LOCAL STAKEHOLDERS PARTICIPATION FOR SMALL SCALE WATER RESOURCES MANAGEMENT IN BANGLADESH

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ABSTRACT

As a lower riparian country Bangladesh is largely dependent on 57 transboundary rivers. The upstream courses of these river systems traverse India, China, Nepal, Bhutan and Myanmar. Each day, approximately 3,000 million cubic meters of water discharge into the Bay of Bengal through these rivers. However, flows are much lower during the dry season when surface water is critical to such uses as irrigation, salinity control, habitat preservation, effluent dilution and navigation. Unilateral diversion of water from the transboundary rivers impedes agricultural development using irrigation-fertilizers-modern varieties technology. Thus, sustainable irrigation system is instrumental for the growth of food production. For this, peoples' participation is prerequisite to form social capital in building consensus about the irrigation water uses. Local Government Engineering Department (LGED) has developed a model to facilitate sustainable use of water resources and demonstrated its effectiveness for irrigation management. It develops stakeholders-driven water infrastructure in subprojects each covering 1,000 ha or less. LGED involves local people in subproject planning, design, construction and operation and maintenance (O&M). It has constructed 320 subprojects under the Small Scale Water Resources Development Sector Project. Case study in a subproject in northwestern part of the country found that local stakeholders' participation in managing water resources and operation of water control infrastructure results in excellent performance of irrigation system and improvement of distribution system. This raises irrigation efficiency with productive use of water and releases constraints on land use through facilitating cultivation in three crop seasons and increases the proportion of irrigated area under small farms.

INTRODUCTION

With frequent flooding and drought in Bangladesh, sustainable water resources management is instrumental for rural development. It continues to play a significant role in attaining food security, employment generation, and reducing poverty in the country. The water resources management activities in the country include flood control (FC), drainage (D) and irrigation (I). The FCD developments include embankments, floodwater control and drainage structures and pumps. The irrigation developments with FCD include primary pumping plants, gravity diversion and secondary lift by low-lift pumps and non-mechanized or traditional irrigation by indigenous methods. FCD protects 3.40 million ha and 0.95 million ha is irrigated with FCD (Khan, 1993).

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The foodgrain production plan of the Government lays major emphasis on development, control and efficient utilization of water resources. This involves both structural and non-structural measures. World Bank (1992) suggests that flood control investments prove to be an appropriate means if Bangladesh wishes to maintain self-sufficiency or surplus of food in the longer run. Of 7.6 million ha of cultivated land under flooded condition, 55.0% is economically feasible for providing improved water control with new flood and drainage managements (BBS, 2004 and Nishat, 1988). Furthermore, WARPO (1991) suggests that irrigable area could possibly be increased through investment in FCD. It was estimated that FCDI could raise the crop area by 1.8 million ha with increase in land use intensity. Since temperatures in the country are suitable for the growth of crops throughout the year, FCDI release the constraints on land use through facilitating cultivation in three seasons on the same land (Islam and Islam, 2001).

The performance of FCDI systems often remained below expectations (Chowdhury, 1988). Many of the earlier FCDI projects were not productive. There has been a serious lack of adequate maintenance and widespread failure of project structures (MPO, 1991). The major cause was identified to address issues related to local participation and distribution of responsibilities between national and local governments in the process of implementation (EIP, 2000). The projects focused mostly on the structural design and inputs from the target beneficiaries were inadequate. Consequently, the project objectives for sustainable water resources management to increase agricultural production were rarely achieved. Accordingly, local stakeholders participation has been recognized as prerequisite for the formation of social capital to build consensus about the use of water resources (Lutz *et al*., 1998). The present study examines LGED experiences on sustainable water resources management involving local stakeholders in Bangladesh.

MATERIALS AND METHODS

The study was carried in 320 subprojects implemented by LGED under SSWRDSP. It was based on information from primary and secondary sources. The primary sources include case study through field visits, household survey and beneficiary interviews. State of participatory water resources management were examined in all the study subprojects at least one year after the construction of physical works. Impacts of participatory water resources management on agriculture and fish production were assessed in 280 subprojects at least two year after the construction. Non-governmental organization (NGO) field workers were involved in the surveys and interviews. Pre-subproject information was collected from secondary sources. These included subproject appraisal and feasibility study and project final report (IWRMU, 2006; SSWRDSP, 2003 and 1994).

