pour resulting low crop production and productivity; some parts of the watershed is low lying, causing stagnation of water, resulting poor yield; most of the agricultural crop field were suffering from irrigation facility; soil is acidic in nature and suffering from micro nutrient deficiencies like zinc, boron and molybdenum, resulting poor crop

production; lack of awareness of farmers in respect of modern technology and modern agriculture; poor socio-economic situation of the watershed community.

Considering the problem in the area the Rangamati micro watershed was implemented in 1st April, 2007 and emphasized on plot making by graded and field banks, gully plugging by vegetative, mechanical and engineering measures, construction and re-excavation of drainage channel, making of barrier bund and periphery bund to enhance water holding capacity and also to protect against stream bank erosion, excavation and re-excavation of Water Harvesting Structure (WHS) and Farm Pond (FP) conserve more rain water or down pour, construction of well in project area helps to meet-up scarcity of water for plants, animals and human beings, sand reclamation by different types of bund and reclamation of soil acidity by incorporation of soil ameliorates like lime, dolomite is useful in respect of soil texture and soil structure, resulting good crop production, testing and demonstration of new indigenous and low cost technology helps for better crop production, crop demonstration from traditional farming system to modern integrated farming system is adopted for optimum production and productivity, Natural resource management, production enhancement and livelihood activities brings positive changes of socio-economic condition of Rangamati watershed project area. The project completed on 31<sup>st</sup> march 2012.

With the above backdrop, the present study was undertaken to assess the impact of this micro watershed on the livelihood of the people with the following specific objectives.

### **Objectives of the study**

1. To study the socio-economic and personal characteristics of the respondents of the watershed area.
2. To study the changes occurred in crop acreage, crop productivity, adoption level of crop production technology and watershed technology in farm level due to introduction of watershed development project.
3. To study the socio-environmental and farm level changes occurred due to introduction of watershed development project.
4. To study the attitude of respondents towards the watershed development project.

5. To assess the relationship between different socio-economic and personal characteristics of the respondents with different impact variables.

### **Limitation of the study**

The limitation of this study emerged as two-fold. One came from the fact that it is a study of social science and used the social science scales and measurements- which have some inherent limitations of precision. The outcome of any social science study is also limited to the extent to which the respondents were faithful in their response. The second came from the time span for a degree oriented research study. It always limits the in-depth enquiry of a topic. The present study is authentic in relation to the specific communities it studied and the generalisation of the results is limited to the extent of diversity of other communities in relation to different physical characters of watershed and the socio-economic and personal characteristics of the respondents.

## CHAPTER-II

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### REVIEW OF LITERATURE

Review of literature regarding particular research problem provides a framework for establishing the importance of the study with other findings thereby getting a clear understanding of the problem in hand. Based on the objectives set forth in this study, the relevant literature reviewed has been presented.

#### General Impact

Budumuru and Gebremedian (2006) in their report on “Participatory Watershed Management for Sustainable Rural Livelihoods in India”. pointed that participatory watershed management projects have been raising income, agricultural productivity, generating employment and conserving soil and water resources. The study suggested that watershed development brought several positive trends including diversification of the rural economy, development of new institutions, increasing cropping intensity, improved fodder production, increased availability of drinking water with rising ground water table, capacity development of the community etc. Based on the evidence found, it had been suggested that participatory watershed management could be a viable strategy of rural development for achieving sustainable rural livelihoods in India.

Charan (2005) conducted a study in Dharwad district, Karnataka and found out that majority (45.34%) of the respondents had medium level of knowledge in respect of watershed practices. There was increase in the number of practices by over 45.00 per cent who had knowledge about watershed practices namely contour bunds, ploughing across the slope, strengthening of existing bunds, water ways, fertilizer application and spacing after implementation of the programme.

Dadheech *et al.* (2008) conducted a study in Udaipur, Rajasthan and found that education, health and load of work were the major personal factors affecting farmers’ participation in NWDP. Study also reveals that age and level of living were the factor which has relatively less effect on farmers’ participation. Among educational factors,

illiteracy and coverage on local media were found major factors which affects farmers' participation in watershed development activities.

Dolli *et al.* (2009) conducted a study in Bijapur district, Karnataka and reveals that though the village level institutions maintained financial stability, its focus is more on supporting self help groups rather than taking operational and maintenance activities in the watershed area. Hence, there is need for reorientation of the local institutions to involve actively in watershed management.

Joy (2003) a review of watershed projects in Karnataka and Maharashtra concluded that watershed development is of crucial importance in India. The progress of globalization and privatization means that local natural resources, synonymous with watershed ecosystem resources, are often the last productive resources that the rural poor have access to.

Kumar and Palanisami (2009) a recent study has indicated that the households contribution towards watershed development and maintenance is influenced by various household level and supra household level factors.

Ninga Reddy (2005) reported that 80.00 per cent of the respondents possessed radio and 54.00 per cent possessed television, while 40.61 per cent of them subscribed newspaper. Further, in case of radio it is reported that 22.0 per cent of them listened to agricultural programme regularly. In case of television 25.34 per cent of respondent farmers viewed the agricultural programmes regularly.

Palanisami *et al.* (2009) indicated that in India Watershed development activities have been found to alter crop pattern, increase in crop yields and crop diversification and thereby could provide enhanced employment and farm income. Therefore, alternative farming system combining agricultural crops, trees and livestock components with comparable profit should be evolved and demonstrated to the farmers.

Priya Deshingkar (2004) concludes that policy makers should be prepared to face increasing migration levels and embrace accumulative migration as a valid livelihood strategy that can be combined with WSD efforts to create win-win situations for the poor and overall economic development.

Raju *et al.* (2011) a study conducted in Alwar district Rajasthan concluded that watershed management is invariably a cooperative and community based activity. Further findings of high extent of cooperation, accommodation, assimilation and low extent of competition and conflict suggest that it is possible and necessary to minimize the competition and conflicts while maximizing cooperation, accommodation and assimilation for successful watershed development. For effective, efficient and sustainable watershed development it is necessary to involve local community in all stages.

Raju *et al.* (2012) conducted a study in Alwar district, Rajasthan and concluded that watershed development has substantial socio-economic impact, increased risk orientation of farmers, higher socio political participation, reduction in women' perceived drudgery in bringing of water, fodder and fuel as well as in pulling of water from wells along with increased knowledge of soil and water conservation practices. The impact was also visible in terms of increased income from agriculture, capital accumulation, increased productivity and employment opportunity along with increased B:C ratio and land value of agricultural land. Watershed management is a viable technology, but efforts should be made to ensure peoples participation to bring sustainability to watershed development.

Reddy (2001) found that, improvement in household income and employment are statistically significant in all the sample villages with the total livelihood capitals.

Reddy (2001) study on watershed development and livelihood security: found that improvements in the household income and employment are statistically significant in all the sample villages with the total livelihoods assets (financial capital); while fuel wood and water availability was not found significant in all the village except mallapuram (natural capital); human capital indicators have improved significantly where as social capital has not changed significantly due to watershed intervention.

Sharma (2001) a study of a watershed project in Chhattisgarh showed the implementing agency's predicament in trying to complete the diverse range of activities on time. Subsidies were made available to all households, irrespective of their economic status. Those with larger areas of land benefited most. This inequitable spread of benefits had a negative impact on local people's sense of ownership of the project and on the project's sustainability.

Sharma and Sisodia (2008) in a study conducted in Udaipur reveals that farmer's better involvement at pre programme implementation stage was recorded for meeting called for formation of users committee. Farmer's consent was taken before construction of soil and water conservation structures. Whereas, least involvement was recorded in case of animal husbandry and crop production activities.

Sharma *et al.* (2007) conducted a study in Jammu district and concluded that to ensure people participation in watershed programme, visit of top officer must be ensured and there should be proper marketing facilities so that farmers could make marketing for input and output. And that the role of people participation in the management of watershed programme has a positive impact on project officer as well as local farming community.

Singh (2007) analysed the benefits from participatory watershed management among arid zone farmers. The study was conducted in Tibna watershed, located in Shergarh Community Development Block of Jodhpur district in the arid part of Rajasthan. The study concluded that the participatory watershed project managed natural resources properly and provided benefits to the villagers: the seasonal flood was controlled, more water, fuel, fodder, employment and income were available, the environment was improved with more greenery and the solar light, and the environment became healthier and scenic. The research institutes provided guidance in selection of the watershed, design of the engineering structure, survey of the watershed and selection of the appropriate agriculture practices. The NGO placed a great stress in educating the villagers about the watershed through various extension methods.

Sundaram (2012) conducted a study in Mizoram and has examined its effect on sustainable development of natural resources, environment protection, and improvement of the socioeconomic conditions of the resource poor sections on participatory approach. Generally people in the watershed area are generously appreciated the watershed project because when we compare with other centrally sponsored schemes it is the only scheme reaching to the common poor people's door. They felt that if this scheme is implemented in a systematic and effective manner it will benefit the common people immensely and more productively.

Wani *et al.* (2008) conducted a study in Patancheru, Andhra Pradesh and reveals that for achieving the desired participation of people, involvement of community

organizations, groups and other stakeholders are crucial. In fact, the new generation watershed development projects are incorporating innovative institutional arrangements to involve the multi-stakeholders for achieving efficiency and sustainability.

Yoganand and Gebremedhin (2006) has been noted that in India participatory watershed management projects have been raising income, agricultural productivity, generating employment and conserving soil and water resources. Evidence from the three case studies and other general impact studies suggests that watershed development brought several positive trends including diversification of the rural economy, development of new institutions, increasing cropping intensity, Increasing cropping intensity, improved fodder production, increased availability of drinking water with rising ground water table, capacity development of the community etc.

### **Socio-economic Impact**

Badal *et al.* (2006) conducted a study in Rajasthan and reveals that a negative relationship was found between participation and off-farm income. This may be due to the fact that the number of days farmers work on an off-farm job leaves them with little time for being associated with the watershed activities. Moreover, their dependence on watershed resources becomes less, leading to their disinterest in the programme. capital), while fuel wood and water availability was not found significant in all villages except Mallapuram, human capital indicators have improved significantly whereas, social capital has not changed significantly due to watershed intervention.

Chavan and Rathod (2003) have acknowledged that the watershed development programmes are potential to augment income and reduce poverty among the watershed communities. These studies have focused that there is positive change in crop yielding and productivity, cropping intensity and optimum use of farm implements despite some odds.

ETC, India (2004) in its report indicated that income generation programme launched through SHGs in all the watersheds have been able to make good impact on the income levels of the landless and the marginal farmers. Training in entrepreneurial activities has been able to increase the income level and bring out the entrepreneurial

abilities of women. This is true in case of those women beneficiaries who owned kirani shops and hotel.

Madhavareddy (2001) in his study on peoples' participation in watershed development programme implemented by government and non-government organization- A comparative analysis revealed that equal percentage of respondents (38.30% each) belonged to the middle age category in both government organization and non-government organization watershed. Higher per cent of farmers (38.30%) of government organization watershed belong to young age category compared to 23.30 per cent of farmers belonging to old age group.

Manjula and Belli (1994) revealed a non-significant relationship between farm size and attitude of farm women towards watershed management programme in Kolar district of Karnataka.

