Study No.- 160

STUDY ON IMPACT EVALUATION OF NATIONAL WATERSHED DEVELOPMENT FOR RAINFED AREAS ENVISAGED AS WARSA JAN SAHBHAGITA DURING TENTH PLAN (2002-2007)

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Preface

In the millennium century, increased population necessitates greater demand for water, timber, livestock, agriculture crops and environmental amenities. This is manifested in degrading natural resources and environment. Hence, efficient, equitable and sustainable use and management of natural resources in dry land environment are necessary for economic development of region and more so in the agrarian country like India. Development, promotion and management of appropriate watershed technologies in dry land regions have been viewed as major priorities to ameliorate the problem of natural resource degradation. This results in multiple benefits such as ensuring food security, enhancing viability of farming and restoring ecological balance. The present strategy of watershed development programme is to protect and sustain the livelihoods of resource poor farmers who are experiencing production constraints in addition to problems created by soil erosion and moisture stress. Watershed development is to ensure the availability of drinking water, fuel wood, fodder and helps in raising income and employment for farmers and landless labourers through improvement in agricultural productivity and production.

In the light of the above background and consideration, the present study entitled "Study on Impact Evaluation of National Watershed Development for Rainfed Areas Envisaged as Warsa Jan Sahbhagita During Tenth Plan (2002-2007)" has been undertaken as common study involving several Centres at the instance of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, with a view to studying the impact of National Watershed Development for Rainfed Areas. The study has been confined to four districts in West Bengal and the number of beneficiaries and non-beneficiaries covered under this study is 320 from different size classes of cultivators.

The study has been carried out by Dr. Debashis Sarkar, Mr. Kali Sankar Chattopadhyay, Mr. Debjit Roy and Mr. Ranjan Biswas. Mr. Kali Sankar

Chattopadhyay and Mr. Ranjan Biswas have collected and tabulated the primary and secondary data. Mr. Debjit Roy has been shouldered the responsibility in analysing the data and preparation of tables. However, the entire responsibility of formation of table design and drafting of report has been carried out by Dr. Debashis Sarkar. The secretarial assistance has been received from Mr. D. Mondal, Mr. P. Das, Mr. N. Maji, Mr. Munsi A. Khaleque, Mr. P. Hazra and Mr. S. Sadhu. The duplicating of the report has been done by Mr. A. Patra.

On behalf of the Centre, the undersigned likes to take the opportunity to thank the officials of the Directorate of Agriculture, Government of West Bengal for their kind cooperation in conducting the study.

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Kazi MB Rahim
Hony. Director

VOLUME I

I
INTRODUCTION

1.1 Preamble

In the millennium century, increased population necessitates greater demand for water, timber, livestock, agriculture crops and environmental amenities. This is manifested in degrading natural resources and environment. Rainfed agriculture forms 70 per cent of cultivable land in India. Dry land regions have been victims of neglect of the policy front. This is due to concentration of public resources through irrigation development and green revolution technologies in the well-endowed regions for meeting the food requirements. While productivity level in well-endowed regions has reached the potential, further increase in area under irrigation is not only limited but also expensive. Hence, efficient, equitable and sustainable use and management of natural resources in dry land environment are necessary for economic development of region and more so in the agrarian country like India.

Development, promotion and management of appropriate watershed technologies in dry land regions have been viewed as major priorities to ameliorate the problem of natural resource degradation. This results in multiple benefits such as ensuring food security, enhancing viability of farming and restoring ecological balance (Reddy, 2000). The present strategy of watershed development programme is to protect and sustain the livelihoods of resource poor farmers who are experiencing production constraints in addition to problems created by soil erosion and moisture stress. Watershed development is to ensure the availability of drinking water, fuel wood, fodder and helps in raising income and employment for farmers and landless labourers through improvement in agricultural productivity and production (Rao, 2000).

1.2 Watershed Development Programme in India

The origin of scientific and planned programme for natural resource (soil and water) conservation on watershed basis was first initiated in early fifties at the Central Soil Water Conservation Research & Training Institute, Dehradun. In 1974, four operation Research Projects (ORP's) were taken up at Sukho Majri and Bunga (Haryana-Shivalik), Fakot (Uttar Pradesh Garhwal), Siha and Bajar Ganiyar (Haryana Aravalli Hills), G.R.Hlli (Karnataka-Chitradurga Hills), Sheetalpur in Bundelkhand Region and Etmadpur at Agra, Uttar Pradesh (Dhruvanarayana, 1987). Ministry of Rural Development initiated Drought Prone Area Programme (DPAP), Desert Development Programme (DDP) and the Wasteland Development Programme for the conservation of land and water resources. The National Afforestation and Ecological Development Board initiated a programme for restoring degraded forestlands. Agencies such as Central Research Institute for Dry land Agriculture (CRIDA), World Bank, Danish Development Agency (DANIDA), and Swiss Development Corporation also designed programme for the conservation of natural resources by launching a number of watershed development projects. The Government of India launched the National Watershed Development Programme for Rainfed Agriculture (NWDPRA) in the Seventh Plan. By 1984-85 the work was launched in 4,400 micro watersheds covering an area of 4.3 m ha in the country.

Due to encouraging results from watershed development programmes, Government of India constituted a technical committee headed by Professor C.H. Hanumantha Rao in 1993 to review and recommend suitable measures for improvement of DPAP and DDP. The committee observed that despite being in operation since two decades these programmes had not created substantial impact. Drought conditions increased ecological degradation in the DPAP and DDP areas.

Keeping in view the knowledge gained from successes and failures, and after consultations with Non-Government Organisations (NGOs), state

governments, professionals and research institutions the Ministry of Rural Development, Government of India in 1994 prepared and adopted ‘Guidelines for Watershed Development’. The NWDPRA brought out its own guidelines in 1995.

Government of India, during the eighth five-year plan made every effort to incorporate wasteland development in NWDPRA, DPAP, DDP and IWDP. Several committees studied the problems in depth in consultation with various stakeholders and made recommendations. These recommendations are being implemented vigorously.

The NWDPRA was further restructured in November, 2000 by retaining technical strengths of the other programme and incorporating lessons learnt from the successful projects, especially on community participation. The watershed development programme was planned, implemented, monitored and maintained by the watershed communities. To bring about uniformity in programmes, being implemented by various agencies, the ‘WARASA-Jan Sahbhagita’ guidelines were issued in conformity with the ‘Common Approach/Principles for Watershed Development’ agreed upon by the Ministries of Agriculture and Rural Development. The salient features of the restructured project are (1) participatory approach in implementation of Watershed Community projects through Watershed Committee (WC), Watershed Associations (WA), User Groups (UG)/Self Help Group (SHG) etc., (2) planning through Participatory Rural Appraisal (PRA) mechanism, (3) revision of cost norms from Rs. 3500 to Rs. 4500 per hectare (<8% slope) and from Rs. 5000 to Rs. 6000 per hectare (>8% slope), (4) revision of component-wise allocation of resources, (5) flexibility of choice of activity and technology, (6) sustainable watershed development through different Project Implementing Agencies (PIAs), (7) role of PIAs as facilitator, (8) broad basing of Watershed Development Team (WDT) for better community mobilization, (9) thrust of Transfer of Technology and innovativeness for utilisation of research funds earmarked for watershed technology through Indian Council of Agricultural

Research (ICAR), Krishi Vigyan Kendras (KVKs), State Agricultural Universities (SAUs) etc., (10) development and management of Common Property Resources (CRPs) and forest lands, (11) convergence of programmes, (12) enlarging role of NGOs and Panchayats, (13) project benefit and cost sharing by beneficiaries, (14) improvement of Monitoring and Evaluation (M&E) System, (15) impact assessment through development of realistic quantifiable indicators, (16) capacity building through training and orientation and (17) extension support through line departments.

In view of the considerable restructuring of the programme with greater decentralisation and community participation, higher degree of flexibility of choice of technology and suitable institutional arrangements for ensuring long-term sustainability had been adopted. Through the programme was being monitored regularly through quarterly, half yearly and annual progress reports and field visit by the officers, yet the need for an independent evaluation through outside agency was felt necessary for assigning the impact of the programme.

Considering the peoples' participation in watershed areas and bottom-up rather than top-down approach, the Ministry of Agriculture had revised its guidelines for the National Watershed Development Project for Rainfed Areas (NWDPRA) again in 2001. In these new guidelines it was mandatory for the 'Watershed Development' to be planned, implemented, monitored and maintained by the Watershed communities themselves. Moreover, to bring about uniformity in approach among the Watershed-based programmes being implemented by various agencies, the WARASA (Watershed Areas' Rainfed Agricultural System Approach) JANSAHBHAGITA guidelines were framed.

Again in 2003, a committee headed by Hariyali has recommended strengthening of Panchayat Raj Institutions (PRIs) and making accountable for planning, implementation, monitoring and management of watersheds at one or two village level (Anonymous, 2003).

Table 1.1: Area proposed and estimated cost for watershed treatment for next 25 years in India

Plan	Area proposed for treatment (M ha)	Per hectare cost (Rs.)	Total cost of treatment (billion Rs.)
IX	10.0	5,000	5.0
X	12.0	7,500	9.0
XI	15.0	11,000	16.5
XII	15.0	15,000	22.5
XIII	11.4	20,000	22.8

Source: Report of working group on Soil and Water Conservation for the formulation of Ninth-FYP, Department of Agriculture and Co-operation, Ministry of Agriculture, 30 April ,1996

In India an area of 172.2 million hectare was planned to be treated through Watershed Development Programme, of which 29.2 per cent had already been treated. For providing watershed based resource conservation treatment for the remaining 122 million hectare area, an investment of Rs. 297.37 billion was required at 1996 prices based on per hectare cost of watershed treatment, which varied from Rs. 1240 in West Bengal to Rs. 7776 in Union Territories. It was planned to treat 12, 15, 15 and 11.4 million hectare during the tenth, eleventh, twelfth and thirteenth five year plans (FYP) (Table- 1.1). Projected investment for watershed treatment varies from Rs. 5,000 in ninth FYP to Rs. 20,000 per hectare in the thirteenth FYP. Up to the end of the X-Plan, a total area of 9402823 hectare has been developed by incurring an expenditure of Rs. 3033.32 crore. During X^{th} Plan the NWDPRA was implemented in 6315 Watersheds and an area of 2413333 hectare have been developed with an expenditure of Rs. 1156.92 crore.

1.3 Watershed Development Programme in West Bengal

West Bengal is very rich in all forms of natural resources such as water (both surface and ground water), forest (wide diversified flora and fauna), average quantum of precipitation, diversification, agro-climatic zones, fertile soil. Taking efforts during both pre-independence and post-independence into account, irrigation potential has been created through different plan periods to strengthen

backbone of the agrarian economy. In spite of this, the food security continues to be fragile when rain fed crop suffers during drought. West Bengal is going through a serious phase of resource crunch and shifted its attention to rainfed areas reducing the area of operation in smaller scale to that of a micro watershed for inculcating sustainable development practices for both arable and non-arable lands with sound technologies. Presently due to pressure of population in West Bengal, the per capita land has come down to as less as 0.1046 ha in respect of geographical area 0.0659 ha to that of arable land. To meet the common need lands are being over used accompanied with faulty management resulting soil exhaustion and degradation. It may be noted that 28.51 per cent of the non-forest area in West Bengal has been affected due to land degradation problems (Table-1.2). The degraded land does not produce expected yield as the fertile topsoil is being washed away exposing the sub-soil. This has dual effect like drought and moisture stress and it also prevents replenishment of ground water. Further land degradation is not only the only factor side by side eroded soils and debris affects the surface water bodies and drainage system through deposition. The reduced storage capacity of the drainage system increases the flood occurrence and stream bank erosion resulting loss of arable land, which is very significant in North Bengal. Therefore, conservation, development and scientific management of land and water resources for food security, sustainable agriculture and allied activites on watershed basis were called for.

Considering the success of watershed development programmes, a separate soil conservation wing was established under the control of Joint Director of Agriculture (Soil Conservation) in West Bengal. This is an impetus to watershed programme in the dry zones of the state.

Apart from the above, recently financial institution like National Bank for Agriculture and Rural Development (NABARD) has also set up two micro

Table 1.2 : Land degradation problems by districts of West Bengal

District	Problems	*Approx. area (ha)*
Darjeeling	In Darjeeling Hills Landslips & landslide, gully, torrential velocity of streams, mining, acidity, outer slope of cultivated terraces, surface flows over the slopes of runoff In Siliguri Sub-Division Splash, sheet & rill erosion, gully formation, sand ladening, stream bank erosion, acidity, mining	67,100
Jalpaiguri	Splash, sheet & rill erosion, stream bank erosion	84,000
Cooch Behar	Sand ladening, gully formation, soil acidity, water logging, flash flood	62,000
North Dinajpur	Sand ladening, gully formation, soil acidity, water logging, flash flood	13,800
South Dinajpur	Stream bank erosion and sand ladening	9,500
Malda	Sand ladening, stream bank erosion and river cutting, water logging	28,000
Murshidabad	Sand ladening, stream bank erosion, river cutting and moisture stress	85,000
Birbhum	Sheet & rill erosion, undulating tract, moisture stress, gully and sand ladening	1,04,000
Burdwan	Sheet erosion, undulating tract, gully, moisture stress, mining and sand ladening	1,33,000
Nadia	Water logging and stream bank erosion	54,200
24-Parganas (N)	Scarcity of sweet water, ingress of saline water	1,82,610
24-Parganas (S)	Water logging, sea coastal erosion and soil salinity	5,00,830
Howrah	Soil salinity, water logging	92,650
Midnapore (E)	Soil salinity, scarcity of sweet water, sea coastal erosion	3,42,310
Midnapore (W)	Sheet erosion, undulating tract, gully and moisture stress	1,46,700
Bankura	Sheet erosion, undulating tract and moisture stress	1,07,200
Purulia	Sheet erosion, undulating tract, moisture stress, mining and gully	1,46,200
Total		21,91,300
Total Non-forest area		76,87,300
% of land (non-forest area) affected by degradation problems		28.51

Source : Soil Conservation Wing, Directorate of Agriculture, Government of West Bengal, 2006

watershed projects in the Ranibandh block of Bankura district of West Bengal. The cost is pegged at Rs 1.17 crore. The projects, to come up predominantly on tribal land and benefit about 2000 families, will be completed in the next five years. NABARD has already allotted Rs 57 lakh for one micro watershed development project. The other project, which spreads across 799 hectares in four mouzas viz., Khouja, Makhnu, Kulam and Belgaria, will enter the capacity building phase (CBP) soon. The cost is estimated to be Rs 60 lakh for this purpose. A Watershed Development Fund (WDF) has been set up with a corpus of

Rs 200 crore. An amount of Rs 30 crore has been allotted for West Bengal to cover six districts viz., Purulia, Bankura, Birbhum, Burdwan, West Midnapur and Darjeeling. The nodal agency that will implement the projects in different phases of implementation, is the Panchayat and Rural Development department. So far, NABARD has sanctioned 34 projects with a total grant of Rs 17.8 crore in the six districts, covering 24,475 hectares. WDF projects are built in two phases i.e. capacity building and full implementation. Watershed development, which involves conservation, regeneration, and judicious utilisation of natural resources, is carried out in both dry and rain-fed areas.