RESULT AND DISCUSSION

Participatory Small Scale Water Resources Management

Taking lessons from the performances of the earlier water resources development projects, LGED facilitates sustainable management of water resources with the participation of local stakeholders along with local government institutions involving public and private sectors,

communities and individuals in the implementation of SSWRDSP. The Project is consistent with the National Water Policy that has defined the role of the local government institutions and given the mandate of implementing FCDI projects having command areas of 1,000 ha or less.

Participatory Approaches

The primary objective of the participatory water management in the SSWRDSP is to intensify land use and increase in agricultural and fisheries production, employment opportunities and income for rural people. The increase in on-farm activities are to be achieved by removing constraints associated with water resources use. This involves controlled flooding, drainage improvement, floodwater conservation, and irrigation command area development at the union (lowest administrative unit of the local government institution comprising several villages) level. The sustainability is to be ensured by establishing stakeholder-driven water management.

Components

The participatory water management in each subproject consists of three components:

I. Beneficiary participation and WMA development: Mobilizing beneficiaries to participate in the selection, design, implementation and O&M of small scale water resource development system through local government institutions and NGOs.

II. Construction of small scale water resource management systems: Intended for flood control, drainage improvement, water conservation and command area development. This includes agricultural development through appropriate agricultural extension activities, landless access to public water bodies to increase fish production, and environmental monitoring.

III. Institutional strengthening for small scale water resource development: Focused on capacity building of relevant stakeholder organizations, including LGED at the national, zila (district) and upazila (sub-district) levels and key governmental organizations at union and sub-district levels to ensure adequate support for small scale water resource development.

Participatory Process

The overall participatory process in subproject development adopted by the LGED is a combination of two parallel but interrelated processes: one that addresses "Institutional" matters, and the other that addresses "Technical" matters. The institutional matters include subproject identification by the local people and submission through local government institutions, analysis to establish social and environmental acceptability, formation and registration of WMA, and preparation of O&M, agriculture, fisheries and resources mobilization plans. The technical matters include development of information database, subproject processing, analysis to establish technical and economic feasibility, preliminary design, detailed design, contractual process, construction and one year trial operation. The whole cycle of subproject development process is sub-divided into three stages.

Stage 1: Identification and Feasibility. In consultation with local stakeholders, the union parishad (council) initiates subproject proposal. The LGED Sub-district Engineer submits it to the Sub-district Development Coordination Committee for approval. If approved, the proposal is forwarded to the Project Management Office through the LGED Executive Engineer at the district level. The Project Management Office pre-screens the proposal during a multidisciplinary field reconnaissance. This is followed by (i) participatory rural appraisal and (ii) feasibility study. Each subproject is reviewed and approved by District Level Inter-Agency Project Evaluation Committee (DLIAPEC).

Stage 2: Design and Institutional Establishment. Subproject design is prepared and the process of establishing WMA is initiated under the legal framework of the Cooperative Societies Act. Contracted NGO facilitator creates awareness, generates local enthusiasm in the local water resource systems, promote membership enrolment, assist in collection of beneficiary contributions, and conflict resolution. The WMA is registered with the Department of Cooperatives (DOC) and becomes Water Management Cooperative Association (WMCA). The Project Management Office undertakes engineering design work in consultation with stakeholders and discusses for their approval. This process culminates in the signing of a formal implementation agreement by the WMCA, union council and LGED Executive Engineer at district level before tendering for the works or contracting labor societies. To sign the implementation agreement, the WMCA must have achieved enrolment of at least 70.0% of beneficiary households, collection of beneficiary contributions equivalent to an annual O&M requirement and deposited in a joint account by LGED and the WMCA, and approved plans in consultation with people-affected by the environmental mitigation and resettlement.