Mondal *et al.* (2013) conducted a study in Bundelkhand region Madhya Pradesh and reveals that participation in watershed development programmes can increase if benefits of land and water resources development is clearly received and perceived by farmers given their own socio-economic conditions. Hence, increasing farmer's knowledge and access towards information flow through extending extension facilities will help them to comprehend the benefits of such programmes in better way.

Naberia and Khare (2006) conducted a study in Jabalpur and concluded that the tribal women play an important role and have medium participation in watershed practices. Their participation is affected by education, type of family, land holding, material possession, occupation, annual income, social participation, extension contact, economic motivation and knowledge of watershed practices.

Ninga Reddy (2005) in his study, 'A study on knowledge, extent of participation and benefits derived by participant farmers of the watershed development programme in Raichur district of Karnataka' reported that 30.00 per cent of the respondents had education upto high school, followed by middle school (28.00%) and primary school (27.33%). Nearly 12.00 per cent of them were illiterates, while a meager 4.00 per cent of them had education up to college and degree programme.

Ninga Reddy (2005) reported that comparatively more number of farmers (64.00%) belonged to semi medium land holding category, followed by 22.00 per cent in medium category, whereas 10.67 per cent of them had small land holding and a meager 3.33 per cent of them belonged to big land holding category.

Raghunandan (2004) in his study, 'A study on knowledge and adoption level of soil and water conservation practices by farmers in northern Karnataka' reported that 45.00 per cent of the respondents belonged to the middle age group, followed by old age (36.25%) and young age group (18.75%), respectively.

Shah (2001) a study in Gujarat found that check dams – the favoured technology for watershed projects – directly benefited only 15 percent of target households.

Shiyani, et al., (2002) in their study on "Socio-economic Impact of Watershed Development in South Saurashtra Region of Gujarat", stated that watershed development played pivotal role in increasing cropping intensity, productivity of various crops, profitability and employment generation. The watershed development also reduced the income disparity among the beneficiaries. Reduction in yield gap and in unit cost of production was the added advantages of watershed development.

### **Technical Impact**

Charan (2005) conducted a study in Dharwad district, Karnataka and reveals that adoption level of the watershed practices by respondents it was revealed that majority (58.00%) of them belonged to medium adoption category. There was increase in number of respondents by more than 40.00 per cent who adopted watershed practices namely contour bunds, improved varieties, strengthening of existing bunds and water ways after implementation of the programme. And the major constraints in soil and water conservation practices faced by farmers were fragmentation of land into unconventional shape, water stagnation near bunded area and time consuming operations. In case of crop production practices, the constraints faced by farmers were non-availability of labour, inadequate finance, heavy risk due to failure of monsoon and expensive chemicals.

Chauhan *et al.* (2009) conducted a study in Jammu district and concluded that change in cropping pattern and productivity was more in those which was managed by people in a participatory mode. Moreover, farmers participated in watershed gained more knowledge in all the direction, as a result shift from food grain crops to fruits and vegetables was observed. During the course of investigation, it was observed that potato, onion and chilly were the main vegetable crops whereas mango and citrus plants were mostly planted by majority of farmers in the study area.

Jat *et al.* (2008) conducted a study in Madhya Pradesh and suggested that appropriate steps needed to be taken by the farmers for rational use of cultivated land, wasteland, forests and other common property resources. Using modern inputs like high yielding varieties, chemical fertilizers, irrigation and plant protection measures, *etc.*, increased the productivity of crops. The co-ordination of farmers and government functionaries, land development activities were some of the measures for improving the Gauri Palasia Micro Watershed. Better co-ordination between development agencies and voluntary organizations is also essential for effective implementation of watershed programme.

Mondal *et al.* (2012) has assessed the technical efficiency of cultivation of major crops in the watersheds and control villages of Bundelkhand region of Madhya Pradesh. On an average, the watershed farmers have been found to be more efficient than their counterparts at control villages, which justify the efforts being made to improve the productivity by land treatment and creation of water resources. The average technical efficiency of most of the crops has been found to be medium to high, whereas in soybean cultivation, it is low to medium. The shortfall in the realized productivity from the frontier has largely been due to technical inefficiency and within the control of individual farmers at both the areas. Thus, farmers have substantial scope to improve their production with the existing levels of input-use and technology.

Palanisami and Kumar (2009) conducted a study in Tamil Nadu and found out that Watershed development activities have been found to alter crop pattern, increase crop yields and crop diversification and thereby provide enhanced employment and farm income. Therefore, alternative farming system combining agricultural crops, trees and livestock components with comparable profit should be evolved and demonstrated to the

farmers. Once the groundwater is available, high water-intensive crops may be introduced. Hence, appropriate water saving technologies like drip be introduced without affecting farmers' choice of crops. The creation and implementation of regulations in relation to depth of wells and spacing between wells will reduce the well failure, which could be possible through formation of Watershed Association.

Patil (2005) conducted a study on Dharwad district and concluded that majority (72.67%) of the respondents had medium level of knowledge in respect of soil and water conservation practices. Majority of respondents possessed the knowledge that contour cultivation reduces soil erosion and conserves soil moisture (66.00%), followed by improves soil fertility, controls weeds, pest and disease, improve soil physical characters and helps to conserve runoff water and eroded soil.

Patil (2005) conducted a study on Dharwad district and reveals that majority 45.34 per cent of the respondents had medium level of knowledge in respect of watershed practices. Fragmentation of land into unconventional shape, water stagnation near bunded area and time consuming operations were the major constraints about soil and water conservation practices faced by the farmers.

Patil (2005) conducted a study on Dharwad district and reveals that extent of participation of farmers in the watershed development programme it was found that majority (70.00%) of the respondents had medium extent of participation in watershed activities. Regarding extent of participation in individual watershed development practices, overall full participation was observed in activities like collection of benchmark information, identification and analysis of problem, determining the needs, consulting officials of watershed, determining the locations for construction of nalabunds and constitute village watershed committee.

Praveen (1997) study on role perceptions and role performance of mitrakisans in transfer of watershed technology in Ranga Reddy district of Andhra Pradesh reported that majority of mitra kisans belonged to low (44.16%) followed by medium (43.34%) and high (12.50%) levels of achievement motivation.

Rai and Singh (2008) in a study conducted in Majhgawan, Madhya Pradesh concluded from the findings of the study that majority of farmers belonged to low socio

economic status and having partial level of awareness and more favourable attitude towards watershed development programme. Highly demanded areas for training were crop planning, water conservation technique and irrigation and water management and significant association was found between socio economic status and training needs. rainfed areas (NWDPRRA) in Burdwan district of west Bengal, inferred that majority (68.33%) of the beneficiaries fall under medium level of achievement motivation followed by high (20.00%) and low (11.67%) levels of achievement motivation.

Roy et al. (2008) conducted a study in Bangkura district and concluded that the watershed development programme has contributed significant increase in the level of adoption of watershed management practices by small and marginal farmers. The increase in the mean adoption score of soil and water conservation practices were 7.48 and 4.59 whereas increase in the mean adoption score of improved crop production practices were 14.32 and 10.54 for small and marginal farmers respectively after implementation of the programme. Further the small and marginal farmers had take-up non-arable land development practices in the areas.

Sadaqath and Devendrappa (2011) a study Karnataka reveals that adoption level of farmers about individual watershed programme practices and impact of the programme on production and productivity of paddy in project area revealed that a majority (58.00%) of the respondents belonged to medium adoption level category with mean adoption score of 13.78. There was increase in the number of respondents with respect to adoption of soil and water conservation practices like contour bunds (55.34%), water ways (44.00%), strengthening of existing bunds (42.67%) and ploughing across the slope (29.33%) due to the programme.

Satyendra (2006) in his case study on “Impact of the national watershed development programmes on income and employment generation in Chhattisgarh”, analysed 194 respondents on watershed area. The study revealed that ` 17.34 lakh was spent to create the basic activities in the project area which was 37.76 per cent of total investment. An expenditure of 14 lakh (30.49 per cent) was spent to improve the production system in available and non – available area which included crop demonstration, agro – forestry, dry land horticulture, organic 21 farming system, poultry, piggery, goat rearing, basket and rope making, etc. The remaining part of the fund

approved was spent to improve the soil and water conservation and livestock management activities. The watershed area had 28.02 per cent irrigation mainly due to relatively more public investments in that area while that figure was only 13.33 per cent in non watershed area.

Sharma *et al.* (2008) conducted a study in Jammu district and concluded that the overall adoption of watershed management practices in the area of participating and non-participating watershed areas was 59.33 and 40.22 per cent, respectively. Whereas a poor adoption was observed in case of animal and pasture management particularly in non-participating areas.

Sridhar (2002) in his evaluative study of watershed programme in Pavagada taluk of Tumkur district in Karnataka found that 44.67 per cent of the respondents were middle aged, while, 28.00 per cent of them were young and remaining 27.33 per cent belong to old age.

The chapter presents a discussion on the concepts used in the thesis and their operationalisation in the present study along with the hypotheses derived for test.

**Watershed:** It can be defined as the drainage basin or catchment area of a particular stream or river. A watershed is a geohydrological unit which drains into a common point by a system of streams. The watershed approach is a project based ridge to valley approach for in-situ soil and water conservation.

**Watershed Area:** It refers to the area from where water to a particular drainage system, like river or stream comes from. The area may range from few hectares to several thousands of hectares. It is a land area that captures rainfall and conveys the overland flow and runoff to an outlet in the main flow channel. The size of the watershed may vary from a few square meters to thousands of square kilometers. The size becomes important, depending upon the objective of working with the watershed. For example, for large irrigation projects, watersheds of thousands of square kilometers size may be considered. On the other hand, for a small storage structure in farm (farm pond), only a few hectares of land is considered. Watershed is also affected by afforestation, grassland development, cultivation etc. The board objectives were the promotion of the overall economic development and improvement of the socio-economic conditions of the resource poor sections of people inhabiting the programme areas. The Drought Prone Area Programme (DPAP) and the Desert Development Programme (DDP) were brought into the Watershed mode in 1987. The Integrated Wasteland Development Programme (IWDP) launched in 1989 under the National Wasteland on watershed basis. All these programmes were brought under the Guidelines for Watershed Development with effect from 1 April, 1995. Other major programmes now being implemented through this approach are the National Watershed Development Project in Rainfed Areas (NWDPA) and the Watershed Development in Shifting Cultivation Areas (WDSCA) of the Ministry of Agriculture.

**Impact:** Impact may be defined as a marked effect or influence of a phenomenon or an activity or some other thing. Impact evaluation assesses the changes that can be

attributed to a particular intervention, such as a project, program or policy, both the intended ones, as well as ideally the unintended ones. In contrast to outcome monitoring, which examines whether targets have been achieved, impact evaluation is structured to answer the question: how would outcomes such as participants' well-being have changed if the intervention had not been undertaken? This involves counterfactual analysis, that is, "a comparison between what actually happened and what would have happened in the absence of the intervention. Impact evaluations seek to answer cause-and-effect questions. In other words, they look for the changes in outcome that are directly attributable to a program.

The impact of a watershed project can be assessed in view of the following sub-components.

**Environmental impact:** For protecting vegetative cover throughout the year, to create ecological balance in the watershed area, protecting fertile top soil, utilizing the land based on its capabilities, in situ conservation of rain water, increasing ground water recharge, etc.