1.4 Need for Impact Assessment of Watershed Development Programme

A study on watershed by Deshpande and Narayanmoorthy (1996) identified four groups of studies in dealing with different aspects of watershed management. The first group dealt with analysis of rainfed farming in India focussing on enlisting constraints, in management and utilisation of soil moisture under rainfed farming. Second group of studies concentrated on impact assessment of watershed development by incorporating individual components of management. Third group included studies covering the entire watershed where impact parameters include agricultural and environmental sectors. The last group comprised of the work by hydro-geologists analysing the changes in the groundwater. Considerable number of studies has reported the impact of watershed on agriculture productivity, afforestation, groundwater recharge, income, and employment and livelihood security. However, only a few studies analysed the direct use benefits and listed the direct non-use benefits (Chopra, 1999). Therefore, there is a need to estimate the direct non-use benefits and indirect non-use benefits from watershed in addition to direct use benefits.

Many services provided by watershed are positive externalities. The flood control benefits, water infiltration services, and species sustaining services offered

by watersheds are usually external to farmers. As a result, habitats that support complex ecosystems are valued cheaply. Since watershed development programmes are public funded ones, it is important to consider the social benefits for public attention. Therefore, valuation of external benefits of watershed is important to provide support for reasonable public policies to protect habitats. This makes it all the more important to determine the values of watershed services.

In recent years both central and state governments have drawn up programmes on watershed development with internal and external assistance. Given the complexity of activities in the watershed development programmes and their linkages, economic evaluation of discerning tangible and intangible benefits is essential to justify investment of scarce financial resources. This will add for better formulation, modification and implementation of watershed development projects with appropriate institutions for sustainable management of watersheds.

In view of the above, this study has been undertaken to assess the long-term economic impact on agriculture productivity, land use and cover, groundwater recharge watershed system and sustenance of watershed technologies/practices in West Bengal.

1.5 Issues Addressed in the Study

The study has been conducted in West Bengal. The main objective of the study is to evaluate the changes which happened due to the interventions of the programmes in the selected watersheds. This means that whether the changes have to be clearly and objectively attributed to NWDPRA programme have been assessed in detail. The issues addressed in the study are (1) analysis of efficiency and equity implications of watershed development, (2) costs and benefits of different watersheds, (3) social mapping of farmers and watershed treatments to analyse the potential to water resource benefits through watershed development

programme, (4) estimation of land value augmentation due to watershed development and (5) assessment of overall benefits and costs of watershed development programmes.

Keeping the above objectives in mind, the present study has been conducted to have full understanding of the programme. The study has been conducted keeping in mind the WARASA-JAANSAHABHAGITA guidelines for NWDPRA and tried to evaluate implementation status of guidelines in the Watershed Projects. The broad perspective of aspects which have been covered in the report are (1) community organisation and institutional aspects, (2) planning aspects, (3) implementation aspects, (4) environmental aspects, (5) social aspects, (6) economic aspects, (7) institutional aspects, (8) indirect benefit, (9) overall impacts and sustainability and (10) people's reaction.

1.6 Scheme of the Chapters

The entire report has been subdivided into two parts i.e. Volume-I and Volume-II. Volume-I of the report contains five chapters. The first chapter introduces the genesis of watershed development programme as restructured and implemented in India as well as in West Bengal. Research methodology has been discussed in Chapter-II. Description of selected watersheds as per the prescribed guidelines has been discussed in Chapter-III. The issues like performance indicator, technical impacts, environmental impacts, social impacts, economic impacts indirect benefits and overall impact on sustainability have been discussed in Chapter-IV. The Volume-I ends with summary and conclusions with appropriate recommendations in Chapter-V. All supporting facts and detailed documents have been presented in Volume-II.

II
RESEARCH METHODOLOGY

2.1 Research Design

Either descriptive or explanatory research it is necessary to have a frame of reference within which to interpret the results i.e. a frame of reference that enables us to do more than simply report the results. The present study has been conducted based on descriptive questions as well as causal processes. So the need for a frame of reference was fairly obvious to conduct this study. The study has been conducted based on classic experimental design. In its simplest form the experimental design has two groups : a beneficiary group (experimental group) and non-beneficiary group (control group). It has also been extended over time so that data has been collected at two points of time (before and after) at least. Between Time-I (before) and Time-II (after) the experimental group has been exposed to an experimental intervention. The non-beneficiary group has been kept alone. At both Time-I and Time-II the experimental and control groups have been measured in relation to the key dependent variables that is of interest in the study.

2.2 Selection of Watersheds

According to the latest estimate, 18 districts in West Bengal and 21,91,300 hectare of non-forest area of these eighteen districts have been affected by land degradation problems. Firstly, these districts have been sub-divided into two groups on the basis of occurrence of land degradation i.e. below and above the average land degradation of West Bengal. Thus, among these districts twelve districts fall under below and rest six districts under above groups. Four districts (two from each group) i.e. Cooch Behar and Birbhum (from below) and 24-Parganas (North) and 24-Parganas (South) (from above) have been selected randomly. There are six sub-watersheds in Cooch Behar, four in Birbhum, two in

24-Parganas (N) and twelve in 24-Parganas (S) (Table 2.1). In the second stage, one watershed from each selected district has been selected randomly. Phulbari Watershed (Block : Dinhata-I) from Cooch Behar; Kanduri Watershed (Block : Rampurhat-I) from Birbhum; Hizta (Part-II) Watershed (Block : Hasnabad) from 24-Parganas (North) and Masjidbati Watershed (Block : Basanti) from 24-Parganas (South) have finally been selected for in-depth study.

Table 2.1 : Watersheds in the selected districts (2005-06)

District	Block	Name of the watershed	Area (ha)	*Proj. cost (Rs.)*
Cooch Behar	Cooch Behar-II	Daulitbari	500.0	2250000
	Dinhata-I	**Phulbari**	**500.0**	**2250000**
	Mathabhanga-I	Panignam	500.0	2250000
	Mathabhanga-II	Sauderbosh	500.0	2250000
	Tuffanganj-I	Jagirchilakhana	500.0	2250000
	Tuffanganj-II	Bhanukumari	500.0	2250000
Birbhum	Dubrajpur	Hazrapur	389.6	1750500
	Dubrajpur	Hetampur	500.0	2250000
	Rampurhat-I	**Kanduri**	**500.0**	**2250000**
	Dubrajpur	Punchra	500.0	2250000
24-Parganas(N)	**Hasnabad**	**Hizta part-II**	**500.0**	**2250000**
	Hasnabad	Patlikhanpur	600.0	2700000
24-Parganas (S)	**Basanti**	**Masjidbati**	**500.0**	**2250000**
	Basanti	Ramkrishna	500.0	2250000
	Mandirbazar	Gabberia	500.0	2250000
	Kakdwip	Bhubannagar	500.0	2250000
	Sagar	Sumaninagar	500.0	2250000
	Mathura-II	Kankandighi	510.0	2295000
	Mathura-II	Kankandighi	500.4	2251800
	Mathura-II	Kankandighi	511.0	2299500
	Jaynagar-II	Rupnagar	510.0	2295000
	Jaynagar	Rupnagar	544.0	2448000
	Gosaba	Kachukhai	565.0	2542500
	Gosaba	Kachukhai	585.0	2632500

Source : Soil Conservation Wing, Directorate of Agriculture, Government of West Bengal

2.3 Selection of Villages and Households

At the first stage, the list of villages along with households of each selected watershed has been collected. Then all the households have been pooled and

stratified into two groups i.e. beneficiary and non-beneficiary. In the second stage all the households in each group have been sub-divided into five categories according to the size of holdings i.e. land less, marginal farmers (less than 1 hectare), small farmers (1.01- 2 hectare), medium farmers (2.01- 4 hectare) and big farmers (above 4.01 hectare). In the next stage, 80 households (40 from beneficiary and 40 from non-beneficiary) from each watershed have been selected by employing the methods of probability proportional to size and random sampling. Thus, in all a total of 320 households (160 beneficiary and 160 non-beneficiary) of different size groups have been selected as the ultimate sample unit of the study.

2.4 Tools and Techniques of Data Collection

2.4.1 Development and pre-testing of survey schedule

The primary data has been collected with the help of survey schedule specially constructed for the purpose of the study, keeping in view the focus, objectives and variables. The entire draft schedule has been pre-tested with ten per cent non-sample respondents before administering into the actual respondents. Pre-testing has been done to ensure the validity of the survey schedule under local condition. Accordingly, after the completion of the pre-testing, the final survey schedule has been revised and improved with appropriate wordings and contents.

2.4.2 Interviewing and data collection

Primary data has been collected by personal interview of the beneficiary and non-beneficiary households. A household schedule had been specially developed for collection of data from the household. The household schedule includes different sub-sections containing the items of production, productivity, changes in cropping pattern, activities and changes in other allied sectors and non-

farm activities etc. As WARSA JAN SAHBHAGITA does essentially uphold the basic principle of people's participation for the sustenance of the watershed project, questionnaire regarding the intense involvement of the local people for successful implementation of watershed project has also been prepared. In view of the purpose and objectives of the study, primary data have been collected for two reference period of time i.e. 2001-02 and 2006-07.

Secondary data have obtained from various published reports and official records of respective watershed, Office of the Principal Agricultural Officer, Office of the Agricultural Development Officer of the selected district etc.

2.5 Analytical Techniques

The cost of cultivation of both groups (beneficiary and non-beneficiary) has been computed. Gross return for each crop has been computed as the value of the output at the prices realised by farmers plus value of by product. Cobb-Douglas type of production function has been fitted to measure the factors contributing to gross returns. This model has been selected purposively to considering advantages in terms of adequacy of fit to the data, computational simplicity and for sufficient unused degrees of freedom for statistical testing (Heady, 1966). Unlike the classical production function, one of the serious limitations of the Cobb-Douglas production function is that it accommodates either constant, increasing or decreasing marginal productivity and does not allow all the tree relationships simultaneously. Despite this limitation, it has the greatest use in the diagnostic analysis as the regression parameters represent the elasticities and can estimate the marginal productivity at geometric mean levels of the input and the output.

The general form of the Cobb-Douglas production function is $Y=AL\mu KbU$

Where,
Y = quantity of output
L = quantity of labour

K = quantity of capital
A = constant or may be treated as efficiency parameter
U = random disturbance term and μ and b are the parameters.

Separate production functions have been estimated for beneficiary and non-beneficiary categories for determining the contribution of factors to gross returns and production efficiency of dry land agriculture.

$$Y=aX_1^{b1} X_2^{b2} X_3^{b3}\ldots\ldots\ldots X_5^{b5}\mu$$

Where,
Y=gross returns from land crops in Rs./ha
X_1= total land under dry land crops (acres)
X_2=expenditure on seeds used by dry land crops (Rs.)
X_3=expenditure on chemical fertiliser used (Rs.)
X_4= expenditure on human labour used (Rs.)
X_5= expenditure on bullock labour (Rs.)
a=intercept
b_1, b_2….. regression coefficients and μ=error term

The non-linear form of Cobb-Douglas function can be transformed into linear function by converting all variables into logarithms. The transformed function takes the following form

$$LnY+Lna+b_1LnX_1 + b_2LnX_2 \ldots\ldots\ldots..+ b_5LnX_5 + Ln\ \mu$$

The degree in inequality in the farm income has been estimated by compounding Gini coefficient ratios for different classes of farmers and fifferent components of watersheds. The Gini ratio ranges between zero and one. A value of one reveals perfect inequality and a zero value implies perfect equity in the distribution of income. In the real world situation, it is difficult to obtain Gini

coefficients perfectly zero or one. Gini coefficient has been calculated using the form

$$G= 1 + 1/n – 1/n2y[Y1 + 2Y2 + 3Y3 + ……..nYn]$$

Where,
G=Gini coefficient
y = is the mean income
Y1, …Yn = represent individual's income/farm in descending order in size
n= size of population

III
CHARACTERISTICS OF THE SELECTED WATERSHEDS

3.1 Watershed Development and Management

Watershed is a topographically delineated area draining water to a channel. It is a geo-hydrological unit draining water through a common point by a system of streams. In the natural resource economics context, watershed is a geographical area in which groundwater, surface water, soil moisture, soil erosion, forestry, biodiversity and ecosystem are conserved as a whole to be managed and used on an efficient, equitable and sustainable basis. In the social science context, watershed is a logical unit for planning and development. However, watershed is a unit, which operates largely on the side of production and not on the side of consumption. It is a concept of economic dynamics. Watershed development is a broader concept that denotes development of land and water resources and their relationship with forests, fish, wildlife, environment quality and ecological balance, while watershed management is defined as a social process of planning, organizing, actuating and generating maximum prosperity and happiness of stakeholders, user groups, other people and the government by controlling through a cooperative group actions for securing maximum benefits from natural resources viz., land, water, vegetation, animals and human with a minimum efforts for welfare of human kind (Yadav and Bhushan, 2000). It may be noted that watershed is a programme designed to develop and improve the management of land and water resources in small watersheds through project approach which envisages joint action by local community, government, non-governmental organisations and stakeholders with their full understanding and support. Thus, watershed project signifies a set of activities embracing protection, development and management of land, forest and water resources to maximize the net economic return, consistent with those tangible objectives and values such as ecological,

environmental and social which cannot be estimated with conventional economic measures in a given geographical area.