Stage 3: Construction and First Year O&M. Subproject infrastructure is handed-over to the WMCA one year after completion. The WMCA forms O&M sub-committee and prepares schedule, beneficiary list and maps, and plan comprising operating guidelines, and maintenance and resource mobilization plans. The Project Management Office provides on-the-job training that helps WMCA to (i) undertake annual inspection, (ii) identify maintenance needs, (iii) prepare and implement annual O&M plan, and (iv) collect O&M fees. After this, the WMCA enters into a formal lease agreement with LGED. The WMCA receives support of agricultural extension and fisheries departments to prepare agriculture and fisheries development plans and to organize trainings and demonstrations for WMCA representatives who work as liaison extensionists to the subproject beneficiaries.

Water Resources Development

LGED has implemented 280 subprojects under the first phase of the Project (SSRDSP-1) during 1995 to 2002. It implements 300 more subprojects since July 2002 under the second phase of the Project (SSWRDSP-2) to benefit 180,000 ha throughout the country. Each subproject benefits 1,000 ha or less area where the productivity of land was low due to unmanaged water resources and number of marginal, small and landless farmers was higher. The following discussion on the water management activities is based on the experience in the 280 subprojects implemented under SSWRDSP-1 and 40 subprojects completed under SSWRDSP-2.

In 320 subprojects, 663 hydraulic structures (regulators, sluices, water retention structures, culverts, siphons, and aqueducts), 988 km of embankment and 18 km of irrigation canal have been constructed and 1,406 km of drainage channel has been re-excavated. Based on the use of these infrastructures for water management, the subprojects can be categorized into command area development (CAD), drainage and water retention (DWR), flood control and drainage (FCD) and flood control, drainage and irrigation (FCDI) type (Table 1). The subprojects cover about 239,500 ha and benefit 187,300 ha of cultivated land. Of the total subprojects, about 61.9% control flood and improve drainage covering almost two-thirds of the cultivated land. The remainders benefit 35.5% cultivated land through irrigation development with or without flood control and drainage.

Table 1.Water Resources Development Benefit Area

Subproject		Area		Infrastructures		
Type	No.	Gross (ha)	Benefit (ha)	Structures (no.)	Embankment/ Canal (km)	Re-Excavated Channel (km)
CAD	5	2453	2076	15	18	1
DWR	43	33382	24553	32	4	460
FCD	198	150871	120706	401	904	361
FCDI	74	52784	39933	215	80	584
Total	320	239490	187268	663	1006	1406

Stakeholders Participation

LGED has brought various local stakeholders including all types of farmers together in subproject O&M. The WMCA established at each subproject plays a fundamental role to functionally represent beneficiaries in all processes of the subproject cycle. The stakeholders' participation includes the following institutional and O&M activities in the subprojects areas.

Membership: The WMCAs provide an excellent means to address the needs of a range of special interests. The membership in 320 WMCAs consists of 96,147 males and 32,298 females from an estimated total of 162,958 households. Average membership covers about three-forth of the total households in the subproject areas. The members include marginal, small, medium and large farmers; landless; women and fishers. Women comprised one-third of the management committee of each of the WMCAs and about 25.1% of the total membership.

Capital: These WMCAs have established a capital base in all subprojects through shares and savings by the members. In 320 subprojects, the capital reached Taka 48.9 million (US$0.75 million). The capital is being used to support micro-credit, procurement of agricultural inputs, and other small-scale business enterprises operated by the individual WMCA. The WMCAs have set up micro-credit programs and have loaned to 19,694 male and 8,631 female members. The average size of each loan is about Taka 3,010 (US$46). Since the capital formation the cumulative investments of the WMCAs accrued to Taka 85.3 million (US$1.3 million). The Department of Cooperatives inspects and audits the accounts of the WMCAs. The WMCA members have increased their income with investment of micro-credit on quality seed

production, poultry farming, milking cow, beef fattening, vegetable production, aquaculture and seasonal crop storage,

Capability Development**:** The WMCAs members are provided with training to increase their capability in institutional management, capital formation, credit management, agricultural and fisheries production planning, environmental management and subproject O&M. Relevant departments and institutes support the project in training need assessments and organization. LGED has signed memorandum of understanding with the Departments of Cooperatives, Agricultural Extension, Women Affairs, Fisheries and Livestock Service and Ministry of Land to support the subproject beneficiaries. They support WMCAs in institutional strengthening, financial management, use of water bodies, preparation and implementation of agricultural and fisheries production plans and adoption of improved farm practices.