**Economic impact:** It draws attention for increase in cropping intensity through inter and sequence cropping, maximizing farm income through agricultural related activities such as dairy, poultry, sheep and goat farming, improved and sustained livelihood status of the watershed community with special emphasis on the poor and women, etc.

**Institutional impact:** It includes formation of watershed committees and self-help- groups, establishing sustainable community organization, etc.

**Social impact:** It includes alleviation of poverty, awareness generation, improving skills of the local community, capacity building activities, women's participation in decision-making process, empowerment of the community, etc.

**Livelihood Impact:** A livelihood comprises the capabilities, assets (stores, resources, claims and access) and recovers from stress and shocks maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next

generation and which contributes net benefits to other livelihoods at the local and global levels and in the long and short run (Chambers and Conway, 1992).

In terms of livelihood, WSD can open up new opportunities by supporting agricultural intensification processes. The subsequent increases in crop intensity can also potentially lead to the creation of labour opportunities. Some of the most striking evidence of intensification comes from the livestock sector.

To specifically assess the impact of watershed in quantitative terms previous concepts were operationalised with the following impact variables and indices.

**Crop productivity:** It is the crop yield per unit area. Crop yield is a measurement of the amount of a crop that was harvested per unit of land area. Crop yield is the measurement often used for a cereal, grain or legume and is normally measured in metric tons per hectare (or kilograms per hectare).

**Crop area:** It is a surface of land on which a crop is grown. In general, the area measured includes the area cultivated, headlands, ditches and other non-cultivated areas. Such an area can be called gross area as against the net area which includes only the portion of the gross area actually cultivated.

**Cropping intensity:** Cropping intensity is the fraction of the cultivated area that is harvested. The cropping intensity may exceed 100 percent where more than one crop cycle is permitted each year on the same area.

**Crop diversity:** The term diversity when applied to crop rotations means more than simply adding another crop or crop type to the rotation. Present study had taken number of crops cultivated per farm.

**Changes in farm condition:** Farm physical condition was assessed by erosion in farm, irrigation in farm, soil erosion from farm, soil sedimentation in ditches and furrows, water availability in farm ponds, water availability in dry seasons, ground water table, crop productivity, cropping area, number of crops, and cultivation area in dry season etc.

Changes in water conflict, farm income and animal husbandry were also assessed.

**Adoption of technology:** Adoption is the use or practice of a technology. Different crop technologies were taken into consideration.

**Knowledge-adoption index:** it is a combine measure of knowledge and adoption level regarding a watershed technology.

### **Derivation of hypothesis**

Hypo-1: There is a significant difference in socio-economic and personal characteristics of the respondents of the watershed and non-watershed area.

Hypo-2: Significant changes occurred in crop acreage, crop productivity, crop diversity and cropping intensity in farm level due to introduction of watershed development project.

Hypo-3: Significant changes occurred in adoption level of crop production technology and watershed technology in farm level due to introduction of watershed development project.

Hypo-4: Significant socio-environmental changes occurred due to introduction of watershed development project.

Hypo-5: Significant relationship exists between different socio-economic and personal characteristics of the respondents with different impact variables.

In this chapter, the methods and procedure of investigation as used in the study are presented under the following points.

- A. Design of research
- B. Selection of the area and the respondents
- C. Variables and scales for measurements
- D. Data collection tools and procedures
- E. Data processing and analysis

#### **Design of Research**

In a study on evaluation of impact of any project requires informal study design like before-after without control; after with control or before-after with control designs. Due to the time constraint, the present study adopted both before-after without control and after with control research designs wherever necessary. However, the present study relied on the memory of the respondents when collected information regarding the time period before inception of the watershed project in the area.

#### **Selection of the area and the respondents**

The present study was an attempt to assess the impact of watershed development programme under the new guidelines in a wider context of rural livelihoods. The study was conducted in the Cooch Behar district of West Bengal. Two blocks namely Mathabhanga-II and Cooch Behar-II were purposively selected considering the

convenience and time frame for the study. In Mathabhanga-II Block, three watershed villages were selected as a treated village and one non-watershed village selected from Cooch Behar-II Block as a control village. After selecting the villages, 90 respondents were selected from the villages as per the following:

Watershed villages

1. Rangamati – 20 No.
2. Ramthenga – 20 No.
3. Mukuldanga – 20 No.

Non-Watershed village

1. Kalarayer Kuthi – 30 No.

### **Collection of data**

**Primary Data:** Primary data was collected by using household interviews. The interview was conducted of all the farm households in the treatment and the control villages. The interview has information on 60 households from the treatment village and 30 households from the control villages, thereby totalling 90 respondents. Pre and post development data were collected from each treatment village (20 households was analysed from each village). Information was collected on socio-economic variables such as caste, religion, education status of the household members, employment patterns, area under cultivation, organizational participation and common farm household assets. Agricultural information collected included those on the crops cultivated in Kharif, Rabi and Pre-kharif seasons, yield, application of fertilizers, pesticides, High yielding varieties, irrigation source and different mechanization for cultivation on a crop-by-crop basis.

### **Variables and scales for measurements**

#### **Measurement of socio-economic and personal characters**

**Age:** Direct numerical value taken as variables.

**Family Information:** Family information collected on total number of members, their educational status, age and occupation. Direct numerical values were taken in each case.

**Organisational participation:** The scale composed of 'no member', 'member', 'office bearer' and 'leader', with corresponding scores of '0', '1', '2' and '3' respectively.

**Cosmo politeness/outside contact:** It is the extent of contact with outside world. It collected responses of the respondents regarding their visit to the district headquarters, mahakuma headquarters, nearest town or bazaar, other towns and State head quarters. Direct numerical values were taken.

**Nature of home:** The scale composed of 'bamboo', 'tin', 'wood' and 'pucca' with corresponding scores of '1', '2', '3' and '4' respectively.

**Nature of sanitation:** The scale composed of 'no sanitation', 'ring(soft wall)', 'ring(hard wall)' and 'sanitary' with corresponding scores of '0', '1', '2' and '3' respectively.

**Information seeking/Communication behaviour:** The scores composed based on the frequency of communication with mass media and interpersonal channels of information with corresponding responses of 'never'; 'sometime'; and 'regular' with '0', '1' and '2' scores respectively.

### **Impact variables**

**Crop yield:** Direct numerical value taken as variables in  $MTha^{-1}$  unit.

Crop acreage: Direct numerical value taken as variables in local unit (Bigha = 33 decimals in the study area= $1333.33 m^2$ ).

**Crop diversity:** It is taken as the number of crops cultivated in the farm. Direct numerical value taken as variable.

**Cropping Intensity:** It is take as the ratio between gross cropped area and net cultivable area in the farm in an year. It is measured in percentage.

**Adoption Quotient:** It is a composite index derived from the formula of Sing and Sing (1974) [which is also a modification of the one developed by Chattopadhyay (1963)]. It is calculated as

$$\frac{\sum_{i=1}^k ni/N}{T} \times 100$$

Where,  $ni$ =number of adopters of  $i$ th technology for a crop

$N$ =total number of farmers

$T$ =total number of technology considered

**Knowledge-adoption quotient:** It is also an index for a technology calculated as follows

$$\text{Knowledge adoption Quotient} = \frac{\text{Knowledge adoption score obtained}}{\text{Maximum score obtainable}} \times 100$$

Obtained score for a technology was achieved by a three point scale [don't know=0, know but not adopted=1, adopted=2]

### Statistical analysis used

The statistical methods in this study include Percentage, Mean, t-test and Wilcoxon Matched Pair Signed Rank (t) test were used as per the characteristics of data.

### Analysis of data

The data of the present investigation, with the help of the above mentioned statistical tools, were analysed taking the support of the data analysis tool of the Microsoft Excel.

This chapter is intended to present a brief description of the area, where study has been carried out. The study has been carried out in the district of Cooch Behar. The setting of this study sought to describe in terms of social, economic and agricultural aspect of areas.

#### **Description of West Bengal**

West Bengal is one of the twenty-nine states in India. Geographically the state is located at 21<sup>0</sup>38' to 27<sup>0</sup>10' N latitude and 85<sup>0</sup>50, to 89<sup>0</sup>50, E longitude. Tropic of Cancer passes through the state over the districts Burdwan, Bankura, Nadia and Purulia. West Bengal is bounded by Nepal in the north, Assam in the north-east, Republic of Bangladesh in the east, Bay of Bengal in the south, Orissa in the south-east, Bihar and Jharkhand in the north-west. Area of the state is 88,752 sq. km.

According to 2011 census its population is 91,276,115 of which male and female are 46,809,027 and 44,467,088 respectively. Density of West Bengal is 1,028 per sq km which is higher than national average 382 per sq km. Literacy rate is 76.26%. Of that, male literacy stands at 81.69 percent while female literacy is at 66.57 percent.

In West Bengal the no. of mouza and inhabited villages according to 2001 census are 40,782 and 37,945 respectively. The total reported area of West Bengal is 8687450 ha. Including this the total cultivable area is 5812686 ha and forest area is 117477 ha.

The total West Bengal state comprises of 19 districts viz. Darjeeling, Coochbehar, Jalpaiguri, Uttar Dinajpur, Dakshin Dinajpur, Malda, Mursidabad, Hoogly, Howrah, Nadia, Burdwan, Birbhum, Bankura, Purulia, 24 Parganas (N), 24 Parganas (S), Purba Medinipur, Paschim Medinipur and Kolkata.



Fig.-1: Map of West Bengal

### Description of Cooch Behar District

Coochbehar lies between  $25^{\circ}57.47''$  to  $26^{\circ}36.2''$  North latitude and between  $89^{\circ}54.35''$  to  $88^{\circ}47.44''$  East longitude. It is located in North-Eastern part of the state and bounded by the Dist. of Jalpaiguri in North, state of Assam in East and the international border in the form of Indo-Bangladesh boundary in the South as well as in the West.

The district contains 12 blocks 128 Gram panchayats and 1188 villages. The main river is Teesta and the main crops are rice, wheat, jute and mustard. This district is familiar in vegetables and fruit production through the year. The total area of Cooch Behar is 3, 31,566 ha.

The birth rate of this district (per 1000 population) is 20.60. The couple protection rate is 62. The death and infant mortality rate is 7.10 and 50 respectively. The health condition is maintained by one district hospital, four sub divisional hospitals and 12 block primary Health centre.

The district comprise of 12 blocks viz. Cooch Behar-I, Cooch Behar-II, Dinhata-I, Dinhata-II, Haldibari, Mathabhanga-I, Mathabhanga-II, Sitai, Sitalkuchi, Tufangange-I, Tufangange-II.

Almost 85-90% of the total population depends on agriculture.

- Agricultural area= 2530.63 sq.kms.
- Forest area=56.99sq.kms.
- Net area for cultivation= 2,46.491ha
- Cropping Intensity=215%
- Irrigated area=35%

### **Climate of the district**

A highly atmosphere and abundant rains characterize the climate of this district, with temperature being seldom excessive. The period from June to beginning of October is South-West monsoon season. Oct to mid Nov constitutes post monsoon season. Cold season begin from Nov to Feb and hot season begin from March to May. January is the coldest month and April is the hottest month. The atmosphere is highly humid throughout the year.