The study has been undertaken in Fulbari Watershed (Block : Dinhata-I) in Cooch Behar district; Kanduri Watershed (Block : Rampurhat-I) in Birbhum district; Hizta (Part-II) Watershed (Block : Hasnabad) in 24-Parganas (North) district and Masjidbati Watershed (Block : Basanti) in 24-Parganas (South) district located in the Terai, Rarh & Eastern Plateau and Coastal agro-climatic zones, respectively of West Bengal. These are the watersheds implemented and sanctioned up to 2005-06. In these projects most of the components of watershed development programme have been covered. Hence it is an opportunity to assess the long-term impact of watershed programme *inter alia* on agriculture, horticulture, forestry, environment and groundwater recharge as well as socio-economic development in the catchments area.

3.2 Background of the Districts of the Selected Watersheds

The district Cooch Behar where the Fulbari micro watershed falls geographically forms part of the Himalayan Terai of West Bengal. The district lies between $25^0 27' 40''$ to $26^0 32' 20''$ North Latitude and $88^0 97' 60''$ - $89^0 54' 35''$ East Longitude covering an area of 3386 sq. kms, with reduced level/altitudes being 43.67 metre. It is bounded by Assam state in the East, Jalpaiguri district of West Bengal state in the West and Jayanti hills in the North and Bangaldesh in the South. It experiences tropical humus monsoon climate with annual rainfall ranging from 3130 mm to 3350 mm with 103-110 days. The soil of the district is formed by alluvial deposition having large admixture of light textured sands porous and acidic in natural causing poor water holding capacity with deficiencies of Bo, Mo, Zn etc. CEC is los. General depth of soil ranges from 015 m to 1.0 m and is super imposed on deep sand. Topographically the district is plain gentle slope towards North Easterly to South-Westerly direction. A large net work of hilly rivers

namely Tista, Torsa, Mansai, Kaljani, Gadadhar, Ghargharia, Raidak, Sankosh etc. and other rivulets traverse the district resulting occurrence of regular flood, stream bank erosion and sand deposition in agricultural crop fields. The district attracts people for its unique characters having pleasant climate, forest beauty temples, number of rivers, tourism spots, air-filed, military barracks, decent and innocent culture-character of local *koch* people and above all gigantic place of *koch* Maharajas (similar to Buckingham Palace).

On 1st March 1986, the erstwhile district of 24-Parganas which was the population wise largest district in India was bifurcated into two separate districts of 24-Parganas (North) and 24-Parganas (South). The district of 24-Parganas (North) where the Hizla micro watershed falls has its administrative Head Quarter at Barasat comprises of five sub-divisions viz., Bongaon, Basirhat, Barasat, Barrackpore and Bidhan Nagar. The district is bounded by Nadia district in the North, 24-Parganas (South) in the South, Hooghly district, Bhagarathi river and Kolkata in the West and Bangladesh in the East. It lies between $21^0 39^/$ to $80^0 12^/$ North Latitude and between $80^0 52^/$ to $89^0 06^/$ East Longitude. The total geographical area is 4094 sq. km. while the projected population as per 1991 Census was 72,81,881 with a population density of 1778 persons/sq. km. A long part of the industrial belt of West Bengal is located here providing employment of large section of people. Even, then, this district occupies a high position in the agricultural map of West Bengal and farming is the main occupation of the rural masses on a large scale and rapid growth of industry. As per major classification this district falls within the Gangetic Alluvium Zone, considered to be the most fertile for crop production. Soil type varies from sandy to clay loam, sandy loam being pre-dominant. Ratio of high:medium:low land is 17:44:39. Soil group is WB-76 to WB-80. The coastal part of this district mainly Basirhat sub-division falls into the soil group of WB-79 and WB-80. The soil is coastal salaine marshy soil consisting of very deep, poorly deep, poorly drain, fine soils occurring on

nearly level upper delta with inter-distributory sediments with clayey surface, severe flooding and moderate saline occurs. Normal rainfall of the district is 1,525 mm with some deviation in some years resulting in considerable crop loss. The temperature varies between 10^0 C in January to 41^0 C in May while the relative humidity varies between 60 per cent to 99 per cent.

The district 24-Parganas (South) where the Masjidbari micro watershed falls having the famous Sundarbans, the largest ,amgrove forest on earth spreading over thirteen of the thirty agricultural blocks of the district. This district has indeed a peculiar geographical location stretching from the metropolitan Kolkata to the remote riverine villages on the mouth of Bay of Bengal. About 84 per cent of the total population of the district live in the rural areas where agriculture is the mainstay of survival. In spite of lack of transport and communication facilities, poor drainage system, lack of irrigation facilities, problems of soil salinity and ingression of saline water, the farmers of the district are struggling hard to match up with these critical constraints. Irrespective of land holding size, they are mostly enterprising which when added to the modern farming technology, would easily be conducive for increasing the productivity as well as the total agricultural production of the district significantly.

3.3 Location and Area of the Selected Watersheds

The Fulbari micro watershed is located in Cooch Behar district. The Fulbari watershed lies between $26^0$07 to $16^0$11$^/$ North latitude and $89^0$19$^/$ to $89^0$23$^/$ East longitude. It is situated in the Fulbari mouza under Dinhata-I Development Block. Dinhata-I block comprises of 16 Gram Panchayats with 146 mouzas.

The Hizla micro watershed (Part-II) is located in 24-Parganas (North) district. The Hizla watershed lies between $88^0$54$^/$ to $88^0$57$^/$ East latitude and $22^0$30$^/$ to $22^0$31$^/$ North longitude. It is situated in the Hizla mouza under Hasnabad

Development Block. Hasnabad block comprises of 16 Gram Panchayats with 146 mouzas.

The Masjidbari micro watershed is located in 24-Parganas (South) district. The Masidbari watershed lies between $21^{0}29^{/}$ to $22^{0}33^{/}45^{/}$ North latitude and $88^{0}3^{/}45^{//}$ to $89^{0}4^{/}50^{//}$ East longitude. It is situated in Masjidbari mouza under Basanti Development Block. Basanti block comprises of 13 Gram Panchayats with 67 mouzas.

The Kanduri micro watershed is located in Birbhum district. The Kanduri watershed lies between $24^{0}08^{/}$ $25^{//}$ to $24^{0}10^{/}55^{//}$ North latitude and $87^{0}48^{/}00^{///}$ to $87^{0}44^{/}20^{///}$ East longitude. It is situated in the Bhatina mouza under Banhat Panchayet of Rampurhat-I Development Block. It comprises of seven villages viz., Bhatina, Harinathpur, Matimahal, Tentul bandhi, Radipur, Moubuni and Kulbuni.

IV
RESULTS AND FINDINGS

4.1 Results and Findings

Watershed Development Programme (WDP) is an approach to address the rural development problems with a primary focus of natural resource conservation thereby sustaining rural livelihoods. Since its inception (1979) WDP has undergone changes in contents and approach broadening its scope. However, Total Economic Valuation (TEV) is crucial to consider benefit cost analysis to justify public investment on watershed.

In recent years, the major agenda in agriculture is to improve agriculture productivity and equity in the rainfed regions with limited land and water resources. These are reflected in the common guidelines (1995) and revised guidelines (2001) issued by the Government of India in watershed development programmes. In the following discussion, the impact of selected watershed is analysed on the system of production approach.

It is evident that there is no uniformity in family size in between the selected watersheds. The literacy rate is higher among males (82.29 per cent) than females (64.47 per cent). In non-watershed (NWP) area literacy rate is lower for both male and female at 71.41 per cent and 55.38 per cent, respectively. The size of land holding is 1.02 hectares and 0.77 hectares in WP and NWP, respectively. In the selected watershed the number of bullock carts, tractors, thresher and sprayer are 35, 1, 26, 31 and 20, respectively. As against this, in the NWP area, these are 31, 6, 22, 31 and 26, respectively. This indicates that the farmers in NWP are somehow well equipped with tractor and sprayer than WP.

The average size of holdings in WP is 1.02 hectares comprising of cultivated (operational), cultivable fallow, permanent fallow, home stead, irrigated

and non-irrigated area. In NWP, the average size of holding is 0.77 hectares. It indicates that the size of holdings is lower in WP than NWP. Total cultivated area of the sample farms in watershed area is 100.96 hectares, out of which 22.14 per cent is under pond irrigation followed by 1.88 per cent under canal irrigation, 8.40 per cent under STW, 1.23 per cent under other wells and 3.41 per cent under other sources. The non-irrigated area in WP is 62.95 per cent. In NWP, the total cultivated area is 87.42 hectares of which 26.66 per cent of area is irrigated under different irrigational sources followed by 73.34 per cent under non-irrigation. It indicates that the WP area is well irrigated in comparison to NWP area. This could be attributed to impact of watershed on groundwater augmentation in watershed area.

The important practices recommended under WDP are improved varieties, use of seed-cum fertiliser drill, plantation crop, inter cropping, protective irrigation, agro-horticulture and agro-forestry. The results pertaining to adoption of recommended watershed/agronomic practices for resource conservation and crop production by sample farmers show that about 97 per cent of the farmers in WP area have used improved varieties. 90 per cent of the farmers in WP area have used seed-cum-fertiliser drill. However, the performance in regard to plantation crop, inter cropping, protective irrigation, agro-horticulture and agro-forestry is not good enough. It is evident that only 8.75 per cent of the farmers have adopted plantation crop. Among the seven improved technologies, only two practices viz., use of improved varieties (88.75 per cent) and use of seed-cum-fertiliser drill (80.63 per cent) were adopted by the farmers in NWP area may be due to spill over/demonstration effect of watershed. However, there is no difference in adoption of other recommended technologies in between WP and NWP farmers. It has been worked out that the overall adoption ratio of recommended watershed/agronomic technologies by WP and NWP farmers are 32.95 per cent and 27.68, respectively. It is evident that the quality of land available in WP area

is suitable for agro-forestry and perennials and farmers are relatively more responsive to adoption agro-forestry and perennials.

In the selected watersheds, though WDP was implemented ago, major water harvesting structures such as nala bunds, farm ponds and check dams are functioning well and serving the purpose. However, it has been found that due to lack of awareness, some of the gully checks had removed by the farmers for house construction. However, all check dams in the WP area are functioning well and providing services in the form of groundwater recharge and drinking water of livestock. However, there is no clear evidence of better management and appreciation of common property resource structure in comparison with private property resource structure.

One of the impacts of watershed is increase in area under high value/commercial crops. Ninan (1994) reported that area irrigated from wells increased WDP. Similar trend has been observed in case of selected watersheds. It has been found that the cropping intensity is slightly better in marginal farms in comparison to small and medium farms. The cropping intensities in all categories of farms in WP area are relatively better than that of NWP area. The point should be noted here is that the a sizeable portion (5.63 per cent) of area under perennials of WP reflects the scarcity of water. Therefore, at the event of scarcity of water both in WP and NWP where farmers can shift to perennials as a coping mechanism. In both WP and NWP areas kharif crops occupied the highest percent of area to overcome water scarcity. Considering the total area under irrigation in the selected watersheds only a few portion occupied under summer cultivation. The summer cultivation is somehow better in NWP area. Paddy was the main crop before watershed project. After WDP, there was no evidence of shift in cropping pattern in favour of high value/commercial crops. The soil and moisture conservation (SWC) measures along with improved agronomic practices in WP are expected to have a positive influence on the yield and thereby the returns from

dry land crops. Studies have reported that there was improvement in productivity of dry land crops after WDP (Deshpande and Narayanamoorty, 1999). In the selected watersheds, the yields of the crops had registered a positive change as compared to non-watershed area over past five years. It may be noted that the beneficiary and non-beneficiary households under landless category are actually the seasonal leased-in farmers. They cultivate crops on the basis of seasonal leased-in land. It has been found that average net return among all categories of farms in WP area are far better than that of NWP area.

The contribution of watershed as reflected in gross returns from rainfed crops was considered as the dependent variables, since the watershed impact is direct and implicit. Accordingly, gross returns from rainfed field crops in 2007 was regressed on dry land cropped area in hectares (X_1), human labour (X_2), bullock labour (X_3), seeds in Rs. (X_4) and fertiliser in Rs. (X_5). The adjusted R^2 for the watershed and non-watershed area was 87 per cent and 94 per cent which indicate adequacy of fit of the model.

The regression coefficients are the estimates of the elasticity of production with respect to the independent variables. In WP, elasticity coefficient for human labour, bullock labour and fertiliser are0.02, -0.01 and -0.03, respectively, and are statistically significant at 5 per cent. For land, the elasticity coefficient is 1.01 and significant at 5 per cent. The coefficient for seed is -0.03 and is not significant.

In NWP, variables land and seed are significant and their elasticities are 0.93and 0.07. For human labour, bullock labour and fertiliser, the elasticity coefficients are 0.06, -0.03 and 0.01, respectively and significant at 5 per cent. The returns to scale are 1.01 and 1.04 in WP and NWP areas, implying constant returns to scale. This shows that the production technology used in watershed and non-watershed is scale neutral.

The geometric mean levels of gross returns for WP and NWP sample farms are Rs. 11500.83/- and Rs. 11764.65/-, respectively. The geometric level of inputs

land, human labour and bullock, seed, fertilisers are computed both watershed and non-watershed sample farms as 0.49, Rs. 2300.87/-, Rs. 413.75/-, Rs. 172.43/- Rs. 612.60 and 0.48, Rs. 2302.69/-, Rs. 418.49/-, Rs. 163.07/- and Rs. 617.26/-, respectively in that order.