O&M Activities: The WMCAs prepare annual O&M plans and budget and mobilize local resources for the O&M costs. Each WMCA collects annual O&M fund from the farmers at the rate of 3.0% and 1.5% of the total cost for the subproject earthworks and hydraulic structures, respectively. In 2005-2006, the WMCA O&M budget amounted to Taka 17.4 million (US$268,000) and fund utilization was Taka 9.7 million (US$149,000) in 320 subprojects. The O&M fund included voluntary labor contribution.

Impacts

Crop production: Participatory water resources management has generated local enthusiasm for each water resource system. Farmers access to information and their influence on the subproject O&M have increased. This has created opportunity to expand cropped area and increase cropping intensity. Improved water management by the beneficiaries has also resulted in the diversification of crop with the increase in cereal and non-cereal crop area. According to the effect monitoring of 280 subprojects in 2004, the annual cereal production has increased by 242,000 tons and non-cereal production by 157,000 tons. Increase in cereal production is due mainly to cultivation of more rice in the monsoon and maize in the pre-monsoon and wheat in the dry season. On the other hand, more pulse, oilseed, vegetable and spice cultivation in the dry season increases non-cereal production. In Bangladesh, drainage improvement and floodwater control and conservation release the constraints on land use through facilitating cultivation in three crop seasons in the year (Islam and Islam, 2001). This enables small farmers to include cash (non-rice) crops in crop patterns and permits double or even triple cropping on the same land.

Fish production: Subproject design with proper control of the depth and duration of flooding and floodwater conservation ensures growing condition for crops while allowing fish migrate to and from floodplain spawning and feeding areas to effectively minimize impediments to growth of fish population in the subproject areas. This increased annual fisheries production in floodplains by 300 tons and in permanent water bodies by 1,300. Open water fisheries in floodplains and permanent water bodies are the major sources of fish in rural areas. The floodplains include lowland cropped areas where the seasonal flooding depth is more than 90 cm. The permanent water bodies include perennially flooded depressions and river and drainage channel beds.

Labor Employment

Implementation of subprojects increases employment opportunities. The employment related to subproject earthworks is provided to local landless people. Farming in subproject areas is now more labor intensive with year-round demands. Subproject O&M activities also require additional laborers. The Government land (including water bodies), embankments and channels are leased to the WMCA, which promotes income-generating activities for the poor. It was estimated that the annual labor employment increased by 5.3 million person-days in crop production, by 0.26 million person-days in fish production and by 5,700 person-days for subproject O&M.

PROCESS OF WMA: A CASE STUDY

The following case study demonstrates the process of organizing WMA at local level for water resources management. The case study was carried out in Agrani subproject implemented by LGED under the SSWRDSP-1 in the northwest region of the country.

Agrani Subproject

This subproject covers a gross area of 685 ha on the left bank of the Mahananda River between latitude 24°34'and 24°37' North and longitude 88°17' and 88°20' East. It is located in the Zhilim union of Sadar sub-district in Chapai Nawabganj District. Mean annual rainfall in this district is about 1,300 mm. Net cultivated land in the study subproject covers 557 ha. Transplanted aman rice is grown under the rainfed condition in the monsoon season. Flooding often damages the crop. Soils are poorly drained in the rainy season and become very dry during post-monsoon to dry season. These soils are suited for rice cultivation with irrigation. Cultivation of transplanted boro (winter) rice with irrigation in the dry season is the predominant landuse. The crop environment during the dry season is favorable for high solar radiation and evapotranspiration rate, low temperature, and wide variation in day and night temperature. Productivity of the winter rice in this season has grown fastest with the use of modern inputs. Fertilizer responsive modern varieties have adapted to those lands having good irrigation systems. The Mahananda River is the source main source of irrigation water.