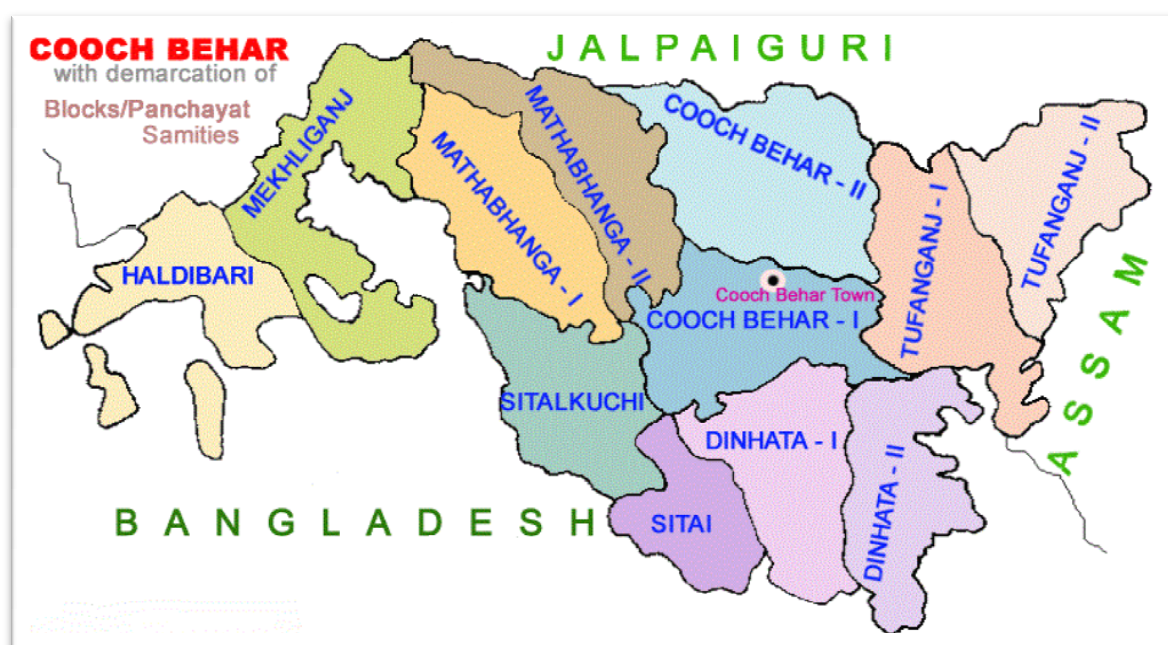
**Rainfall:** Average annual rainfall in the district is 5,348.8 mm. Rainfall is generally increases from South-West to North-East. About 70% of the annual rainfall is received during south-west monsoon season, June being the rainiest month.

### Soil and agriculture

The soil is alluvial of very recent formation. It is mostly sandy and loose. The surface soil is loam and hardly any good clay is found. Most of the high lands appertain to Sitalkuchi area and most of the low lands lie in Dinhata area.

**Table 5.1: Demography of the district**

Actual Population:	2,822,780
Male:	1,453,590
Female:	1,369,190
Population Growth:	13.86%
Sex Ratio (Per 1000):	942
Average Literacy:	75.49
Male Literacy:	81.52
Female Literacy:	69.08



**Fig.-2: Map of Cooch Behar**

### 5.3. Mathabhanga-II:

The block Mathabhanga-II consists of 10 Gram Panchayats (GPs) in her area of operation. Total number of villages is 93. The total geographical area of this block is 313.84 sq. km. Total agricultural land is 18,293 ha (cultivable). The total irrigated area is 9811 ha. The main sources of irrigation are river lift irrigation (8), shallow tube well (130). The soil condition is sandy loam and the climate is modest dry with moderate rainfall.

The total population of this block is 1,86,683 (male-96,031 and female-90,652). Among this population the total no. of Schedule Caste and Schedule Tribe population is 1,07,718 and 2,173 respectively. The sex ratio is 944:1000 of the block and the child sex ratio is 979:1000. The percentage of child population in respect of total population is 16.17%. The literacy rate (excluding 0-6 year's population) of this block is 68.56%. The total no. of literate is 1,12,793 (male- 65,517 and female- 45,276). Among this 15,748 people are associated with agricultural labour.

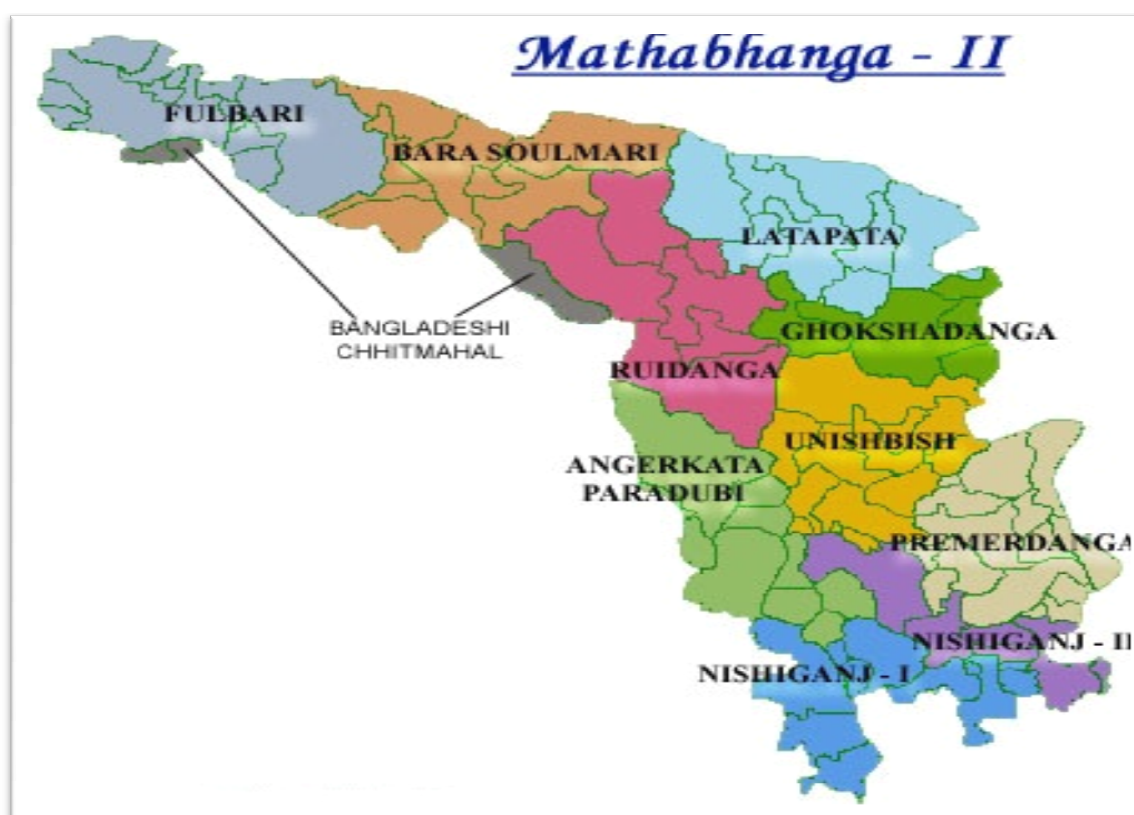


Fig.-2: Map of Mathabhanga-II block

#### **5.4. Cooch Behar-II:**

The block Cooch Behar-II consists of 13 Gram Panchayats (GPs) in her area of operation. The total geographical area of this block is 362.36 sq. km. The net cultivable area is 24,011 ha. The agricultural land is 18,789 ha. The total irrigated area is 9811 ha. The main sources of irrigation are river lift irrigation (10), deep tube well (7), shallow tube well (718). The soil condition is sandy loam and the climate is modest dry with moderate rainfall.

The total population of this block is 2,98,163 (male-1,54,011 and female-1,44,152). Among this population the total no. of Schedule Caste and Schedule Tribe population is 1,19,479 and 2,904 respectively. The sex ratio is 936:1000 of the block and the child sex ratio is 960:1000. The percentage of child population in respect of total population is 14.49%. The literacy rate (excluding 0-6 year's population) of this block is 74.56%. The total no. of literate is 1,90,093 (male- 1,09,694 and female- 80,399). Among this 20,221 people are associated with agricultural labour. No. of below poverty line family of this block is 31,226.

##### **5.4.1. Gram panchayat (Pundibari):**

The study was conducted in the village Kalarayerkuthi in the gram panchayat of Pundibari. The Gram Panchayat Pundibari consists of six villages, viz., Anrakata, Bag Bhandar, Basdaha Natibari, Hoglabari, Kalarayerkuthi and Sajherpar Ghoramara. The total land situation is semi medium to low in nature. The main water source is ground water and river. Under this Gram Panchayat the total area is 3660.95 hectares and the agricultural area among this is 2368.11 hectares. The main source of irrigation is deep tube well (7 Hand pump, 1 PWS and other-1) in Basdaha Natibari, Hoglabari and Kalarayerkuthi village. The total cultivable lands are under rain fed condition. The domestic water supply is mainly from tube-well.

In this Gram Panchayat the total population is 37,648 (male- 19623 and female-18025). The total literacy rate of this Gram Panchayat is 70.05%. The total agricultural labourer in this area is 4521 (main and marginal agricultural labourer). The farmers are

using agricultural inputs from the private fertilizer shop prevailing mainly in the Pundibari market. The total no. of market or hat is four. The no. of bank is one (Central Bank of India, Pundibari) and another bank named State Bank of India-Grahak Seva Kendra is there in Pundibari.

In the context of educational facilities, the no. of primary school is 20 and no. of high school is 2. The health status is quite good. There is one primary health centre, Pundibari Block Primary Health Centre.

#### **5.4.2. Kalarayerkuthi:**

Most part of the village Kalarayerkuthi falls under the Gram Panchayat Pundibari and some part falls under the Gram Panchayat Patlakhawa. It consists of three small hamlets, viz., Uttar Kalarayerkuthi, Madhya Kalarayerkuthi and Dakshin Kalarayerkuthi. The village Kalarayerkuthi mainly is agriculture dominated village as well as some secondary income generating activities are also prevailing in the village. The total geographical area of this village is 1486.65 hectare. Out of this the total agricultural area is 763.87 hectare and 9.31 hectare area is under forest land. The soil type is sandy loam and land condition is medium to sloppy low in nature. The irrigation is being monitored by own tube well and one diesel operated deep tube well and one electricity operated deep tube well are there in the village.

The total population of this village is 20739 (male- 10812 and female- 9927). The total Schedule Caste and Schedule Tribe population is 4007 (male- 2109 and female- 1898) and 41 (male- 24 and female- 17) respectively. The no. of small and marginal farmer is 4637. The domestic water supply is done through tube well. The people use market of Pundibari, Sonapur, Rajarhat, Duriahath and others. One commercial bank (Central Bank of India, Pundibari) and one mini Stae Bank is there. The main health centre is Pundibari Block Primary Health Centre, one primary health sub-centre is also there in the village.

The education status is quite good; literacy rate is 71%. There are eight primary schools, three Sishu Siksha Kendras and one High School in the village.