Groundwater is an important resource in watershed development for productivity, sustainability, livelihoods and equity. Water resource particularly groundwater is viewed as a stock and flow resource. As a stock resource, groundwater is built up over the years in deeper aquifers. Annual availability of groundwater is regarded as a flow resource with steady state of recharge. Very often increase in irrigated area is taken as a success of watershed programme but whether this increase is due to a stock or flow resource is seldom addressed. Groundwater use within the watershed should be planned, as far as possible, within the annual flows or within the annual renewability limits. There may be however be ‘bad’ years when even the domestic water requirements may not be met through annual flows. In such cases water from the ‘stock’ could be used that ‘stock’ is recharged in ‘good’ years.

Management of groundwater aquifer on watershed basis is crucial in hard rock areas as the recharge and depletion of groundwater is quick. In hard rock area the recharge rate is 8-10 per cent of rainfall as the water infiltrate and stored in vertical and horizontal cracks. Wells get recharge within two to three months after good rainfall and also deplete quickly during drought period. Therefore, sustainable management of groundwater on watershed basis needs to be evolved by regulating the well density, water allocation, cropping pattern by considering the rainfall uncertainty. Water harvesting structures augment the recharging of groundwater (flow), thereby improvement in availability of irrigation water.

In watershed area, the major source of irrigation is groundwater from tank/ponds. All tanks were excavated before watershed development programme. The impact of WDP is assessed based on number of irrigation ponds. Another

measure of impact of WDP is the increased water yield in the ponds. However, the average yield of ponds is not available. Out of the 65 total ponds in the selected watersheds, only 4 ponds are non-functional, whereas in NWP area 3 ponds are non-functional out of the 29 ponds. Average water area of the pond in WP area is 0.12 hectare, whereas it is 0.17 hectare in NWP area. The average command area and average depth of the tank in WP area is higher than that of NWP area.

Age and life of ponds and wells in watershed and non-watershed area are the key indicators of impact of watershed on the groundwater recharge. The historical data on irrigation wells indicate that dug well technology became obsolete after 1980s as it did not yield adequate water due to groundwater depletion. Due to influence of water harvesting structures constructed for groundwater recharge, the life of the pond may be increased.

Average age of pond is 38.75 and 45.75 years in case of WP and NWP area, respectively. The shorter life of pond in WP could be attributed to water harvesting structures. The impact of WDP on groundwater recharge enabled farmers to take advantage of the increased life and age in the selected watershed areas to extract higher volume of groundwater. This may result in reduced investment on additional irrigation structures and the associated investment in irrigation.

Most of the soil and water conservation measures serve the purpose of conserving rain or runoff water and it is difficult to separate them and analyse their contribution to groundwater recharge. However, we can broadly divided them into (1) measures that increase in-situ water availability and (2) measures that increase availability of applied water stored off-farm or below the ground. The ubiquitous check dams and nala bunds, diversion channels and all their variants store water on surface or enhance subsurface storage. However, the use of farm ponds is for protective irrigation. The total investment on soil and water conservation structures in the selected watersheds is Rs. 35,52,403/- . The increased availability

of groundwater due to WDP manifests in decreased irrigation cost. The net returns per farm has been observed to be Rs. 189.68/-, Rs. 518.48/- and Rs. 1057.91/- for marginal, small and medium farms, respectively. It has been observed that the cropping intensity decreases with the increase in size of holdings. This may be due to less irrigated area in higher holdings. It has been observed that the decrease in cost of irrigation and corresponding increase in net returns in WP is due to impact of WDP.

A large number of farmers in WP are rearing livestock on a small scale after the WDP. Farmers expressed during the discussion that due to availability of fodder on farm and common lands, the number of bullocks, cows, buffaloes, sheep, goat has increased. The net return from livestock per farm and per acre are Rs. 24.12/- and Rs. 38.22/-, respectively in WP area and Rs. 21.42/- and Rs. 5.15/- in NWP area.

The equity in the distribution of income among different categories of farmers due to WDP has been analysed using Gini coefficients. Gini coefficients are computed for marginal, small and medium farms. Gini coefficients for WP and NWP areas are 0.44 and 0.41 for all farms, respectively. This indicates a fairly equitable distribution of income in WP area than that of NWP area.

The target and achievement with regard to physical and financial components and the expenses in four selected watersheds indicating financial aspects bring in to home that success has been up to the mark in case of entry point activity. Similarly in case of entry point activity, the corpus for WDF, expenses at districts head quarters and training programmes etc. are up to the mark in the selected watersheds.

The performance indicators of the selected watersheds show that more or less cent per cent of the targeted area has been developed and there has been encouraging number of man days have been generated in all the selected watersheds. The additional area brought under cultivation also indicates a growing

trend. Similarly, there are also positive performance with regard to irrigation. A substantial additional areas were brought under supplementary irrigation.

A comparative analysis of the productivity and the area under major crops has also shown a positive trend in all the selected watersheds. Thus, it has been established that watershed development programme has been able to regenerate natural resources including land, forest and water to a large extent and it is playing a crucial role in augmenting agricultural growth, productivity and cropping pattern in West Bengal.

V
SUMMARY AND CONCLUSIONS

5.1 Introduction

Challenges to meet the needs of growing population in a sustainable way require comprehensive insight to ecologically sound agriculture in resources-poor countries. This problem is severe in developing countries with a low growth ratre of 1.7 per cent. It is estimated that population in South Asia will be 1.9 billion in 2020 and of this 1.4 billion will be in India. Hence, there is need to increase the production with limited land and water resources. More than 60 per cent of the cultivated area in India is rainfed. It supports 40 per cent population and contributes 44 per cent to food basket. It contributes 90 per cent of coarse cereals, 90 per cent of pulses, 80 per cent of oilseeds and 65 per cent of cotton in the country. By 2020, about 600 million people would depends on dry land agriculture for livelihood.

Development, promotion and management of appropriate watershed technologies in dry land regions have been viewed as major priorities to ameliorate the problem of natural resource degradation. This results in multiple benefits such as ensuring food security, enhancing viability of farming and restoring ecological balance (Reddy, 2000). The present strategy of watershed development programme is to protect and sustain the livelihoods of resource poor farmers who are experiencing production constraints in addition to problems created by soil erosion and moisture stress. Watershed development is to ensure the availability of drinking water, fuel wood, fodder and helps in raising income and employment for farmers and landless labourers through improvement in agricultural productivity and production (Rao, 2000).

In view of the above, this study has been undertaken to assess the long-term economic impact on agriculture productivity, land use and cover, groundwater

recharge watershed system and sustenance of watershed technologies/practices in West Bengal. The broad perspective of aspects which have been covered in the report are (1) community organisation and institutional aspects, (2) planning aspects, (3) implementation aspects, (4) environmental aspects, (5) social aspects, (6) economic aspects, (7) institutional aspects, (8) indirect benefit, (9) overall impacts and sustainability and (10) people's reaction.

5.2 Data Base and Research Methodology

According to the latest estimate, 18 districts in West Bengal and 21,91,300 hectare of non-forest area of these eighteen districts have been affected by land degradation problems. Firstly, these districts have been sub-divided into two groups on the basis of occurrence of land degradation i.e. below and above the average land degradation of West Bengal. Thus, among these districts twelve districts fall under below and rest six districts under above groups. Four districts (two from each group) i.e. Cooch Behar and Birbhum (from below) and 24-Parganas (North) and 24-Parganas (South) (from above) have been selected randomly. There are six sub-watersheds in Cooch Behar, four in Birbhum, two in 24-Parganas (N) and twelve in 24-Parganas (S) (Table 2.1). In the second stage, one watershed from each selected district has been selected randomly. Phulbari Watershed (Block : Dinhata-I) from Cooch Behar; Kanduri Watershed (Block : Rampurhat-I) from Birbhum; Hizta (Part-II) Watershed (Block : Hasnabad) from 24-Parganas (North) and Masjidbati Watershed (Block : Basanti) from 24-Parganas (South) have finally been selected for in-depth study.

5.3 Main Findings

It is evident that there is no uniformity in family size in between the selected watersheds. The literacy rate is higher among males (82.29 per cent) than females (64.47 per cent). In non-watershed (NWP) area literacy rate is lower for

both male and female at 71.41 per cent and 55.38 per cent, respectively. The size of land holding is 1.02 hectares and 0.77 hectares in WP and NWP, respectively. It has been found that the farmers in NWP are somehow well equipped with tractor and sprayer than WP.

The average size of holdings in WP is 1.02 hectares comprising of cultivated (operational), cultivable fallow, permanent fallow, home stead, irrigated and non-irrigated area. In NWP, the average size of holding is 0.77 hectares. It indicates that the size of holdings is lower in WP than NWP. Total cultivated area of the sample farms in watershed area is 100.96 hectares, out of which 22.14 per cent is under pond irrigation followed by 1.88 per cent under canal irrigation, 8.40 per cent under STW, 1.23 per cent under other wells and 3.41 per cent under other sources. The non-irrigated area in WP is 62.95 per cent. In NWP, the total cultivated area is 87.42 hectares of which 26.66 per cent of area is irrigated under different irrigational sources followed by 73.34 per cent under non-irrigation. It indicates that the WP area is well irrigated in comparison to NWP area. This could be attributed to impact of watershed on groundwater augmentation in watershed area.

It has been observed that there is no difference in adoption of other recommended technologies in between WP and NWP farmers. It has been worked out that the overall adoption ratio of recommended watershed/agronomic technologies by WP and NWP farmers are 32.95 per cent and 27.68, respectively. It is evident that the quality of land available in WP area is suitable for agro-forestry and perennials and farmers are relatively more responsive to adoption agro-forestry and perennials.

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bullock labour (X_3), seeds in Rs. (X_4) and fertiliser in Rs. (X_5). The adjusted R^2 for the watershed and non-watershed area was 87 per cent and 94 per cent which indicate adequacy of fit of the model.

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The geometric mean levels of gross returns for WP and NWP sample farms are Rs. 11500.83/- and Rs. 11764.65/-, respectively. The geometric level of inputs land, human labour and bullock, seed, fertilisers are computed both watershed and non-watershed sample farms as 0.49, Rs. 2300.87/-, Rs. 413.75/-, Rs. 172.43/- Rs. 612.60 and 0.48, Rs. 2302.69/-, Rs. 418.49/-, Rs. 163.07/- and Rs. 617.26/-, respectively in that order.

In watershed area, the major source of irrigation is groundwater from tank/ponds. All tanks were excavated before watershed development programme. The impact of WDP is assessed based on number of irrigation ponds. Another measure of impact of WDP is the increased water yield in the ponds. However, the average yield of ponds is not available. Out of the 65 total ponds in the selected watersheds, only 4 ponds are non-functional, whereas in NWP area 3 ponds are non-functional out of the 29 ponds. Average water area of the pond in WP area is

0.12 hectare, whereas it is 0.17 hectare in NWP area. The average command area and average depth of the tank in WP area is higher than that of NWP area.

Average age of pond is 38.75 and 45.75 years in case of WP and NWP area, respectively. The shorter life of pond in WP could be attributed to water harvesting structures. The impact of WDP on groundwater recharge enabled farmers to take advantage of the increased life and age in the selected watershed areas to extract higher volume of groundwater. This may result in reduced investment on additional irrigation structures and the associated investment in irrigation.

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The equity in the distribution of income among different categories of farmers due to WDP has been analysed using Gini coefficients. Gini coefficients are computed for marginal, small and medium farms. Gini coefficients for WP and NWP areas are 0.44 and 0.41 for all farms, respectively. This indicates a fairly equitable distribution of income in WP area than that of NWP area.

The target and achievement with regard to physical and financial components and the expenses in four selected watersheds indicating financial aspects bring in to home that success has been up to the mark in case of entry point activity. The performance indicators of the selected watersheds show that more or less cent per cent of the targeted area has been developed and there has been encouraging number of man days have been generated in all the selected watersheds. The additional area brought under cultivation also indicates a growing trend. Similarly, there are also positive performance with regard to irrigation. A substantial additional areas were brought under supplementary irrigation.

A comparative analysis of the productivity and the area under major crops has also shown a positive trend in all the selected watersheds. Thus, it has been established that watershed development programme has been able to regenerate natural resources including land, forest and water to a large extent and it is playing a crucial role in augmenting agricultural growth, productivity and cropping pattern in West Bengal.

5.4 Suggestions for Policy Implications

In view of the above, the following suggestions are made for policy implications.

(1) Watershed development programme intervention in natural resource conservation resulted in diversified land use and cover. Therefore, for sustainability of the programme other incentive augmenting rural development programmes could be linked in watershed development programme in phased manner. In the aggregate, the watershed development programme can be considered as an appropriate rural development strategy by implementing all land based rural development programmes under the concept of watershed development programme.

(2) Dry land horticulture component increased and stabilised the net farm returns by improving the socio-economic conditions of marginal and small farmers. Hence, higher budgetary allocation in watershed development programme could be given to dry land horticulture development to maintain the environmental economic goal of maximized net farm income of marginal and small farmers together conserving the ecosystem.

(3) Promotion of local institutions through training and education of members for maintenance of water harvesting structures is crucial for sustainability of the watershed development programme.

(4) Construction of water harvesting structures through watershed development approach enhanced groundwater recharge. Proximity of irrigation ponds to water harvesting structures played a complimentary role in augmenting yield, age and life of ponds. Hence, a large proportion of water harvesting structures preferably located closer to cultivated lands to realize greater economic impact on irrigated farms.

(5) Policy guidelines for institutional mechanisms for management of groundwater as well as assets created under watershed need to be developed.