The Mahananda River

The Mahananda River originates in the Darjeeling Hills in the extreme northern part of West Bengal state in India (Garrett, 1910 and Islam, 1978). In Bangladesh, the River flows through Chapai Nawabganj district which include the study subproject and meets the Ganges River in neighboring Rajshahi district in the northwest region of Bangladesh (BWDB, 1988 and Rashid, 1991). The barrage across the River in the West Bengal, divert maximum flows through the main canals for fulfilling irrigation and hydropower requirements (Majumder, 2005). It also regulates flood flows. The conveyance and distribution systems are designed on the basis of peak irrigation requirements in the post-monsoon period. The use of the Mahananda River flow is even limited to fulfilling the agreed share of the neighboring Bihar state in India. As a lower riparian country, Bangladesh is largely dependent on transboundary rivers for the management of

its water resources. In recent years, increase rice production on the Mahananda River basin indicates that irrigation demands could exceed the water availability in the river. Moreover, water shortages are often compounded by inefficient uses.

Pre-Subproject Situation

The irrigated area covered 44.2% of the net cultivated or potential irrigable area. The subproject area is elevated and pumping up water for irrigation from the Mahananda River on the northwest involves a high lift. In the past, flow in the Mahananda River was adequate to meet the irrigation requirements. However, unilateral withdrawal of water by India upstream reduced the flow in the dry season since the 1980s. During the period of April-May when irrigation requirement reached peak, 80.0% dependable water level was found to be 12.5 m in some years. The level was not sufficient to allow pumping from the shore with full capacity. The concern grew stronger as frequent drought in the post-monsoon season required supplementary irrigation. This led to efficient use of water on irrigated land. The techniques available for irrigation included practices such as lifting water from the Mahananda River to provide on adjacent lands directly by 300 m brick-lined canal and to conserve in a manmade reservoir for second lifting using low-lift pumps to irrigate crop on distant highlands through 1,500 m earthen canal. The double-lifting irrigated lands covered 65.0% of the total irrigation area. Irrigation was uneconomical in the double lifting lands for high operation cost, inadequate section of the earthen canal and excess water loss. However, farmers had no choice because rice production in the monsoon season was uncertain both for flooding and drought. There was little incentive for these farmers for high irrigation costs and low production. Moreover, farmers were more concerned with poor credit availability, which made difficult to procure quality seeds, fertilizers and other inputs. Since water was irrigated through earthen canals, farmers were worried about water shortage during the peak season, decrease in water level in the reservoir and low flow in the Mahananda River. The local people had no idea how to solve the problem.

Organization to deal with the problem was initiated by local people interested for water management. A committee was formed with representatives from the farmers on highlands and lowlands from adjoining and distant areas. The committee in consultation with the union council, agricultural extension agent and community leaders familiar with local water resources approached government departments for intervention. Simultaneously, the committee attempted to improve water management. They focused on the inadequate water availability, water losses, low coverage and high irrigation costs. The strategy of the committee was to reduce irrigation cost with more area under irrigation using the available water resources. The committee actively tried to achieve these goals. Expansion of existing command area through level fields, earthen canals, rotational irrigation and other appropriate methods was attempted. The committee rented a floating pump with 12.5 cusec capacity. With this total irrigation capacity of the pumps reached to 27.5 cusec. The floating pump helped to lift water with full capacity throughout the year. However, damage of the brick-lined canal, second lifting and distribution of water by earthen canal would still cost irrigation high. Moreover, water demand in the dry season by the winter rice growers was difficult to meet for the inadequate conveyance capacity of the damaged canals.

Subproject Construction

In 1996, the committee approached LGED district office at Chapai Nawabganj through their union council to improve irrigation facilities and increase area under irrigation. The subproject was reviewed and approved by the sub-district and district level committees. The subproject beneficiaries deposited 10.0% of the construction cost to the LGED district office as required for subproject construction. The SSWRDSP-1 design called for beneficiaries to contribute to capital costs at a rate that was approximately equivalent to one years O&M. The beneficiary contribution was collected prior to signing the implementation agreement. According to total households along with the amount of land they own within the subproject area were identified and listed. The beneficiary contribution was then collected on the basis of the land owned by the individual beneficiaries and deposited to a bank account opened by LGED. It was later credited to the subproject for construction of the physical works. A feasibility study was carried out by the LGED. Design of irrigation water distribution was initiated after the subproject was found to be feasible. The subproject construction started in 1996. The physical works included 4,055 m main lined canal, 750 m branch lined canals, two siphons, three aqueducts, one sluice and four culverts. The construction required Taka 22.6 million (US$0.42 million).