## The Rangamati Micro-Watershed

**Location and area:** The Rangamati micro watershed (3A1C6-r) falls under Ruidanga Gram Panchayat and Barsoulmari Gram Panchayat under Mathabhanga-II Block in Cooch Behar district of West Bengal. The latitude and longitude of the watershed are 26°26'28" N to 26°29'21" N and 89°11'17" E to 89°13'47" E respectively surrounded by Barasoulmari in the north, Rangamati in the west and Dawaguri mouza in the east. Southern boundary of the micro watershed is lined by the river Mansai. A highway passes along the eastern border of the micro watershed and a drainage channel, Ramthenga nala passes through the lower part of it. The region falls under the Terai sub region (Agro climatic sub region).

The geographical area of the micro watershed Rangamati is 842.995 ha. Total effective project area under micro watershed is 640 ha. out of this about 65% of land is arable and only 18.03% of this arable land is irrigated. The soil is very shallow with light texture pH ranging from 5.5 to 6.0. Almost 15.16% area was suffering from drainage congestion before implementation of the project.

**Soil:** Being the distinct near the Eastern Himalayan Foothills, after rains in the catchment area of each of the rivers generally attain strong current and flood at the adjacent area. The turbulent water carries sand, silt, pebbles which causes many problems in productivity as well as hydrology. The soil is formed by alluvial deposits and in acidic in nature. It is friable loam to sandy loam in depth ranging 2.0 to 2.5 meter. the soil has a low level of nitrogen while potassium and phosphorus levels are medium. Deficiency of zinc, boron, calcium, magnesium, sulphur and molybdenum is quite high.

**Climate:** The project area has a moderate type of climate characterized by heavily rainfall during the monsoon and slight rainfall in the month of October to mid November. The summer season is from April to May with april being the hottest month with mean daily temperature of 32.5°C and mean daily minimum temperature of 20.2°C. the winter season lasts from late November to February, with journey the coldest month with

temperature ranging from 10.4°C to 24.1°C. The atmosphere is very humid except the period from February to May. The average annual rainfall is 3300 mm.

**Institution building:** Rangamati Watershed Association was constituted comprising of all the community members of delineated micro-watershed area. There is one watershed committee, having 12 (twelve) members of which, 5 nos. members represent from users groups (UGs) 4 nos. members came from Self Help Groups (SHGs), one member nominated by Pradhan, Gram Panchayat as representative of Gram Panchayat, one member is Sub-Assistant Engineer (Soil Conservation), Mathabhanga and remaining one is Assistant Director of Agriculture (Soil Conservation), Mathabhanga, who is functioned as Project Implementing Agency (PIA) cum Watershed Development Team Leader (WDTL) of Rangamati Watershed Project. Watershed Committee is performing as executive body of the Watershed Association. The Association is registered under West Bengal Society Registration Act, 1961. The registration no. of the Rangamati Association is S/1L/No- 50637 of 2007-2008.

In case of Rangamati Watershed Project 5 nos. Of Self Help Groups and 22 nos. Of User Groups are constituted. Members of these groups get benefit through credit and thrift activity by which they uplift their socio-economic status after completion of the project.



The chapter presents systematically the results obtained from the study followed by the discussion after every table. The results are presented in the following sub-sections.

1. Personal and socio-economic characteristics of the respondent.
2. Changes occurred in crop acreage, crop productivity, adoption level of crop production technology and watershed technology in farm level.
3. Socio-environmental and farm level changes.
4. Attitude of respondents towards the watershed development project.
5. Relationship between different socio-economic and personal characteristics of the respondents with different impact variables.

### **Personal and socio-economic characteristics of the respondent**

The data in Table 6.1 depicts the personal and socio-economic characteristics of the respondent. The table indicated that in watershed villages 13.33 percent of respondents from watershed villages are under the age group of 24-30 years followed by 70.00 percent respondents are under the age group of 31-50 years and 16.67 percent respondents are above 50 years whereas in case of non-watershed village 6.67 percent respondents are under the age group of 24-30 years followed by 76.67 percent respondents are under the age group of 31-50 years and 16.67 percent respondents are above 50 years respectively.

In case of education it is found that 48.33 percent of respondents from watershed villages are having primary education, followed by 46.67 percent with secondary education, and 5.00 percent of them are graduates and above, whereas in case of non-watershed village 36.67 percent of respondents are having primary education followed by 56.67 percent with secondary education, and 6.67 percent of them are graduates and above respectively.

**Table 6.1: Distribution of respondents according to age and education:**

Category	Age					Education				
	Score range	Watershed		Non-watershed		Score range	Watershed		Non-watershed	
		Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage
Low	Upto 30	8	13.33	2	6.67	Upto 5	29	48.33	11	36.67
Medium	31 to 50	42	70.00	23	76.67	6 to 12	28	46.67	17	56.67
High	>50	10	16.67	5	16.67	>12	3	5.00	2	6.67

**Table6.2: Distribution of respondents according to organizational participation and outside contact**

Category	Organizational participation					Outside contact				
	Score range	Watershed		Non-watershed		Score range	Watershed		Non-watershed	
		Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage
Low	0	34	56.67	26	86.67	4	2	3.33	7	23.33
Medium	1	25	41.67	4	13.33	5 to 8	18	30.00	17	56.67
High	>1	1	1.67	0	0	>8	40	66.67	6	20.00

Table-6.2 showed the distribution of respondents according to organizational participation and outside contact (cosmopolitaness) participation. In the study area watershed villages have more organisational participation than non-watershed village. Data from Table revealed that the 56.67 per cent of respondents reported low score followed by 41.67 percent have medium score and 1.67 percent have high score in watershed area, where as in non-watershed villages 86.67per cent of respondents reported to have low level of organisational participation followed by 13.33 per cent of respondents which have medium level of organisational participation.

In cosmopolitaness also most of the watershed villages had medium to high level of outside contact in comparison to non-watershed village. It is found that 3.33 percent respondents of the watershed villages have low level of outside contact, followed by 30.00 percent have medium level and 66.67 percent have high level, where as in non-watershed villages 23.33 per cent of respondents reported to have low level of outside contact followed by 56.67 per cent of respondents have medium level and 20.00 percent of respondents which have high level of outside contact.

Table 6.3 presents the distribution of the respondents according to Personal and mass media contact. In case of personal media participation results show that the 21.67 per cent of respondents reported to have low score followed by 35.00 percent have medium score and 43.33 percent have high score in watershed villages, where as in non-watershed villages 80.00 per cent of respondents reported to have low level of organisational participation followed by 20.00 per cent of respondents which have medium level of personal media participation.

In mass media participation results show that the 95.00 per cent of respondents reported to have low score followed by 5.00 percent have medium score in watershed villages, where as in non-watershed villages all of the respondents reported to have low level of mass media participation.

**Table 6.3: Distribution of respondents according to personal and mass media contact**

Category	Personal media					Mass media				
	Score range	Watershed		Non-watershed		Score range	Watershed		Non-watershed	
		Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage
Low	Upto 4	13	21.67	24	80.00	Upto 4	57	95.00	30	100.00
Medium	5 to 8	21	35.00	6	20.00	5 to 8	3	5.00	0	0.00
High	>8	26	43.33	0	0.00	>8	0	0.00	0	0.00

**Table 6.4: Distribution of respondents according to land holding and occupational diversity**

Category	Land holding					Occupational Diversity				
	Score range	Watershed		Non-watershed		Score range	Watershed		Non-watershed	
		Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage
Low	Upto 10	58	96.67	26	86.67	Upto 0.33	22	36.67	14	46.67
Medium	11 to 15	2	3.33	3	10.00	0.34 to 0.67	38	63.33	16	53.33
High	>15	0	0.00	1	3.33	>0.67	0	0.00	0	0.00

Table 6.4 presents the distribution of the respondents according to their land holding. The results show that majority of the respondents from watershed villages are under the land holding group of up to 10.00 bigha (96.67%) followed by 11.00-15.00 bigha land holding (3.33%) and above 15.00 bigha land holding group (0.00%) respectively whereas in case of non-watershed village 86.67 percent respondents are under the the land holding group of up to 10.00 bigha followed by 10.00 percent respondents are under the the land holding group of up to 11.00-15.00 bigha and 3.33 percent respondents are above 15.00 bigha land holding group respectively.

In case of occupational diversity results show that 36.67 per cent of respondents reported to have low score followed by 63.33 percent have medium score in watershed villages, where as in non-watershed villages 46.67 per cent of respondents reported to have low score followed by 63.33 percent have medium score.

Table-6.5 depicts the distribution of respondents (on family basis) according to the housing condition of the families. From the table it is found that 70.00 percent families of watershed villages are dominated by houses wall made of tin, followed by 15.00 percent household wall made of bamboo, 11.67 percent household wall made of wood and 3.33 percent houses are pucca wall whereas in non-watershed village 76.67 percent household wall made of tin, followed by 20.00 percent houses wall of the families are made of bamboo and 3.33 percent houses are pucca wall.

In case of floor both watershed and non-watershed villages are same i.e. 86.67 percent families have kaccha floor and 13.33 percent families have pucca floor.

Roofs are basically made of tin in non-watershed village whereas in watershed villages 91.67 percent roofs are made of tin followed by 6.67 percent made of thatched and 1.67 percent made of talli.

**Table-6.5: Distribution of respondents according to housing conditions**

Category	Wall				Category	Floor				Category	Roof			
	Watershed		Non-watershed			Watershed		Non-watershed			Watershed		Non-watershed	
	Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage
Bamboo	9	15.00	6	20.00	Kachha	52	86.67	26	86.67	Thatched	4	6.67	0	0.00
Tin	42	70.00	23	76.67	Pucca	8	13.33	4	13.33	Talli	1	1.67	0	0.00
Wood	7	11.67	0	0.00	Tiles	0	0.00	0	0.00	Tin	55	91.67	30	100.00
Pucca	2	3.33	1	3.33	Marbel	0	0.00	0	0.00	Pucca	0	0.00	0	0.00

**Table-6.6: Distribution of respondents according to sanitation and drinking water**

Category	Sanitation				Category	Drinking water			
	Watershed		Non-watershed			Watershed		Non-watershed	
	Frequency	Percentage	Frequency	Percentage		Frequency	Percentage	Frequency	Percentage
No toilet	2	3.33	4	13.33	Dugwell/pond	1	1.67	3	10.00
Kacha toilet	57	95.00	26	86.67	Tube well	59	98.33	27	90.00
Pucca toilet	1	1.67	0	0.00	Pipeline	0	0.00	0	0.00

Table-6.6 depicts the distribution of respondents (on family basis) according to the sanitation and drinking water facilities of the families. It is found that 95.00 percent families of watershed villages have at least unimproved types of sanitation, followed by 3.33 percent are having no toilet facilities, and 1.67 percent of them have pucca toilet, whereas in case of non-watershed village 86.67 percent families have unimproved types of sanitation, followed by 10.00 percent are having no toilet facilities, and have no pucca toilet facilities.

It is also found that 1.67 percent families of watershed villages used pond water as drinking water followed by 98.33 percent families used tube well whereas in case of non-watershed village 10.00 percent families used pond water as drinking water followed by 90.00 percent families used tube well.