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Table 1: Socio-economic characteristics of sample farmers of the selected watersheds (beneficiary and non-beneficiary), 2007

Sl. No.	Particulars	Beneficiary	Non-beneficiary
	Birbhum		
1.	Family size (Avg.)	5.25	5.30
2.	Literacy (%)	60.48	61.32
	1. Male	73.33	77.01
	2. Female	47.62	50.40
3.	Avg. land holdings (ha.)*	1.45	1.36
4.	Total number of bullock carts	15	11
5.	No. of Tractors/Power Tillers	0	2
6.	No. of Pump Sets	7	9
7.	Thresher	10	11
8.	Sprayer	5	4
	Cooch Bhear		
1.	Family size (Avg.)	4.85	4.47
2.	Literacy (%)	75.26	70.95
	1. Male	80.37	78.31
	2. Female	68.97	61.04
3.	Avg. land holdings (ha.)*	1.02	.72
4.	Total number of bullock carts	11	9
5.	No. of Tractors	1	2
6.	No. of Pump Sets	13	9
7.	Thresher	15	16
8.	Sprayer	8	12
	24-Parganas (North)		
1.	Family size (Avg.)	4.45	5.65
2.	Literacy (%)	81.36	62.39
	1. Male	87.76	66.67
	2. Female	73.42	58.47
3.	Avg. land holdings (ha.)*	.74	.55
4.	Total number of bullock carts	6	11
5.	No. of Tractors	0	2
6.	No. of Pump Sets	3	2
7.	Thresher	4	3
8.	Sprayer	5	7
	24-Parganas (South)		
1.	Family size (Avg.)	5.13	4.55
2.	Literacy (%)	78.54	51.65
	1. Male	85.58	59.79
	2. Female	71.29	42.35
3.	Avg. land holdings (ha.)*	.87	.43
4.	Total number of bullock carts	3	0
5.	No. of Tractors	0	0
6.	No. of Pump Sets	3	2
7.	Thresher	2	1
8.	Sprayer	2	3
	All		
1.	Family size (Avg.)	4.91	4.99
2.	Literacy (%)	73.75	62.22
	1. Male	82.29	71.41
	2. Female	64.47	55.38
3.	Avg. land holdings (ha.)*	1.02	0.77
4.	Total number of bullock carts	35	31
5.	No. of Tractors	1	6
6.	No. of Pump Sets	26	22
7.	Thresher	31	31
8.	Sprayer	20	26

Table 2: Land use pattern of sample farmers in selected watershed (beneficiary and non-beneficiary), 2007

Sl. No.	Land type	Beneficiary		Non-beneficiary	
		Area	%	Area	%
	Birbhum				
1.	A. Cultivated (Operational)	37.21	64.22	38.93	71.43
	B. Current Fallow*	20.73	35.78	15.57	28.57
	a) Cultivable Fallow	4.83	8.34	4.14	7.60
	b) Permanent Fallow	14.02	24.20	8.82	16.18
	c) Home Stead	1.89	3.26	2.61	4.79
2.	A. Non-Irrigated Area	24.78	66.60	27.96	71.82
	B. Irrigated Area	12.43	33.40	10.97	28.18
	Tank/Pond	6.84	18.38	5.44	13.97
	Canal	2.79	7.50	4.33	11.12
	STW	1.90	5.11	0.00	0.00
	Other Well s	0.27	0.73	0.50	1.28
	Other Sources	0.63	1.69	0.70	1.80
	Cooch Behar				
1.	A. Cultivated (Operational)	24.63	60.31	20.53	71.28
2.	B. Current Fallow*	16.20	39.67	8.28	28.75
	a) Cultivable Fallow	2.66	6.51	0.30	1.04
	b) Permanent Fallow	9.55	23.38	3.76	13.06
	c) Home Stead	4.00	9.79	4.22	14.65
3.	A. Non-Irrigated Area	13.37	54.28	13.57	66.10
4.	B. Irrigated Area	11.26	45.72	6.96	33.90
	Tank/Pond	2.07	8.40	0.20	0.97
	Canal	0.00	0.00	0.00	0.00
	STW	7.02	28.50	5.92	28.85
	Other Wells	0.00	0.00	0.00	0.00
	Other Sources	2.17	8.81	0.84	4.09
	24-Parganas (North)				
1.	A. Cultivated (Operational)	17.62	59.63	13.82	62.96
2.	B. Current Fallow*	11.93	40.37	8.12	36.99
	a) Cultivable Fallow	0.00	0.00	0.00	0.00
	b) Permanent Fallow	8.97	30.36	4.79	21.82
	c) Home Stead	2.95	9.98	3.33	15.17
3.	A. Non-Irrigated Area	12.15	68.96	11.71	84.73
4.	B. Irrigated Area	5.47	31.04	2.11	15.27
	Tank/Pond	5.09	28.89	0.82	5.93
	Canal	0.00	0.00	0.00	0.00
	STW	0.00	0.00	1.19	8.61
	Other Wells	0.32	1.82	0.07	0.51
	Other Sources	0.06	0.34	0.03	0.22
	24-Parganas (South)				
1.	A. Cultivated (Operational)	21.50	61.46	14.14	81.73
2.	B. Current Fallow*	13.49	38.56	3.16	18.27
	a) Cultivable Fallow	0.52	1.49	0.00	0.00
	b) Permanent Fallow	7.87	22.50	0.69	3.99
	c) Home Stead	5.05	14.44	2.47	14.28
3.	A. Non-Irrigated Area	13.32	61.95	10.00	70.72
4.	B. Irrigated Area	8.18	38.05	4.14	29.28
	Pond	7.07	32.88	0.79	5.59
	Canal	0.00	0.00	0.00	0.00
	STW	0.00	0.00	0.00	0.00
	Other Wells	0.51	2.37	2.65	18.74
	Other Sources	0.60	2.79	0.70	4.95

Table 2 contd…

Table 2 contd…

	All				
1.	C. Cultivated (Operational)	100.96	61.41	87.42	71.85
2.	D. Current Fallow*	62.35	38.60	35.13	28.15
	a) Cultivable Fallow	8.01	4.09	4.44	2.16
	b) Permanent Fallow	40.41	25.11	18.06	13.76
	c) Home Stead	13.89	9.37	12.63	12.22
3.	C. Non-Irrigated Area	63.62	62.95	63.24	73.34
4.	D. Irrigated Area	37.34	37.05	24.18	26.66
	Pond	21.07	22.14	7.25	6.62
	Canal	2.79	1.88	4.33	2.78
	STW	8.92	8.40	7.11	9.37
	Other Wells	1.10	1.23	3.22	5.13
	Other Sources	3.46	3.41	2.27	2.77

Table 3: Adoption of watershed/agronomic technologies in selected watershed (beneficiary and non-beneficiary), 2007

Technology	Beneficiary		Non-beneficiary	
	Adopted	%	Adopted	%
Birbhum				
Use of improved var.	40	100.00	40	100.00
Use of seed cum fert. Drill	40	100.00	39	97.50
Plantation crop	3	7.50	2	5.00
Inter cropping	7	17.50	6	15.00
Protective irrigation	2	5.00	2	5.00
Agro-horticulture	2	5.00	0	0.00
Agro-forestry	3	7.50	0	0.00
Total adoption ratio	97/280	34.64	89/280	31.79
Cooch Behar				
Use of improved var.	38	95.00	37	92.50
Use of seed cum fert. Drill	36	90.00	36	90.00
Plantation crop	7	17.50	3	7.50
Inter cropping	9	22.50	8	20.00
Protective irrigation	4	10.00	1	2.50
Agro-horticulture	5	12.50	3	7.50
Agro-forestry	4	10.00	1	2.50
Total adoption ratio	103/280	36.79	89/280	31.79
24-Parganas (North)				
Use of improved var.	39	97.50	34	85.00
Use of seed cum fert. Drill	37	92.50	27	67.50
Plantation crop	1	2.50	2	5.00
Inter cropping	5	12.50	4	10.00
Protective irrigation	0	0.00	1	2.50
Agro-horticulture	5	12.50	2	5.00
Agro-forestry	0	0.00	0	0.00
Total adoption ratio	87/280	31.07	70/280	25.00
24-Parganas (South)				
Use of improved var.	37	92.50	31	77.50
Use of seed cum fert. Drill	31	77.50	27	67.50
Plantation crop	3	7.50	1	2.50
Inter cropping	4	10.00	2	5.00
Protective irrigation	1	2.50	0	0.00
Agro-horticulture	4	10.00	1	2.50
Agro-forestry	2	5.00	0	0.00
Total adoption ratio	82/280	29.29	62/280	22.14
All				
Use of improved var.	154	96.25	142	88.75
Use of seed cum fert. Drill	144	90.00	129	80.63
Plantation crop	14	8.75	8	5.00
Inter cropping	25	15.63	20	12.50
Protective irrigation	7	4.38	4	2.50
Agro-horticulture	16	10.00	6	3.75
Agro-forestry	9	5.63	1	0.63
Total adoption ratio	369/1120	32.95	310/1120	27.68

Table 4: Distribution of land by source of irrigation among sample farmers in selected watershed (beneficiary and non-beneficiary), 2007

Particulars	Beneficiary					Non-beneficiary				
	No. of farmers	%	Area under Irrigation	%	Avg. Farm Size*	No. of farmers	%	Area under Irrigation	%	Avg. Farm Size*
Birbhum										
Dry land	3	7.50	0	0.00	0.58	6	15.00	0	0.00	0.39
Pond	14	35.00	3.52	28.32	1.03	16	40.00	2.71	24.70	0.93
Wells (incl. STW)	6	15.00	1.7	13.68	1.05	-		-		-
Other (incl. Canal)	2	5.00	0.22	1.77	0.62	4	10.00	1.39	12.67	0.7
Ponds + Wells	1	2.50	0.37	2.98	0.67	1	2.50	0.67	6.11	3.33
Ponds + Others	12	30.00	5.42	43.60	0.89	13	32.50	6.2	56.52	1.2
Wells + Others	-		-		-	-		-		-
Ponds+Wells+Others	2	5.00	1.2	9.65	1.1	-		-		
Total (All)	40	100.00	12.43	100.00	0.93	40	100.00	10.97	100.00	0.97
Cooch Behar										
Dry land	5	12.50	0	0.00	0.4	6	15.00	0	0.00	0.08
Pond	2	5.00	0.17	1.51	0.12	-		-		-
Wells (incl. STW)	12	30.00	2.44	21.67	0.43	23	57.50	4.72	67.82	0.62
Other (incl. Canal)	4	10.00	0.7	6.22	0.59	4	10.00	0.5	7.18	0.5
Ponds + Wells	11	27.50	4.52	40.14	0.75	2	5.00	0.37	5.32	0.4
Ponds + Others	-		-		-	-		-		-
Wells + Others	4	10.00	2.39	21.23	1.25	5	12.50	1.37	19.68	0.61
Ponds+Wells+Others	2	5.00	1.04	9.24	0.87	-		-		-
Total (All)	40	100.00	11.26	100.00	0.62	40	100.00	6.96	100.00	0.51
24-Parganas (North)										
Dry land	2	5.00	0	0.00	0	22	55.00	0	0.00	0.2
Pond	32	80.00	4.77	87.20	0.5	8	20.00	0.5	23.70	0.55
Wells (incl. STW)	4	10.00	0.27	4.94	0.17	6	15.00	0.96	45.50	0.5
Other (incl. Canal)	-		-		-	1	2.50	0.03	1.42	0.26
Ponds + Wells	1	2.50	0.1	1.83	0.27	3	7.50	0.62	29.38	0.58
Ponds + Others	1	2.50	0.33	6.03	0.53	-		-		-
Wells + Others	-		-		-	-		-		-
Ponds+Wells+Others	-		-		-	-		-		-
Total (All)	40	100.00	5.47	100.00	0.44	40	100.00	2.11	100.00	0.35
24-Parganas (South)										
Dry land	10	25.00	0	0.00	0.03	16	40.00	0	0.00	0.16
Pond	24	60.00	5.67	69.32	0.6	-		-		-
Wells (incl. STW)	-		-		-	15	37.50	2.13	51.45	0.47
Other (incl. Canal)	-		-		-	-		-		-
Ponds + Wells	2	5.00	0.37	4.52	0.33	4	10.00	0.84	20.29	0.52
Ponds + Others	3	7.50	1.32	16.14	0.8	5	12.50	1.17	28.26	0.51
Wells + Others	-		-		-	-		-		-
Ponds+Wells+Others	1	2.50	0.82	10.02	3.8	-		-		-
Total (All)	40	100.00	8.18	100.00	0.54	40	100.00	4.14	100.00	0.35
All										
Dry land	20	12.50	0	0.00	0.25	50	31.25	0	0.00	0.21
Pond	72	45.00	14.13	37.84	0.56	24	15.00	3.21	13.28	0.37
Wells (incl. STW)	22	13.75	4.41	11.81	0.41	44	27.50	7.81	32.30	0.40
Other (incl. Canal)	6	3.75	0.92	2.46	0.30	9	5.63	1.92	7.94	0.37
Ponds + Wells	15	9.38	5.36	14.35	0.51	10	6.25	2.5	10.34	1.21
Ponds + Others	16	10.00	7.07	18.93	0.56	18	11.25	7.37	30.48	0.43
Wells + Others	4	2.50	2.39	6.40	0.31	5	3.13	1.37	5.67	0.15
Ponds+Wells+Others	5	3.13	3.06	8.19	1.44	0	0.00	0	0.00	0.00
Total (All)	160	100.00	37.34	100.00	0.63	160	100.00	24.18	100.00	0.55

Table 5: Cropping pattern of sample farmers in selected watersheds (beneficiary and non-beneficiary), 2007

(area in ha.)