**Table-6.7: Comparison of respondents based on mean score**

Respondents' Characteristics	Unit of measurement	Watershed	Non-Watershed	t-value	Significance
Age	Years	42.12	42.03	0.04	NS
Education	Class standard	6.07	7.5	1.52	NS
Outside contact	Score	9.25	6.57	5.49	**
Mass media exposure	Score	1.45	1.3	0.43	NS
Land holding (including all types)	Bigha (=0.13 ha)	3.81	5.36	2.28	*
Organisational Participation	Score	0.45	0.13	2.95	**
Personal media contact	Score	7.23	3.03	7.26	**
Occupational diversity	Number	0.38	0.37	0.23	NS
Drinking water	Score	2.9	2.37	4.96	**
Housing condition	Score	6.01	6	0.07	NS
Sanitation	Score	1.28	1	2.32	*
Crop diversity	Number	6.62	6.06	1.19	NS
Cropping intensity	Percentage	235.43	140.95	15.59	**
Crop technology adoption	Percentage	96.87	79.4	15.92	**

NS=Non-significant    \*=Significant at 5% level    \*\*=Significant at 1% level

From table 6.7 it is depicted that most of the respondents from both the area (watershed and non-watershed) vary from middle age group; in both the areas the respondent had low-medium education status upto 6<sup>th</sup> standard in watershed areas and upto 7-8<sup>th</sup> standard in non-watershed areas. Respondent from watershed areas had higher outside contact than the non-watershed area; they had also more media contact (mass media and personal media) and organizational participation on an average. It may be due to the fact that the watershed development programme created an opportunity of mass exposure to different among awareness programme through impact, local television channel or group meeting. Different workers and officers of watershed project has also visited time to time to the watershed areas. Watershed programme has an inbuilt objective of creating different grass root organization like SHG, WUA etc. which enhanced the overall average score of organizational participation. Drinking water facility and sanitation were also higher in watershed area than in non-watershed area, which is quite natural for an area where watershed project is implemented. But in case of land holding non-watershed farmers have more occupancy than the farmers of watershed area on an average. This finding confirms the similarity of the study area to be included for the project.

All of the cases like occupational diversity, house condition and crop diversity, the mean score of both the area were more or less similar.

However from t-value, it can be concluded that there is no significant difference between the two areas in age, education, mass media exposure, occupational diversity, housing condition and cropping diversity.

The table shows that there is significant difference in socio-economic characteristics such as outside contact, personal media contact, cropping intensity and technology adoption between the farmers of watershed and non-watershed areas.

So, hypothesis-1 is partially accepted and partially rejected.

### Changes occurred in crop acreage, crop productivity, adoption level of crop production technology and watershed technology in farm level

A before-after study revealed that in acreage and productivity of most of the crops increased significantly. Highest percentage in productivity increase was found in Jute followed by boro paddy. After increase in water in the farm ponds majority of jute retting

**Table-6.8: Changes in crop acreage**

Crop	Average per capita acreage (bigha=0.13 ha)		Percent increase	t-value	Significance
	After	Before			
Rice (including all seasons)	1.81	1.07	69.16	12.89	**
Jute	0.98	0.64	53.13	5.87	**
Maize	1.26	0.77	63.64	9.68	**
Potato	1.59	0.85	87.06	10.57	**
Brinjal	0.78	0.47	65.96	7.04	**
Chilli	0.68	0.41	65.85	4.35	**
Cabbage	1.02	0.53	92.45	5.70	**

\*\*=Significant at 1% level

**Table-6.9: Production scenario of main cultivated crops**

Crops	productivity of crops(MT/Ha)		Percent increase	t-value	Significance
	After	Before			
Aus Paddy	1.65	1.51	9.27	0.627	NS
Aman Paddy	2.31	2.00	15.50	1.254	NS
Boro Paddy	3.01	2.39	25.94	2.508	*
Jute	3.11	2.21	40.72	8.431	**
Maize	2.50	2.19	14.16	2.099	*
Brinjal	4.99	4.50	10.89	0.476	NS
Potato	16.48	14.11	16.80	3.009	**
Chilli	9.69	9.01	7.55	2.216	*
Cabbage	5.22	4.51	15.74	0.613	NS

improved considerably and was productivity also improved. Percentage of productivity is higher in case of all the crops which requires higher water consumption like potato, boro

paddy or maize. However t-value reveals that the productivity is significantly higher in crops such as boro paddy, jute, maize, potato and chilli after the adoption of watershed technologies.

In crop-acreage scenario, the same picture was found as in case of productivity of crops.

So, hypothesis-2 is accepted.

### **Adoption scenario of water conservation and crop production technology**

The adoption scenario of watershed technology was made to access the impact of watershed project in the areas. A control area was also studied for comparison. All the watershed technologies which were advocated by the project were taken into consideration and measured against a 3-point scale. For comparison knowledge-adoption quotient was calculated. It is seen from the table that the most unknown watershed technology was roof rain water harvesting (100.00% respondent for both the areas did not have any idea about the technologies) followed by gully plugging, deep furrow, vegetative barrier, contour farming, stone bunds, deep tillage and mulching.

In watershed area, the farmer have some knowledge about watershed technology such as farm ponds, check dams, open wells, intercropping and use of compost but have not adopted. This may be due to lack of proper knowledge, improper training facilities, least exposure to media etc. But the farmers' adoption of technologies such as earthen bunds, crop rotations and use of farm yard manure were high. This is because the technologies are easy to adopt and easily available. In case of non-watershed area, the technologies adopted are crop rotation and farm yard manure. Overall comparison between watershed area and non-watershed area shows that the adoption of water conservation/ harvesting technology in farm is more in case of watershed area.

Table-6.10: Adoption scenario of water conservation and crop production technology

Watershed Technology	Watershed area				Non-watershed area			
	Don't know	Know but not adopted	Adopted	Knowledge-Adoption Quotient	Don't know	Know but not adopted	Adopted	Knowledge-Adoption Quotient
Roof Rain Water Harvesting	60 (100.00)	0 (0.00)	0 (0.00)	0.00	30 (100.00)	0 (0.00)	0 (0.00)	0.00
Farm Ponds	0 (0.00)	51 (85.00)	9 (15.00)	0.58	0 (0.00)	30 (100.00)	0 (0.00)	0.50
Check dams	0 (0.00)	60 (100.00)	0 (0.00)	0.50	0 (0.00)	30 (100.00)	0 (0.00)	0.50
Open wells	0 (0.00)	58 (96.67)	2 (3.33)	0.52	5 (16.67)	25 (83.33)	0 (0.00)	0.42
Earthen bunds	33 (55.00)	3 (5.00)	24 (40.00)	0.43	25 (83.33)	5 (16.67)	0 (0.00)	0.08
Stone bunds	58 (96.67)	2 (3.33)	0 (0.00)	0.02	29 (96.67)	1 (3.33)	0 (0.00)	0.02
Gully plugging	60 (100.00)	0 (0.00)	0 (0.00)	0.00	30 (100.00)	0 (0.00)	0 (0.00)	0.00
Deep tillage	56 (93.33)	4 (6.67)	0 (0.00)	0.03	28 (93.33)	2 (6.67)	0 (0.00)	0.03
Deep furrows	60 (100.00)	0 (0.00)	0 (0.00)	0.00	29 (96.67)	1 (3.33)	0 (0.00)	0.02
Vegetative barriers	60 (100.00)	0 (0.00)	0 (0.00)	0.00	30 (100.00)	0 (0.00)	0 (0.00)	0.00
Mulching	54 (90.00)	4 (6.67)	2 (3.33)	0.07	29 (96.67)	1 (3.33)	0 (0.00)	0.02
Contour farming	60 (100.00)	0 (0.00)	0 (0.00)	0.00	30 (100.00)	0 (0.00)	0 (0.00)	0.00
Crop rotations	0 (0.00)	0 (0.00)	60 (100.00)	1.00	0 (0.00)	3 (10.00)	27 (90.00)	0.95
Intercropping	35 (58.33)	24 (40.00)	1 (1.67)	0.22	29 (96.67)	1 (3.33)	0 (0.00)	0.02
Use of FYM	0 (0.00)	0 (0.00)	60 (100.00)	1.00	0 (0.00)	0 (0.00)	30 (100.00)	1.00
Use of compost	3 (5.00)	45 (75.00)	12 (20.00)	0.58	4 (13.33)	24 (80.00)	2 (6.67)	0.47
Drought prone crop	59 (98.33)	1 (1.67)	0 (0.00)	0.01	30 (100.00)	0 (0.00)	0 (0.00)	0.00
Mean Score of all technology	<b>0.29</b>				<b>0.24</b>			
<b>Statistical Implication</b>								
Wilcoxon Matched-pair Sign rank Test (T)-value = 2 which is significant at p = 0.015 level								

Table-6.11: Adoption Quotient of Watershed and Non-watershed areas

Crops	Non Watershed					Watershed				
	Improved Variety	Org. nutrient source	Fertilizer	Plant Protection	Adoption Quotient	Improved Variety	Org. nutrient source	Fertilizer	Plant Protection	Adoption Quotient
Brinjal	2 (6.67)	12 (40.00)	12 (40.00)	12 (40.00)	0.32	23 (38.33)	26 (43.33)	26 (43.33)	26 (43.33)	0.42
Broad bean	1 (3.33)	13 (43.33)	13 (43.33)	13 (43.33)	0.33	25 (41.67)	31 (51.67)	31 (51.67)	31 (51.67)	0.49
Cabbage	2 (6.67)	9 (30.00)	9 (30.00)	9 (30.00)	0.24	23 (38.33)	25 (41.67)	25 (41.67)	25 (41.67)	0.41
Chilli	2 (6.67)	6 (20.00)	6 (20.00)	6 (20.00)	0.17	9 (15.00)	11 (18.33)	11 (18.33)	11 (18.33)	0.18
Jute	0 (0.00)	6 (20.00)	22 (73.33)	22 (73.33)	0.42	1 (1.67)	19 (31.67)	28 (46.67)	28 (46.67)	0.32
Maize	4 (13.33)	10 (33.33)	10 (33.33)	10 (33.33)	0.28	38 (63.33)	40 (66.67)	40 (66.67)	40 (66.67)	0.66
Pointed Gourd	1 (3.33)	2 (6.67)	2 (6.67)	2 (6.67)	0.06	15 (25.00)	17 (28.33)	17 (28.33)	17 (28.33)	0.28
Potato	1 (3.33)	27 (90.00)	27 (90.00)	27 (90.00)	0.68	43 (71.67)	44 (73.33)	44 (73.33)	44 (73.33)	0.73
Rice	6 (20.00)	30 (100.00)	30 (100.00)	30 (100.00)	0.80	55 (91.67)	60 (100.00)	60 (100.00)	60 (100.00)	0.98
Tomato	0 (0.00)	7 (23.33)	7 (23.33)	7 (23.33)	0.18	21 (35.00)	21 (35.00)	21 (35.00)	21 (35.00)	0.35
Ridge gourd	0 (0.00)	6 (20.00)	6 (20.00)	6 (20.00)	0.15	8 (13.33)	8 (13.33)	8 (13.33)	8 (13.33)	0.13
<b>Overall adoption Quotient</b>	<b>0.33</b>					<b>0.45</b>				
<b>Statistical Implication</b>										
Wilcoxon Matched-pair Sign rank Test (T)-value = 6.5 which is significant at p = 0.019 level										

The data in the table indicated that the farmers in watershed and non-watershed area had 0.58 and 0.50 adoption quotient respectively. Whereas the adoption quotient of open wells was 0.52 (watershed) and 0.42 (non-watershed) respectively. Similarly for earthen bunds, watershed farmers (0.43) had more adoption quotient as comparison to non-watershed farmers (0.08). Watershed and non-watershed farmers recorded 0.07 and 0.02 adoption quotient respectively on mulching. While high adoption quotient (1.00 and 0.95) was found in crop rotation, comparatively less adoption quotient (0.22 and 0.02) was found in intercropping. Further, the table revealed that farmers of watershed and non-watershed had adoption quotient up to 0.58 and 0.47 respectively in use of compost.