Particulars	Beneficiary				Non-beneficiary			
	Landless*	Marginal	Small	Medium	Landless*	Marginal	Small	Medium
Birbhum								
Kharif	-	18.10	19.11	-	-	17.88	12.26	8.79
Rabi	-	8.24	3.74	-	-	7.39	2.63	1.48
Summer	-	6.29	3.59	-	-	4.86	5.35	0.80
GCA	-	32.63	26.44	-	-	30.13	20.24	11.07
NCA	-	18.10	19.11	-	-	17.88	12.26	8.79
C. intensity	-	180.28	138.36	-	-	168.51	165.09	125.94
Cooch Behar								
Kharif	0.00	13.55	8.81	2.27	0.00	15.20	5.33	-
Rabi	0.18	12.86	3.95	0.70	0.00	9.36	2.04	-
Summer	0.13	5.16	0.74	0.33	0.00	2.56	1.87	-
GCA	0.31	31.57	13.50	3.30	0.00	27.12	9.24	-
NCA	0.00	13.55	8.81	2.27	0.00	15.20	5.33	-
C. intensity	(-)	232.99	153.23	145.37	0.00	178.42	173.36	-
24-Parganas (North)								
Kharif	0.00	12.69	2.66	2.27	0.00	7.83	6.00	-
Rabi	0.01	2.49	1.28	0.09	0.29	2.39	0.98	-
Summer	0.00	0.34	0.94	0.09	0.00	0.66	0.13	-
GCA	0.01	15.52	4.88	2.45	0.29	10.88	7.11	-
NCA	0.00	12.69	2.66	2.27	0.00	7.83	6.00	-
C. intensity	(-)	122.30	183.46	107.93	(-)	138.95	118.50	-
24-Parganas (South)								
Kharif	0.00	11.03	6.67	3.80	0.00	14.14	-	-
Rabi	0.32	5.39	1.78	0.81	0.00	8.90	-	-
Summer	0.47	3.34	0.00	0.00	0.00	0.78	-	-
GCA	0.79	19.76	8.45	4.61	0.00	23.82	-	-
NCA	0.00	11.03	6.67	3.80	0.00	14.14	-	-
C. intensity	(-)	179.15	126.69	121.32	(-)	168.46	-	-
All								
Kharif	0.00	55.37	37.25	8.34	0.00	55.05	23.59	8.79
Rabi	0.51	28.98	10.75	1.60	0.29	28.04	5.65	1.48
Summer	0.60	15.13	5.27	0.42	0.00	8.86	7.35	0.80
GCA	1.11	99.48	53.27	10.36	0.29	91.95	36.59	11.07
NCA	0.00	55.37	37.25	8.34	0.00	55.05	23.59	8.79
C. intensity	0.00	178.68	150.44	93.66	0.00	163.59	114.24	31.49

Table 6: Cost and returns for field crops in selected watershed (beneficiary and non-beneficiary), 2007

(figures in Rs.'000)

Size-Class	Beneficiary			Non-beneficiary			Absolute change	
	Avg. Gross return	Avg. Total cost	Avg. Net return	Avg. Gross return	Avg. Total cost	Avg. Net return	Avg. Net return	%
Birbhum								
Landless*	-	-	-	-	-	-	-	-
Marginal	31.92	11.24	20.67	30.08	9.65	20.43	0.24	1.17
Small	57.96	19.57	38.39	60.04	28.67	31.37	7.02	22.38
Medium	-	-	-	104.36	39.8	64.57	-	-
Cooch Behar								
Landless*	2.5	0.93	1.57	-	-	-	-	-
Marginal	29.41	12.75	16.66	21.62	8.85	12.77	3.89	30.46
Small	58.03	24.41	33.62	62.95	29.53	33.41	0.21	0.63
Medium	89.17	40.8	48.38	-	-	-	-	-
24-Parganas (North)								
Landless*	0.13	0.05	0.08	0.67	0.14	0.53	-0.45	-84.91
Marginal	10.14	3.57	6.58	13.2	4.65	8.55	-1.97	-23.04
Small	65.00	24.73	40.28	34.58	14.61	19.97	20.31	101.70
Medium	65.83	19.96	45.87	-	-	-	-	-
24-Parganas (South)								
Landless*	2.82	0.95	1.87	-	-	-	-	-
Marginal	18.51	7.41	11.11	17.6	7.59	10.01	1.10	10.99
Small	35.31	17.95	17.35	-	-	-	-	-
Medium	96.61	58.61	38.00	-	-	-	-	-
All								
Landless*	2.34	0.82	1.53	0.36	0.07	0.29	1.24	427.59
Marginal	21.8	8.47	13.34	21.05	7.92	13.13	0.21	1.60
Small	54.16	20.67	33.49	53.61	24.96	28.66	4.83	16.85
Medium	83.87	39.79	44.08	104.36	39.8	64.57	-20.49	-31.73

Table 7: Regression estimates of factors contributing to gross returns from rainfed field crops on sample farms in selected watershed, 2007

Sl. No.	Variables	Beneficiary		Non-beneficiary	
		Coefficient	t stat	Coefficient	t stat
Birbhum					
1.	Log of intercept	4.14	11.19	3.86	12.67
2.	Log of land (acres)	0.89	6.77	0.78	6.65
3.	Log of human labour (Rs.)	0.03	0.31	0.16	1.79
4.	Log of bullock labour (Rs.)	0.01	0.08	-0.02	-0.29
5.	Log of seed (Rs.)	-0.04	-0.36	-0.04	-0.33
6.	Log of fertiliser (Rs.)	0.08	0.89	0.04	0.38
7.	R^2	.87	-	.94	-
9.	Returns to Scale	.97	-	.92	-
Cooch Behar					
1.	Log of intercept	3.70	4.08	3.42	4.50
2.	Log of land (acres)	0.89	3.00	0.74	2.98
3.	Log of human labour (Rs.)	0.08	0.42	0.09	0.84
4.	Log of bullock labour (Rs.)	-0.02	-0.20	0.00	-0.04
5.	Log of seed (Rs.)	0.02	0.09	0.23	2.84
6.	Log of fertiliser (Rs.)	0.12	0.91	0.02	0.15
7.	R^2	.90	-	.96	-
9.	Returns to Scale	1.09	-	1.08	-
24-Parganas (North)					
1.	Log of intercept	3.25	4.73	2.76	6.69
2.	Log of land (acres)	0.65	2.94	0.46	3.39
3.	Log of human labour (Rs.)	0.26	1.75	0.23	2.76
4.	Log of bullock labour (Rs.)	0.11	1.77	0.07	1.79
5.	Log of seed (Rs.)	-0.08	-0.89	-0.07	-0.96
6.	Log of fertiliser (Rs.)	0.01	0.14	0.25	3.24
7.	R^2	.96	-	.98	-
9.	Returns to Scale	.95	-	.94	-
24-Parganas (South)					
1.	Log of intercept	6.39	6.99	4.33	11.09
2.	Log of land (acres)	1.66	5.36	1.03	6.90
3.	Log of human labour (Rs.)	-0.33	-1.78	0.06	0.92
4.	Log of bullock labour (Rs.)	-0.06	-1.08	0.05	1.10
5.	Log of seed (Rs.)	0.03	0.30	-0.09	-1.04
6.	Log of fertiliser (Rs.)	-0.21	-2.52	-0.04	-0.76
7.	R^2	.97	-	.97	-
9.	Returns to Scale	1.09	-	1.01	-
All					
1.	Log of intercept	4.31	15.55	4.14	20.11
2.	Log of land (acres)	1.01	10.98	0.93	13.05
3.	Log of human labour (Rs.)	0.02	0.37	0.06	1.30
4.	Log of bullock labour (Rs.)	-0.01	-0.16	-0.03	-1.20
5.	Log of seed (Rs.)	-0.03	-0.47	0.07	1.36
6.	Log of fertiliser (Rs.)	0.02	0.41	0.01	-0.09
7.	R^2	.93	-	.95	-
9.	Returns to Scale	1.01	-	1.04	-

Table 8: Geometric mean levels of gross return and input use in rainfed field crops on sample farms in selected watershed, 2007

Sl. No.	Variables	Beneficiary	Non-beneficiary
Birbhum			
1.	No. of farms	40	40
2.	Gross returns (Rs.)	20681.97	19333.02
3.	Land (ha.)	0.80	0.74
4.	Human labour (Rs.)	3678.53	3344.16
5.	Bullock labour (Rs.)	618.84	560.86
6.	Seed (Rs.)	258.75	226.13
7.	Fertiliser (Rs.)	918.69	914.09
Cooch Behar			
1.	No. of farms	36	37
2.	Gross returns (Rs.)	10660.04	9877.68
3.	Land (ha.)	0.50	0.43
4.	Human labour (Rs.)	2489.19	2042.07
5.	Bullock labour (Rs.)	414.62	384.18
6.	Seed (Rs.)	187.27	148.19
7.	Fertiliser (Rs.)	677.88	562.45
24-Parganas (North)			
1.	No. of farms	38	26
2.	Gross returns (Rs.)	7463.70	9507.23
3.	Land (ha.)	0.32	0.37
4.	Human labour (Rs.)	1340.51	1714.71
5.	Bullock labour (Rs.)	236.21	337.93
6.	Seed (Rs.)	101.04	128.47
7.	Fertiliser (Rs.)	373.53	462.69
24-Parganas (South)			
1.	No. of farms	32	31
2.	Gross returns (Rs.)	10051.38	9129.59
3.	Land (ha.)	0.44	0.39
4.	Human labour (Rs.)	2225.05	2102.75
5.	Bullock labour (Rs.)	485.60	380.02
6.	Seed (Rs.)	178.46	146.43
7.	Fertiliser (Rs.)	592.73	529.24
All			
1.	No. of farms	146	134
2.	Gross returns (Rs.)	11500.83	11764.65
3.	Land (ha.)	.49	.48
4.	Human labour (Rs.)	2300.87	2302.69
5.	Bullock labour (Rs.)	413.75	418.49
6.	Seed (Rs.)	172.43	163.07
7.	Fertiliser (Rs.)	612.60	617.26

Table 9: Age, depth and yield of irrigation tanks/ponds in selected watershed (beneficiary and non-beneficiary), 2007

BIRBHUM (Tanks/Ponds)			
Sl. No.	Particulars	Beneficiary	Non-Beneficiary
1.	Total	15	4
2.	Functional (Nos.)	13	3
3.	Non-functional (Nos.)	2	1
4.	Avg. Water Area of Tanks (ha.)	0.10	0.11
5.	Avg. Command Area of Tanks (ha.)	0.53	1.81
6.	Average depth (ft.)	6	5.5
7.	Average age (yrs)	30	35
8.	Average life (yrs.)	n.a.	n.a.
9.	Average Yield (gallons/hr)	n.a.	n.a.
COOCH BEHAR (Tanks/Ponds)			
Sl. No.	Particulars	Beneficiary	Non-Beneficiary
1.	Total	7	6
2.	Functional (Nos.)	7	5
3.	Non-functional (Nos.)	0	1
4.	Avg. Water Area of Tanks (ha.)	0.16	0.27
5.	Avg. Command Area of Tanks (ha.)	0.30	0.04
6.	Average depth (ft.)	4.5	4
7.	Average age (yrs)	75	86
8.	Average life (yrs.)	n.a.	n.a.
9.	Average Yield (gallons/hr)	n.a.	n.a.
24 PARGANAS (NORTH) (Tanks/Ponds)			
Sl. No.	Particulars	Beneficiary	Non-Beneficiary
1.	Total	12	3
2.	Functional (Nos.)	12	3
3.	Non-functional (Nos.)	0	0
4.	Avg. Water Area of Tanks (ha.)	0.11	0.17
5.	Avg. Command Area of Tanks (ha.)	0.42	0.27
6.	Average depth (ft.)	4.5	4
7.	Average age (yrs)	25	30
8.	Average life (yrs.)	n.a.	n.a.
9.	Average Yield (gallons/hr)	n.a.	n.a.
24 PARGANAS (SOUTH) (Tanks/Ponds)			
Sl. No.	Particulars	Beneficiary	Non-Beneficiary
1.	Total	31	16
2.	Functional (Nos.)	29	15
3.	Non-functional (Nos.)	2	1
4.	Avg. Water Area of Tanks (ha.)	0.09	0.13
5.	Avg. Command Area of Tanks (ha.)	0.24	0.05
6.	Average depth (ft.)	7	4
7.	Average age (yrs)	25	32
8.	Average life (yrs.)	n.a.	n.a.
9.	Average Yield (gallons/hr)	n.a.	n.a.
ALL (Tanks/Ponds)			
Sl. No.	Particulars	Beneficiary	Non-Beneficiary
1.	Total	65	29
2.	Functional (Nos.)	61	26
3.	Non-functional (Nos.)	4	3
4.	Avg. Water Area of Tanks (ha.)	0.12	0.17
5.	Avg. Command Area of Tanks (ha.)	0.35	0.28
6.	Average depth (ft.)	5.50	4.38
7.	Average age (yrs)	38.75	45.75
8.	Average life (yrs.)	n.a.	n.a.
9.	Average Yield (gallons/hr)	n.a.	n.a.

Table 10: Investment on irrigation wells in selected watershed (beneficiary and non-beneficiary) area, 2007

Birbhum										
Particulars	Beneficiary				Non-beneficiary				Impact of WS	
	Lndls	M	S	Me	Lndls	M	S	Me	Absolute	%
Field crops (ha.)	-	18.10	19.11	-	-	17.88	12.26	8.79	-1.72	-4.62
No. of farmers	-	27	13	-	-	28	9	3	-	-
GCA	-	32.63	26.44	-	-	30.13	20.24	11.07	-2.37	-4.01
No. of failed tanks/ponds	-	1	1	1	-	-	1	-	2.00	66.67
No. of working tanks/ponds	-	6	7	-	-	2	1	-	10.00	76.92
Total no. of tanks/ponds	-	7	8	-	-	2	2	-	11.00	73.33
Cooch Behar										
Particulars	Beneficiary				Non-beneficiary				Impact of WS	
	Lndls	M	S	Me	Lndls	M	S	Me	Absolute	%
Field crops (ha.)	-	13.55	8.81	2.27	-	15.20	5.33	-	4.10	16.65
No. of farmers	4	29	6	1	3	33	4	-	-	-
GCA	.31	31.57	13.50	3.30	.00	27.12	9.24		12.32	25.31
No. of failed tanks/ponds	-	-	-	-	-	1	-	-	-1.00	-
No. of working tanks/ponds	-	5	1	1	-	4	1	-	2.00	28.57
Total no. of tanks/ponds	-	5	1	1	-	5	1	-	1.00	14.29
24-Parganas (North)										
Particulars	Beneficiary				Non-beneficiary				Impact of WS	
	Lndls	M	S	Me	Lndls	M	S	Me	Absolute	%
Field crops (ha.)	-	12.69	2.66	2.27	-	7.83	6.00	-	3.79	21.51
No. of farmers	2	35	2	1	14	21	5	-	-	-
GCA	.01	15.52	4.88	2.45	.29	10.87	7.10	-	4.60	20.12
No. of failed tanks/ponds	-	-	-	-	-	-	-	-	0.00	-
No. of working tanks/ponds		10	1	1	-	3	-	-	9.00	75.00
Total no. of tanks/ponds	-	10	1	1	-	3	-	-	9.00	75.00
24-Parganas (South)										
Particulars	Beneficiary				Non-beneficiary				Impact of WS	
	Lndls	M	S	Me	Lndls	M	S	Me	Absolute	%
Field crops (ha.)	-	11.03	6.67	3.80	-	14.14	-	-	7.36	34.23
No. of farmers	8	26	5	1	9	31	-	-	-	-
GCA	.79	19.76	8.45	4.61	.00	23.82	-	-	9.79	29.13
No. of failed tanks/ponds	-	1	1	-	-	1	-	-	1.00	50.00
No. of working tanks/ponds	-	25	4	-	-	15	-	-	14.00	48.28
Total no. of tanks/ponds	-	26	5	-	-	16	-	-	15.00	48.39
All										
Field crops (ha.)	-	55.37	37.25	8.34	-	55.05	23.59	8.79	13.53	13.40
No. of farmers	14	117	26	3	26	113	18	3	-	-
GCA	1.11	99.48	53.27	10.36	.29	91.95	36.58	11.07	24.33	14.82
No. of failed tanks/ponds	-	2	2	1	-	2	1	-	2.00	40.00
No. of working tanks/ponds	-	46	13	2	-	24	2	-	35.00	57.38
Total no. of tanks/ponds	-	48	15	2	-	26	3	-	36.00	55.38

Table 11: Investment on major water harvesting structure in selected watershed

Birbhum			
Particulars	No.	Unit cost	Total cost
Farm pond	42	11,309.52	4,75,000.00
Nalabunds	2	25,000.00	50,000.00
Check dams	2	57,500.00	1,15,000.00
Total	46	13,913.05	640000.00
Cooch Behra			
Particulars	No.	Unit cost	Total cost
Farm pond	15	30,382.73.00	4,55,741.00
Nalabunds	1	47,600.00	47,600.00
Check dams	2	1,12,031.00	2,24,062.00
Total	18	40,411.28	7,27,403.00
24-Parganas (North)			
Particulars	No.	Unit cost	Total cost
Farm pond	50	19,000.00	9,50,000.00
Nalabunds	1	1,15,000.00	1,15,000.00
Check dams	-	-	-
Total	51	20,882.35	10,65,000.00
24-Parganas (South)			
Particulars	No.	Unit cost	Total cost
Farm pond	127	7,444.44	10,70,000.00
Nalabunds	-	-	-
Check dams	1	50,000.00	50,000.00
Total	128	8,750.00	11,20,000.00
All			
Particulars	No.	Unit cost	Total cost
Farm pond	234.00	12,610.00	29,50,741.00
Nalabunds	4.00	53,150.00	2,12,600.00
Check dams	5.00	77,812.40	3,89,062.00
Total	243.00	14,618.94	35,52,403.00

Table 12: Impact of WDP on irrigated farm economy of selected watershed in 2007

Birbhum				
Particulars	Marginal	Small	Medium	Large
Avg. farm size	.65	1.43	2.93	-
Net irrigated area	12.61	8.72	2.07	-
Cropping intensity	174.45	151.12	124.98	-
Net returns per farm	295.47	585.68	1322.57	-
Cooch Behar				
Particulars	Marginal	Small	Medium	Large
Avg. farm size	.46	1.41	2.27	-
Net irrigated area	12.89	4.47	.86	-
Cropping intensity	225.02	161.69	145.37	-
Net returns per farm	172.377	499.24	639.97	-
24-Parganas (North)				
Particulars	Marginal	Small	Medium	Large
Avg. farm size	.37	1.24	2.27	-
Net irrigated area	5.28	1.77	.53	-
Cropping intensity	133.72	137.33	107.93	-
Net returns per farm	148.81	443.68	1067.61	-
24-Parganas (South)				
Particulars	Marginal	Small	Medium	Large
Avg. farm size	.44	1.33	3.80	-
Net irrigated area	9.70	1.80	.82	-
Cropping intensity	170.49	129.11	121.32	-
Net returns per farm	146.57	366.00	672.18	-
All				
Particulars	Marginal	Small	Medium	Large
Avg. farm size	.4801	1.3827	2.8550	-
Net irrigated area	40.48	16.76	4.28	-
Cropping intensity	177.1844	148.8269	124.9252	-
Net returns per farm	189.6781	518.4834	1057.913	-

Table 13: Livestock assets of sample farmers in selected watershed (beneficiary and non-beneficiary), 2007

Particulars	Beneficiary					Non-beneficiary					Change
	Nos.	Value	Mtc. Cost	GR	NR	Nos.	Value	Mtc. Cost	GR	NR	NR
Birbhum											
Bullocks	48.00	282.50	61.20	409.63	348.43	62.00	349.06	70.18	506.14	435.95	-20.08
Cows	31.00	245.83	60.76	373.66	312.90	33.00	265.06	57.26	402.89	345.63	-9.47
Buffaloes	4.00	49.40	8.40	88.92	80.52	0.00	0.00	0.00	0.00	0.00	100.00
Sheep	18.00	13.41	2.07	21.46	19.39	12.00	7.58	1.16	12.13	10.97	76.75
Goat	56.00	37.24	6.72	65.17	58.45	124.00	79.48	10.29	139.10	128.81	-54.62
Total	157.00	628.38	139.15	958.84	819.69	231.00	701.18	138.90	1060.25	921.36	-11.03
Per farm	3.93	15.71	3.48	23.97	20.49	5.78	17.53	3.47	26.51	23.03	-11.03
Per acre	4.22	16.89	3.74	25.77	22.03	5.93	18.01	3.57	27.23	23.67	-6.93
Cooch Behar											
Bullocks	44.00	278.08	51.35	403.22	351.87	56	338.55	70.28	490.89	420.61	-16.34
Cows	52.00	423.38	96.41	643.54	547.14	34	270.37	67.15	410.96	343.81	59.14
Buffaloes	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	-
Sheep	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	-
Goat	68.00	39.10	5.10	68.43	63.33	57	39.05	5.24	68.33	63.08	0.40
Total	164.00	740.56	152.86	1115.18	962.33	147	647.96	142.67	970.18	827.51	16.29
Per farm	4.10	18.51	3.82	27.88	24.06	3.68	16.20	3.57	24.25	20.69	16.29
Per acre	6.66	30.07	6.21	45.28	39.07	7.16	31.56	6.95	47.26	40.31	-3.08
24-Parganas (North)											
Bullocks	12	75.84	11.18	109.97	98.78	23	149.96	27.46	217.44	189.98	-48.01
Cows	48	408.10	74.16	620.31	546.15	36	316.51	68.29	481.10	412.81	32.30
Buffaloes	0	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	-
Sheep	22	13.79	1.43	22.07	20.64	2	1.45	0.17	2.31	2.15	860.00
Goat	53	38.43	2.92	67.24	64.33	81	54.68	5.83	95.68	89.85	-28.40
Total	135	536.16	89.69	819.59	729.90	142	522.59	101.75	796.54	694.78	5.05
Per farm	3.38	13.40	2.24	20.49	18.25	3.55	13.06	2.54	19.91	17.37	5.07
Per acre	7.66	30.43	5.09	46.51	41.42	10.27	37.81	7.36	57.64	50.27	-17.60
24-Parnagas (South)											
Bullocks	6	38.65	6.87	56.05	49.18	0	0.00	0.00	0.00	0.00	100.00
Cows	102	890.46	156.67	1353.50	1196.83	58	495.44	101.04	753.06	652.03	83.55
Buffaloes	0	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	-
Sheep	22	16.17	1.21	25.87	24.66	16	10.16	0.72	16.26	15.54	58.69
Goat	69	45.20	3.11	79.09	75.99	54	39.15	1.89	68.51	66.62	14.06
Total	199	990.48	167.86	1514.51	1346.65	128	544.75	103.65	837.83	734.19	83.42
Per farm	4.98	24.76	4.20	37.86	33.67	3.20	13.62	2.59	20.95	18.35	83.49
Per acre	9.26	46.07	7.81	70.44	62.63	9.05	38.53	7.33	59.25	51.92	20.63
All											
Bullocks	110	675.07	130.6	978.87	848.26	141	837.57	167.92	1214.47	1046.54	-18.95
Cows	233	1967.77	388	2991.01	2603.02	161	1347.38	293.74	2048.01	1754.28	48.38
Buffaloes	4	49.4	8.4	88.92	80.52	0	0	0	0	0	100.00
Sheep	62	43.37	4.71	69.4	64.69	30	19.19	2.05	30.7	28.66	125.72
Goat	246	159.97	17.85	279.93	262.1	316	212.36	23.25	371.62	348.36	-24.76
Total	655	2895.58	549.56	4408.12	3858.57	648	2416.48	486.97	3664.8	3177.84	21.42
Per farm	4.09	18.10	3.43	27.55	24.12	4.05	15.10	3.04	22.91	19.86	21.42
Per acre	6.49	28.68	5.44	43.66	38.22	7.41	27.64	5.57	41.92	36.35	5.15

Table 14: Gini coefficient of income in selected watershed (beneficiary and non-beneficiary), 2007

Type of farm	Beneficiary				Non-beneficiary			
	Marginal	Small	Medium	All	Marginal	Small	Medium	All
Birbhum	.2403	.2075	0.00*	.3175	.2613	.1900	.1854	.3860
Cooch Behar	.3891	.1027	0.00*	.4468	.3515	.1866	-	.4007
24 parganas (North)	.3814	.1765	0.00*	.4710	.3840	.0566	-	.4114
24 Parganas (South)	.4076	.0568	-.	.4791	.2670	-	-	.2670
All	.3375	.1681	.2791	.4417	.3322	.1635	.1854	.4161

* Single observation

Table 15: Physical and financial achievement of the selected watershed

Sl. No.	Activity	Unit	Physical			Financial (Rs.)		
			Proposed	Achieved	%	Estimated	Actual Exp.	%
Birbhum								
1.	Management Component							
	A.Admn. Cost	-	-	-	-	1,12,500/-	1,12,500/-	100.00
	B.Community Organisation							
	(i) Entry point activity	No.	1	1	100.00	67,500/-	67,500/-	100.00
	(ii) Corpus for WDF	%	1.00	1.00	100.00	22,500/-	22,500/-	100.00
	(iii) Hon.to village community organizer	-	-	-	-	45,000/-	45,000/-	100.00
	(iv) Expenses at District HQ	-	-	-	-	33,750/-	33,750/-	100.00
	C.Training Programme	No.	25	25	100.00	1,12,500/-	1,12,500/-	100.00
2.	Development Component							
	A.Arable land							
	i) Soil & Moisture Conservation	Ha.	11.10	51.10	460.36	50000.00/-	230000.00/-	460.00
	ii) Agronomic Conservation	Ha.	6.70	10.00	149.25	30000.00/-	45000.00/-	150.00
	B.Non-arable land							
	i) Run-off Management	Ha.	25.60	0	-	1,15,000.00/-	0	-
	ii) WHS	Ha.	111.10	122.20	109.99	5,00,000.00/-	5,50,000.00/-	110.00
	iii) Dry-land Horticulture	Ha.	6.70	15.80	235.82	30,000.00/-	71,160.00/-	237.20
	iv) Bio-mas Development	Ha.	22.20	30.90	139.18	1,00,000/-	1,38,850.00/-	138.85
	C. Drainage line treatment							
	Upper reaches	Ha.	22.20	0	-	1,00,000.00/-	0	-
	Middle reaches	Ha.	22.20	20.00	90.09	1,00,000.00/-	90,000.00/-	90.00
	Lower reaches	Ha.	22.20	0	-	1,00,000.00/-	0	0
	Farm Ponds	-	-	-	-	-	-	-
	Water harvesting structure	-	-	-	-	-	-	-
3.	Farm production system for land owing families	HHs	430	429	99.77	450000.00/-	450000/-	100.00
4.	Livelihood support system for landless families	HHs	350	345	98.57	168750.00/-	168750.00/-	100.00

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 16: Physical and financial achievement of the selected watershed

Sl. No	Activity	Unit	Physical			Financial (Rs.)		
			Proposed	Achi-eved	%	Estimated	Actual Exp.	%
Cooch Behar								
1.	Management Component							
	A.Admn. Cost	-	-	-	-	1,12,500/-	1,12,500/-	100.00
	B.Community Organisation							
	(i) Entry point activity	No.	1	2	200.00	67,500/-	67,500/-	100.00
	(ii) Corpus for WDF	%	1.00	1.00	100.00	22,500/-	22,500/-	100.00
	(iii) Hon. to village community organizer	-	-	-	-	45,000/-	45,000/-	100.00
	(iv) Expenses at District HQ	-	-	-	-	33,750/-	33,750/-	100.00
	C.Training Programme	No.	25	25	100.00	1,12,500/-	1,12,500/-	100.00
2.	Development Component							
	A.Arable land							
	i) Construction of Culvert	No.	2	2	100.00	224062.50/-	224000.00/-	99.97
	ii) Construction of Water Retention Structure	No	1	1	100.00	310855.35/-	310800.00/-	99.98
	iii) Excavation of Drainage Channels	Rmt	742	742	100.00	47,600/-	47,600/-	100.00
	iv) Correction of Soil Acidity	No.	200	200	100.00	75,000/-	75,000/-	100.00
	B.Non-arable land							
	i) Construction of WHS	No.	5	5	100.00	196228.57/-	196200.00/-	99.98
	ii) Seedling Distribution	No.	200	200	100.00	90,000/-	90,000/-	100.00
	iii) Culvert for Drainage & Footbridge	No.	1	1	100.00	169642.85/-	169600.00/-	99.97
	iv) Field Bunding	Mouza	1	1	100.00	11,625/-	11,600/-	99.78
	C. Drainage line treatment							
	Upper reaches	-	-	-	-	-	-	-
	Middle reaches	-	-	-	-	-	-	-
	Lower reaches	-	-	-	-	-	-	-
	Farm Ponds	No	15	15	100.00	144186.00/-	144100.00	99.94
	Water harvesting structure	No	0	0	-	0	0	0
3.	Farm production system for land owing families	HHs	460	459	99.78	3,02,500/-	300588.00/-	99.37
4.	Livelihood support system for landless families	HHs	140	140	100.00	168750.00/-	168750.00/-	100.00