The overall mean score of all the watershed technologies in watershed areas was 0.29 and non-watershed areas was 0.24. It was observed that farmers of non-watershed areas have significant difference of knowledge and adoption of watershed technologies as comparison to watershed areas. Thus, it could be inferred that due to the knowledge on watershed technologies in the watershed areas, farmers were able to gear up their adoption on different watershed technologies.

The data in the table reveals that the adoption quotient of brinjal was 0.42 in watershed areas and 0.32 in non-watershed areas. It was observed that the adoption quotient of broad bean was 0.49 in watershed areas and 0.33 in non-watershed areas. Less adoption quotient (0.41 and 0.24) was found in cabbage. While comparatively less adoption quotient (0.66 and 0.28) and (0.28 and 0.06) was found in maize and pointed gourd respectively. The adoption quotient of chilli and potato had not shown much difference (0.18 and 0.17) and (0.73 and 0.68) respectively. Whereas the adoption quotient of rice crop in watershed and non-watershed areas was 0.98 and 0.80 respectively. Further, in case of tomato the adoption quotient was 0.35 in watershed areas and 0.18 in non-watershed areas. But the adoption quotient of jute (0.32 and 0.42) and ridge gourd (0.13 and 0.15) is more in non-watershed areas.

The overall adoption quotient of all the crops is 0.45 in watershed areas and 0.33 in non-watershed areas. It was observed that there was significant difference in adoption quotient of different crops in watershed and non-watershed areas. To test the significant

difference between the adoption quotient score in watershed and non-watershed areas Wilcoxon Matched-pair Sign rank test was applied and found that the value of (t)-value (6.5) significant at 0.019 level of probability. Thus the different cultivation practices on different crops shows positive impact on watershed areas. Hence the farmers in watershed areas are more aware about crop production practices in watershed areas as compared to non-watershed areas.

So, hypothesis-3 is accepted.

### **Socio-environmental and farm level changes**

The frequency of the respondents was presented in the table along with a mean score in table-8. It was assumed through a 5-point perception scale from highly improved (with score value of +2) to highly deteriorated (with score value of -2). From mean score, it can be concluded more specifically that soil erosion from farm, water availability in farm ponds, water availability in dry season, crop productivity, relationship among the villagers and income from farm had highly improved, whereas all others are moderately improved. After setting up the watershed project, the changes such as soil erosion from farm, soil sedimentation in ditches and furrows, water availability in farm ponds, water availability in dry seasons, ground water table, crop productivity, cropping area, no. of crops, cultivation area in dry season, conflict for water, relationship among the villagers, income from farm and animal husbandry has been improved. Again relationship among the villagers and income from farm has been highly improved after the beginning of watershed project. But to some extent there is less change in animal husbandry and cultivation in dry season.

So, hypothesis-4 is accepted.

**Table-6.12: Changes in farm condition**

Changes occurred in	Highly improved	Improved	No change	Deteriorated	Highly Deteriorated	Mean score
Soil erosion from farm	27 (45.00)	33 (55.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.725
Soil sedimentation in ditches and furrows	1 (1.67)	47 (78.33)	12 (20.00)	0 (0.00)	0 (0.00)	0.408
Water availability in farm ponds	27 (45.00)	31 (51.67)	2 (3.33)	0 (0.00)	0 (0.00)	0.708
Water availability in dry seasons	25 (41.67)	31 (51.67)	4 (6.67)	0 (0.00)	0 (0.00)	0.675
Ground water table	16 (26.67)	40 (66.67)	4 (6.67)	0 (0.00)	0 (0.00)	0.600
Crop productivity	27 (45.00)	33 (55.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.725
Cropping area	16 (26.67)	37 (61.67)	7 (11.67)	0 (0.00)	0 (0.00)	0.575
No. of crops	11 (18.33)	39 (65.00)	10 (16.67)	0 (0.00)	0 (0.00)	0.508
Cultivation area in dry season	12 (20.00)	31 (51.67)	17 (28.33)	0 (0.00)	0 (0.00)	0.458
Conflict for water	8 (13.33)	43 (71.67)	8 (13.33)	1 (1.67)	0 (0.00)	0.483
Relationship among the villagers	30 (50.00)	30 (50.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.750
Income from farm	35 (58.33)	23 (38.33)	2 (3.33)	0 (0.00)	0 (0.00)	0.775
Animal husbandry	5 (8.33)	33 (55.00)	22 (36.67)	0 (0.00)	0 (0.00)	0.358

### Attitude of respondents towards the watershed development project

A scale was by Kishore (2006) to test the attitude of the respondents towards Watershed Development Project in Karnataka. To avoid the testing of the scale the same developed scale was used in this study to measure the attitude of the respondents towards Rangamati watershed Project. However, to fit with the micro-watershed situation some of the statements were modified without changing the basic structure of the scale. The scale consisted of 15 items with five point responses continuum for all the scale items. It is hoped that the scale could be useful in explicitly measuring the attitude of beneficiaries towards

WUA i.e., from more favourable to less favourable. The items covered by this scale basically represented the objectives of WUA, feasibility of WUA, peoples involvement planning and implementation and environmental concerns of Rangamati watershed project, which were equally relevant for all the respondents of watershed area. Positive attribute of the technologies towards any impact is an indirect means of efficacy of the phenomenon.

Positive statements is produce positive mean value or negative statements is produce negative mean value indicate favourable attribute towards the watershed project.

From the table it is found that the respondents of the watershed area had a favourable attitude; varies from moderate to highly favourable attitude. The average mean scores (highest value ranging from -0.658 for negative statements to 0.825 for positive statements) of people's attribute indicates a good impact of watershed on the livelihood of the people of Cooch Behar district.

**Table—6.13: Attitude of respondents towards Watershed Development Project**

Attitude statements	Strongly Agree	Agree	Undefined	Disagree	Strongly Disagree	Mean Score
Watershed Development Project (WUA) is a boon to farmers in watershed area (+)	31 (51.67)	29 (48.33)	0 (0.00)	0 (0.00)	0 (0.00)	0.758
WUA helps to increase income both from agriculture and non-agriculture activities in the area (+)	14 (23.33)	46 (76.67)	0 (0.00)	0 (0.00)	0 (0.00)	0.617
Cost sharing with beneficiaries by watershed project ensures respect and responsibility to the farmers participating in watershed development (+)	14 (23.33)	36 (60.00)	10 (16.67)	0 (0.00)	0 (0.00)	0.533
Management of resources can be effectively done through community based organizations in WUA	8 (13.33)	50 (83.33)	2 (3.33)	0 (0.00)	0 (0.00)	0.550
Trainings provided by WUA are monotonous and not practical	0 (0.00)	0 (0.00)	1 (1.67)	50 (83.33)	9 (15.00)	-0.567
WUA helps small farmers, marginal farmers and even the landless to take up viable income generation activities	22 (36.67)	38 (63.33)	0 (0.00)	0 (0.00)	0 (0.00)	0.683
WUA improved the livelihood of only the big farmers	0 (0.00)	0 (0.00)	1 (1.67)	43 (71.67)	16 (26.67)	-0.625
WUA is not concerned with the increase in groundwater table in the area	0 (0.00)	0 (0.00)	2 (3.33)	37 (61.67)	21 (35.00)	-0.658
WUA do not ensure efficient mobilization of people to participate in watershed activities	0 (0.00)	0 (0.00)	2 (3.33)	42 (70.00)	16 (26.67)	-0.617
Group approach is an appropriate method to involve every farmer in watershed	30 (50.00)	29 (48.33)	1 (1.67)	0 (0.00)	0	0.742
Effective accountability and transparency is not ensured in conducting the watershed activities through participatory approach	0 (0.00)	0 (0.00)	2 (3.33)	50 (83.33)	8 (13.33)	-0.550
WUA gives adequate concern to social and environmental issues for sustainable development of farmers in watershed area	7 (11.67)	53 (88.33)	0 (0.00)	0 (0.00)	0 (0.00)	0.558
Favouritism is shown while availing credit to the members of different groups.	0 (0.00)	0 (0.00)	9 (15.00)	49 (81.67)	2 (3.33)	-0.442
If there was no watershed, production of livestock and crops would drastically reduced	33 (55.00)	27 (45.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.775
If there was no watershed conflict over water use would be more	39 (65.00)	21 (35.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.825

### Correlation between Socio-economic and personal variables with impact variables

The table shows that age does not show any relationship with crop adoption, adoption of WSD, change in crop area, change in cropping intensity and cropping diversity. The probable reason for age not correlating with the benefits might be that irrespective of age, all the farmers are included in planning of the activities on the farmers lands during the watershed action plan and the WUA officials see that the benefits are equally distributed among the farmers.

But there is significant relationship between education and change in crop area. The probable reason for this might be that the formal education might have helped the beneficiaries to become aware of the very purpose of the programme and could participate early in the programme to obtain more benefits than others.

In case of land holding, there is high significant relationship between crop rotation, adoption of WSD, and change in crop area and crop diversity. The probable reason might be that the larger farm size lead farmers to posses higher incomes leading to taking up larger number of land based activities on their farms which a poorer farmer could not due to lack of finance.

**Table-6.14: Correlation of Socio-economic and personal variables with impact variables**

Socio-economic and personal variable	Crop Adoption	WSD Adoption	Crop Area Change	Cropping Intensity Change	Crop Diversity
Age	0.227	0.082	0.041	-0.182	0.213
Education	-0.016	-0.019	0.273*	-0.124	-0.014
Land hold	0.585**	0.365**	0.855**	-0.183	0.583**
Outside Contact	0.281*	0.246*	0.067	-0.375**	0.297*
Occupational diversity	0.242*	0.316**	0.054	0.052	0.230
Mass Media Contact	0.163	0.083	0.495**	-0.030	0.141
Persona Media Contact	0.637**	0.571**	0.323**	-0.219	0.647**
H/S/DW	0.073	0.017	0.134	-0.011	0.054

\*\*=Significant at 1% level      \*= Significant at 5% level

Further it shows that farmers outside contact and personal media shows significant relationship with crop rotation, adoption of WSD, and change in crop area and crop diversity. The possible reason which could attributed to this might be that the frequent contacts of farmers with extension worker might have learned more about the technologies and could have benefited more.

Farmers' occupation diversity also has significant relationship with adoption of crop and WSD. This could be due to that the farmers with diversified occupation of higher income are capable of taking up the costlier activities on their lands. Thus, the positive relationship could be explained.

And lastly, mass media exposure of farmers shows significant relationship with the change in crop area as the improved farmers who are really involved in mass media have acquired interest to obtain the benefits by becoming aware of the benefits and thus, the positive relationship with benefits was obtained.

So, hypothesis-5 is accepted.