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 17: Physical and financial achievement of the selected watershed

Sl. No	Activity	Unit	Physical			Financial (Rs.)		
			Proposed	Achi-eved	%	Estimated	Actual Exp.	%
24-Parganas (North)								
1.	Management Component							
	A.Admn. Cost	-	-	-	-	1,12,500/-	1,12,500/-	100.00
	B.Community Organisation							
	(i) Entry point activity	No.	2	2	100.00	67,500/-	67,500/-	100.00
	(ii) Corpus for WDF	%	1.00	1.00	100.00	22,500/-	22,500/-	100.00
	(iii) Honorarium to village community organizer	-	-	-	-	45,000/-	45,000/-	100.00
	(iv) Expenses at District HQ	-	-	-	-	33,750/-	33,750/-	100.00
	C.Training Programme	No.	25	25	100.00	1,12,500/-	1,12,500/-	100.00
2.	Development Component							
	A.Arable land							
	i) Soil & Moisture Conservation	Ha.	2	2	100.00	25,000.00/-	25,000.00/-	100.00
	ii) Agronomic Conservation	Rmt	868.00	712.00	82.00	150000.00/-	149800.00/-	99.87
	B.Non-arable land							
	i) WHS	No.	50	81	162.00	9,50,000/-	9,48,000/-	99.80/-
	C. Drainage line treatment							
	Upper reaches	-	-	-	-	-	-	-
	Middle reaches	-	-	-	-	-	-	-
	Lower reaches	-	-	-	-	-	-	-
	Farm Ponds	-	-	-	-	-	-	-
	Water harvesting structure	-	-	-	-	-	-	-
3.	Farm production system for land owing families	HHs	320	320	100.00	345000.00/-	345000.00/-	100.00
4.	Livelihood support system for landless families	HHs	145	145	100.00	168750.00/-	167750.00/-	99.41

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 18: Physical and financial achievement of the selected watershed

Sl. No.	Activity	Unit	Physical			Financial (Rs.)		
			Proposed	Achi-Eved	%	Estimated	Actual Expenditure	%
24-Parganas (South)								
1.	Management Component							
	A.Admn. Cost	-	-	-	-	1,12,500/-	1,12,500/-	100.00
	B.Community Organisation							
	(i) Entry point activity	No.	2	3	150.00	67,500/-	67,500/-	100.00
	(ii) Corpus for WDF	%	1.00	1.00	100.00	22,500/-	22,500/-	100.00
	(iii) Hon. to village community organizer	-	-	-	-	45,000/-	45,000/-	100.00
	(iv) Expenses at District HQ	-	-	-	-	33,750/-	33,750/-	100.00
	C.Training Programme	No.	25	25	100.00	1,12,500/-	1,12,500/-	100.00
2.	Development Component							
	A.Arable land							
	i) Periphery Bunding	Rmt	1200.00/-	1460.00/-	121.66	50,000.00/-	43063.00/-	86.12
	B.Non-arable land							
	i) Re-excavation of SWR	No.	100	90	90.00	6,50,000.00/-	6,70,982.00/-	103.22
	ii) New SWR	No.	40	37	92.50	4,00,000.00/-	4,02,500.00/-	100.62
	iii) Dry-land Horticulture	Ha.	3.00	1.00	33.33	25,000.00/-	8455.00/-	33.82
	C. Drainage line treatment							
	Upper reaches	-	-	-	-	-	-	-
	Middle reaches	-	-	-	-	-	-	-
	Lower reaches	-	-	-	-	-	-	-
	Farm Ponds	-	-	-	-	-	-	-
	Water harvesting structure	-	-	-	-	-	-	-
3.	Farm production system for land owing families	HHs	515	509	98.83	400000.00/-	393000.00/-	98.25
4.	Livelihood support system for landless families	HHs	380	387	101.84	168750.00/-	168750.00/-	100.00

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 19: Performance Indicators of the selected watershed

Sl. No.	Item	Details
	Birbhumn	
1.	Name of the watershed	Kanduri
2.	Name of the district	Birbhum
3.	Project cost (in Rs.)	22.50 lakh
4.	Watershed area taken up for development (in ha)	500.00
5.	Area developed (in ha)	495.00
6.	Internal Rate of Return (%)	119.66%
7.	B.C. Ratio	1:1.5
8.	Net project value (NPV) in watershed (in Rs.)	22.50
9.	Agro Forestry	
	(i) No. of seedlings planted	20500
	(ii) No. of seedlings survived	18450
	(iii) Survival percentage (%)	90%
	(iv) Area covered (in ha)	14.4 ha
10.	Horticulture	
	(i) No. of seedlings planted	-
	(ii) No. of seedlings survived	-
	(iii) Survival percentage (%)	-
	(iv) Area covered (in ha)	-
11.	Employment generated (man days)	11526
12.	No. of training conducted	3
13.	No. of persons trained	-
14.	Total fund given to SHG/others	
	(i) SHG	24197.00
	(ii) UG	144553.00
	(ii) MKM	
15.	Additional area brought under cultivation	15 ha
16.	Additional area brought under supplemental irrigation	18 ha

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 20: Performance Indicators of the selected watershed

Sl. No.	Item	Details
	Cooch Behar	
1.	Name of the watershed	Phulbari
2.	Name of the district	Cooch Behar
3.	Project cost (in Rs.)	22.50 lakh
4.	Watershed area taken up for development (in ha)	500.00 ha
5.	Area developed (in ha)	500.00 ha.
6.	Internal Rate of Return (%)	97.54%
7.	B.C. Ratio	1:1.4
8.	Net project value (NPV) in watershed (in Rs.)	22.50
9.	Agro Forestry	
	(i) No. of seedlings planted	-
	(ii) No. of seedlings survived	-
	(iii) Survival percentage (%)	-
	(iv) Area covered (in ha)	-
10.	Horticulture	
	(i) No. of seedlings planted	3800
	(ii) No. of seedlings survived	3694
	(iii) Survival percentage (%)	97.21
	(iv) Area covered (in ha)	HHs distribution
11.	Employment generated (man days)	-
12.	No. of training conducted	6
13.	No. of persons trained	265
14.	Total fund given to SHG/others	
	(i) SHG	67500.00
	(ii) UG	135000.00
	(ii) MKM	-
15.	Additional area brought under cultivation	263 ha.(rabi,summer)
16.	Additional area brought under supplemental irrigation	113 ha.

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 21: Performance Indicators of the selected watershed

Sl. No.	Item	Details
	24-Parganas (North)	
1.	Name of the watershed	Hizla-II
2.	Name of the district	North 24 Parganas
3.	Project cost (in Rs.)	22.50
4.	Watershed area taken up for development (in ha)	500.00
5.	Area developed (in ha)	500.00
6.	Internal Rate of Return (%)	116.63%
7.	B.C. Ratio	1:1.5
8.	Net project value (NPV) in watershed (in Rs.)	22.50
9.	Agro Forestry	
	(i) No. of seedlings planted	1800
	(ii) No. of seedlings survived	1680
	(iii) Survival percentage (%)	93.5%
	(iv) Area covered (in ha)	2.5 ha
10.	Horticulture	
	(i) No. of seedlings planted	-
	(ii) No. of seedlings survived	-
	(iii) Survival percentage (%)	-
	(iv) Area covered (in ha)	-
11.	Employment generated (man days)	24656
12.	No. of training conducted	10
13.	No. of persons trained	1004
14.	Total fund given to SHG/others	
	(i) SHG	267800.00
	(ii) UG	118200.00
	(ii) MKM	-
15.	Additional area brought under cultivation	70 ha
16.	Additional area brought under supplemental irrigation	35 ha

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 22: Performance Indicators of the selected watershed

Sl. No.	Item	Details
	24-Parganas (South)	
1.	Name of the watershed	Masjidbati
2.	Name of the district	South 24 Parganas
3.	Project cost (in Rs.)	22.50
4.	Watershed area taken up for development (in ha)	500
5.	Area developed (in ha)	500
6.	Internal Rate of Return (%)	137.29%
7.	B.C. Ratio	1:1.65
8.	Net project value (NPV) in watershed (in Rs.)	26.16577
9.	Agro Forestry	
	(i) No. of seedlings planted	3500
	(ii) No. of seedlings survived	3317
	(iii) Survival percentage (%)	94.76
	(iv) Area covered (in ha)	1 ha
10.	Horticulture	
	(i) No. of seedlings planted	310
	(ii) No. of seedlings survived	295
	(iii) Survival percentage (%)	95
	(iv) Area covered (in ha)	0.5
11.	Employment generated (man days)	32140
12.	No. of training conducted	14
13.	No. of persons trained	955
14.	Total fund given to SHG/others	
	(i) SHG	168750.00
	(ii) UG	135000.00
	(ii) MKM	
15.	Additional area brought under cultivation	99 ha
16.	Additional area brought under supplemental irrigation	96 ha

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 23: Pre and post scenario of the selected watershed

Sl. No.	Item	Pre project	Post project	% changes
Birbhum				
1.	Productivity of major crops (qt/ha.)			
	Cereals	22.72	25	4.84
	Pulse	0	0	0
	Oilseeds	0	0	0
	Vegetables & Others	110	130	18.18
2.	Major cropped area (in ha)			
	Cereals	390	450	15.38
	Pulse	0	0	0
	Oilseeds	0	0	0
	Vegetables & Others	0	0	0
3.	Cropping intensity (%)	120	0	0
4.	Farm income/ha/year (in Rs.)	0	0	0
5.	Family income/ha/year (in Rs.)	14000	0	0
6.	Migration of rural labour	0	0	0
7.	Green cover/biomass (%)	0	0	0
8.	Ground water level (Meters)	8	0	0
9.	Animal breed improvement	0	0	0
10.	Fodder yield (kg/ha)	0	0	0
11.	Average mil yield (lit/day)	0	0	0
12.	No. of farmers adopted stall feeding	0	0	0
13.	% of run of from the watershed	0	0	0

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 24: Pre and post scenario of the selected watershed

Sl. No.	Item	Pre project	Post project	% changes
Cooch Behar				
1.	Productivity of major crops (qt/ha.)			
	Cereals	45	60	33
	Pulse	0	0	0
	Oilseeds	0	0	0
	Vegetables & Others	8	15	87.5
2.	Major cropped area (in ha)			
	Cereals	413	478	15.7
	Pulse	0	0	0
	Oilseeds	0	0	0
	Vegetables & Others	20	170	750
3.	Cropping intensity (%)	150	173	23
4.	Farm income/ha/year (in Rs.)	0	0	0
5.	Family income/ha/year (in Rs.)	0	0	0
6.	Migration of rural labour	120	62	51
7.	Green cover/biomass (%)	75	95	20
8.	Ground water level (Meters)	6	5	16.6
9.	Animal breed improvement	0	0	0
10.	Fodder yield (kg/ha)	0	0	0
11.	Average mil yield (lit/day)	0	0	0
12.	No. of farmers adopted stall feeding	0	0	0
13.	% of run of from the watershed	75	30	45

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 25: Pre and post scenario of the selected watershed

Sl. No.	Item	Pre project	Post project	% changes
24-Parganas (North)				
1.	Productivity of major crops (qt/ha.)			
	Cereals	25	31.5	26
	Pulse	0	0	0
	Oilseeds	0	8.0	0
	Vegetables & Others	0	0	0
2.	Major cropped area (in ha)			
	Cereals	380	380	0
	Pulse	0	0	0
	Oilseeds	30	65	120
	Vegetables & Others	0	0	0
3.	Cropping intensity (%)	112	148	0
4.	Farm income/ha/year (in Rs.)	12500	25000	100
5.	Family income/ha/year (in Rs.)	8250	15000	81.81
6.	Migration of rural labour	87	45	95
7.	Green cover/biomass (%)	12.5	42.5	37.5
8.	Ground water level (Meters)	0	0	0
9.	Animal breed improvement	0	0	0
10.	Fodder yield (kg/ha)	-	3250	0
11.	Average mil yield (lit/day)	1	2.5	150
12.	No. of farmers adopted stall feeding	-	17.5	0
13.	% of run of from the watershed	22.5	75	0

Source: SCO, Dept. of Agril., Govt. of West Bengal

Table 26: Pre and post scenario of the selected watershed

Sl. No.	Item	Pre project	Post project	% changes
24-Parganas (North)				
Sl. No.		Pre project	Post project	% changes
1.	Productivity of major crops (qt/ha.)			
	Cereals	35.13	38.05	8
	Pulse	7.8	8.5	9
	Oilseeds	10.5	11.9	13
	Vegetables & Others	13	13.35	3
2.	Major cropped area (in ha)			
	Cereals	317	412	30
	Pulse	12	35	192
	Oilseeds	19	41	116
	Vegetables & Others	26	60	114
3.	Cropping intensity (%)	120	140	17
4.	Farm income/ha/year (in Rs.)	12000	24000	100
5.	Family income/ha/year (in Rs.)	8500	15400	81
6.	Migration of rural labour	116	34	
7.	Green cover/biomass (%)	17.5	52.5	
8.	Ground water level (Meters)	3	3	
9.	Animal breed improvement	2	31	1450
10.	Fodder yield (kg/ha)			
11.	Average mil yield (lit/day)	1	2.5	150
12.	No. of farmers adopted stall feeding	-	45	0
13.	% of run of from the watershed	19	3	-

Source: SCO, Dept. of Agril., Govt. of West Bengal