Soil, water and vegetation are most important natural resources; they provide food, firewood, fibre and raw materials to satisfy a variety of needs of people. Soil and water constitutes the vital resources of the country. These two elements nourish and support the plant and animal life. The prosperity and welfare of humanity is entirely depending on and water which irreplaceable resources. Watershed development is aimed at conservation of natural resources and maintaining the ecology of the area by using the simple soil and water conservation techniques. In other words, watershed management is overall development of particular region including water conservation, maintaining soil fertility, pasture land, agriculture, horticulture, forestry and allied aspects.

Watershed development is an approach to build and strengthen the basic sources in a watershed, so as to enable establishment of sustainable life support. Watershed development programmes aim to conserve soil and moisture as well as to put the land to the best use according to their capabilities to improve the overall productivity of the catchment in a holistic manner. The programmes primarily consider land as a single entity and help in synchronizing all the land based activities to achieve production potentials in the farm as a whole. Keeping this in view, the present investigation was designed to evaluate a watershed with the following specific objectives.

1. To study the socio-economic and psycho-personal characters of the respondents of watershed and non-watershed area.
2. To assess the general socio-economic, technological and environmental impact of watershed in the study area.
3. To study the attitude of the respondents towards the watershed development programmes.
4. To assess the relationship between socio-economic and psycho-personal variables with the impacts variables.

The study was conducted in the Cooch Behar district of West Bengal. Two blocks namely Mathabhanga-II and Cooch Behar-II were purposively selected considering the

convenience and time frame for the study. In Mathabhanga-II Block, three watershed villages were selected as a treated village and one non-watershed village selected from Cooch Behar-II Block as a control village.

After selecting, the villages 90 respondents were selected. 60 respondents from watershed areas and 30 respondents from non-watershed areas were selected for the study. A pre-tested Schedule was administered to the selected individuals and data collected through personal interview method.

Based on the review of literature and objectives of the study a number of independent and dependent variables were selected and to assess and compare between variables, a numbers of indices had been developed in the study. Based on the findings of the study the following conclusions have been drawn:

Majority of the respondents 70 per cent belong to middle aged group (31-50yrs) in watershed areas whereas 76 per cent of the respondents belong to middle aged group. Majority of the respondents are literates in both watershed and non-watershed areas of which 48.33 per cent and 39.67 per cent respectively of them studied up to five standards.

Respondents of non-watershed areas had lower organizational participation than watershed areas. Majority of the respondents 66.67 per cent have outside contact in watershed areas whereas respondents in non-watershed areas have medium level of outside contact 56.67 per cent.

Majority of respondents in watershed areas had high level of personal media 43.33 per cent than non- watershed areas. Respondents of both watershed and non-watershed areas has less used of mass media. Majority of the respondents have low size of land holdings and medium level of occupational diversity.

Majority of the respondents 90 per cent in both watershed and non-watershed areas used tube wells as their source of drinking water. Most of the respondents in both the areas have poor sanitary conditions.

The change in farm and area after inception of watershed project shows that after setting up the watershed project, the changes such as soil erosion from farm (0.73), soil sedimentation in ditches and furrows (0.41), water availability in farm ponds (0.71), water

availability in dry seasons (0.68), ground water table (0.60), crop productivity (0.71), cropping area (0.58), number of crops (0.51), cultivation area in dry season (0.46), conflict for water (0.48), relationship among the villagers (0.75) and animal husbandry (0.36) has been improved.

Overall comparison between watershed area and non-watershed area shows that the adoption of water conservation/harvesting technology in farm is more in case of watershed area (0.46) than non-watershed areas (0.18) but does not show much difference.

There was significant difference in socio-economic characteristics such as outside contact (5.49), personal media (7.26), cropping intensity (15.59) and technology adoption (15.92) between the farmers of watershed and non-watershed areas.

The productivity was significantly high in crops such as boro paddy (2.51), jute (8.43), maize (2.10), potato (3.00) and chilli (2.22) after the adoption of water shed technologies.

Age does not show any relationship with crop adoption, adoption of WSD, change in crop area, change in cropping intensity and cropping diversity. But there was significant relationship between education and change in crop area. In case of land holding, there is high significant relationship between crop rotation, adoption of WSD, and change in crop area and crop diversity. Further it shows that farmers outside contact and personal media shows significant relationship with crop rotation, adoption of WSD, change in crop area and crop diversity. Farmers' occupation diversity also has significant relationship with adoption of crop and WSD. And lastly, mass media exposure of farmers shows significant relationship with the change in crop area.

## **Suggestion**

Watershed management is a landscape-based strategy that aims to implement improved natural resource management systems for improving livelihoods and promoting beneficial conservation, sustainable use, and management of natural resources. Watershed Development can open up new opportunities for households to both intensify and extensify production through increasing the frequency of cultivation, adoption of new

technologies, expansion of cultivable areas. It tends to generate increased demands for labour and generates employment opportunities for households – often poor and the landless – which depend on labouring for their livelihoods. The present study confirmed all the above general trends. From the study it was concluded that the farmers of the watershed area had developed a positive attitude towards the project. The socio-personal characters like education, outside contact, personal and mass media contact had a positive bearing with the increase of adoption of improved technology, adoption of watershed technology or change in crop area and productivity, cropping intensity and diversity. So, it is suggested that with the introduction of watershed project, government should take initiative to improve these personal characters among the farmers to reap the highest benefit from the scheme.

### **Future scope of research**

The followings topics are suggested for future research under disaster management:

1. Impact of the project on creation of social capital and human relationship.
2. Impact of the project on reducing community and household level vulnerability.

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### 8. Family information

Name of family members	Age	Sex	Education	Primary occupation	Where does he/she work (1=own land 2= others land locally; 3= outside locality)	Whether a member of SHG/Water User Association/Farmers' club/ Other water related bodies/other

### 9. Cultivated land details (in Bigha):

Irrigation status		Topography			Nature of land		
Irrigated	Un-irrigated	High	Medium	Low	Plain	Sloppy	Undulating

10. Uncultivated land area:

11. Homestead land area:

12. Pond area, if any:

13. Have you irrigation source in your plots? (mention in details)

### 14. Outside contact

Places of Visits	Frequency of Visit
District head quarters( every 6 months)	
Mahakuma head quarters( every months)	
Nearest town/ Bazar( every week)	
Other towns of State( every 6 months)	
State head quarters( every 6 months)	

### 15. Sources of income

Sources of Income	As primary	As secondary	Approximate share in family income (percent)
Agriculture			
Livestock			
Caste occupation			
Farm work (own)			
Business			
Farm/casual labour			
Govt employment			
Pvt. Employment			
Van/rikshaw puller			
Minor business			
Fishery			
Animal husbandry (Piggery/goatery/cow)			
Poultry/duckery			
Marginal works			
Other specify			

### 16. Mass media participation

How often do you participate in different mass media sources?

Sl. No.	Sources	Participation		
		Regular	Occasional	Never
1.	Listening to radio (general programmes)			
2.	Listening to radio (Agril./Rural dev. Programmes)			
3.	Watching TV (general programmes)			
4.	Watching TV (Agril./Rural dev. Programme)			
5.	Reading newspaper			
6.	Reading farm magazine			

### 17. Extension media contact

Sl No	Name of Extension Media	Nature and frequency of contact		
		Regular	Sometimes	Never
1.	ADA/Line dept. expert			
2.	KPS			
3.	Extension Training			
4.	Development exhibition / krishimela			
5.	Daily Newspaper / extension bulletin			
8.	Contact/progressive farmers			
9.	NGO personnel			
10.	SHG/WUA leaders			

### 18. Housing, sanitation and drinking water (√ mark)

Wall	Floor	Roof	No. of rooms	Sanitation	Drinking water
Bamboo	Kachha	Thatched		No	Pond/river
Tin	Pucca	Talli		Ring (soft wall)	STW (others)
Wood	Tiles	Tin		Ring (hard wall)	STW (Own)
Pucca	Marbel	Pucca		Sanitary	Pipeline

### 19. Soil erosion problem in your farm

Extent of erosion/type of erosion	Whether you experience in your farm (√ mark)	
	Before inception of watershed project	After inception of watershed project (At present)
Sheet erosion		
Rills in the farm		
Gullies in the farm		
Patches of surface soil layer washed out and hard layer emerges in patched		
Whole mass of surface soil layer washed out and hard layer emerges every where		







**21. Adoption scenario of water conservation/harvesting technology in your farm**

Sl. No.	Name of technology	Adoption scenario			If adopted, state the following			If you know about the technology but not adopted, state the constraints**
		Don't know	Know but not adopted	Adopted	Year of inception	Initiated by*	Price sharing (mention the amount of subsidy, if any)	
1.	Roof Rain Water Harvesting							
2.	Farm Ponds							
3.	Check dams							
4.	Open wells							
5.	Earthen bunds							
6.	Stone bunds							
7.	Gully plugging							
8.	Deep tillage							
9.	Deep furrows							
10.	Vegetative barriers							
11.	Mulching							
12.	Contour farming							
13.	Crop rotations							
14.	Intercropping							
15.	Use of FYM							
16.	Use of compost							
17.	Drought prone crop							

**KEY**

\*Government =1; NGO =2; Community=3; Self=4; Other (specify)=5

\*\*It is costly=1; High labor demanding=2; High time demanding=3; Others =4

**22. Have you noticed the following changes in your farm/area after the inception of watershed project, if yes what extent**

Changes	Highly improved	Improved	No change	Deteriorated	Highly Deteriorated
Soil erosion from farm					
Soil sedimentation in ditches and furrows					
Water availability in farm ponds					
Water availability in dry seasons					
Ground water table					
Crop productivity					
Cropping area					
No. of crops					
Cultivation area in dry season					
Conflict for water					
Relationship among the villagers					
Income from farm					
Animal husbandry					

**23. What do you agree with the following statements?** (Please indicate your feeling at appropriate column provided against each statement (SA =Strongly agree, A = Agree, UD = Undecided, DA = Disagree and SDA = Strongly Disagree)

Statements	SA	A	UD	DA	SDA
1. Watershed Development Project (WDP) is a boon to farmers in watershed area					
2. WDP helps to increase income both from agriculture and non-agriculture activities in the area					
3. Cost sharing with beneficiaries by watershed project ensures respect and responsibility to the farmers participating in watershed development					
4. Management of resources can be effectively done through community based organizations in WDP					
5. Trainings provided by WDP are monotonous and not practical					
6. WDP helps small farmers, marginal farmers and even the landless to take up viable income generation activities					
7. WDP improved the livelihood of only the big farmers					
8. WDP is not concerned with the increase in groundwater table in the area					
9. WDP do not ensure efficient mobilization of people to participate in watershed activities					
10. Group approach is an appropriate method to involve every farmer in watershed					
11. Effective accountability and transparency is not ensured in conducting the watershed activities through participatory approach					

<b>Statements</b>	<b>SA</b>	<b>A</b>	<b>UD</b>	<b>DA</b>	<b>SDA</b>
12. WDP gives adequate concern to social and environmental issues for sustainable development of farmers in watershed area					
13. Favouritism is shown while availing credit to the members of different groups.					
14. If there was no watershed, production of livestock and crops would drastically reduced					
15. If there was no watershed conflict over water use would be more					

**24. Any other relevant information**

Signature of the Enumerator