Beneficiaries Organization: The LGED Socio-economist at district and Community Organizer at sub-district offices brought local stakeholders together with the formation of a WMA in the subproject area. An NGO Facilitator was employed in subproject area to organize the local stakeholders and strengthen the WMA. It was registered to Department of Cooperative in 1997 and called as Agrani subproject WMCA. The WMCA members included the people who benefited directly or indirectly by the irrigation in the subproject area. The WMCA has now 855 members including 186 women from 62.0% of 1,379 households in the subproject area. It has developed own capital with shares and savings by the members. The capital now reached Taka 233,290 (US$3,500). The WMCA has introduced micro-credit program. It disbursed Taka 1.1 million (US$16,000) among 415 male and 64 female loan recipients in 2006.

Subproject Benefit

The subproject construction works completed in 1998 and operation started in the dry season of the following year. The irrigation area increased from 246 ha to 537 ha occupying 96.4% of the net cultivated area in 2005. This required increase in pump capacity to 43 cusec (1.14 cumec). Single lifting area now covers 78.8% of the irrigation area and double lifting is practiced in 21.2%. Irrigation expenditures reduced particularly for the increase in irrigation area and decrease in diesel procurement and canal repairing costs (Fig. 1). Occasional rainfalls in the late dry or early pre-monsoon season further reduce the expenditures as in 2001. The water users now pay 16.0% less for irrigation to their lands compared with that required during the pre-subproject period. The WMCA plans to expand irrigation area with the increase in canal lengths using the excess fees. Accordingly, irrigation fees are collected at higher rate than the actual expenditures.

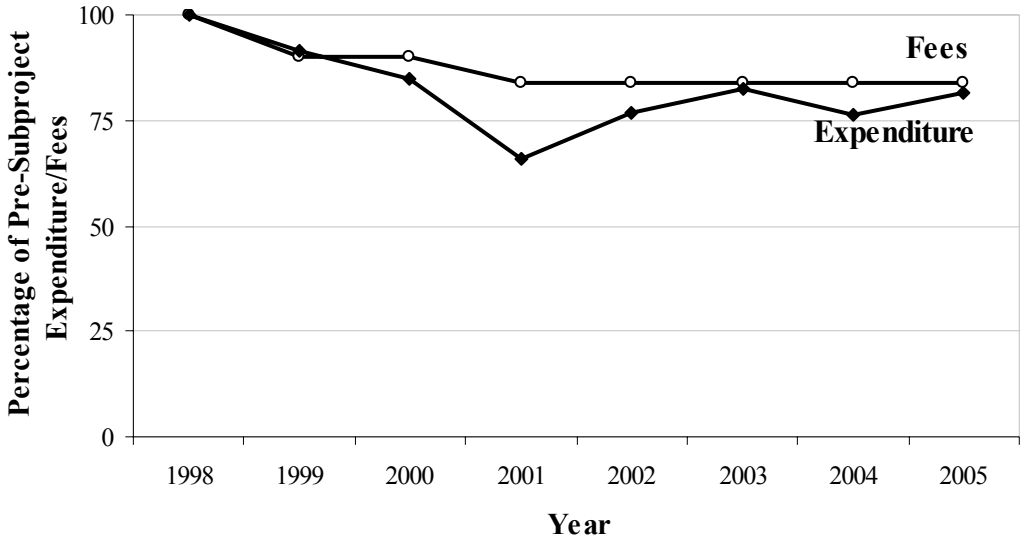

Figure 1. Changes in per ha irrigation expenditures and fees (dry season)

Single lifting now helps more farmers obtain higher income from irrigated crops. Moreover, low irrigation cost enables farmers to use inputs at recommended rate and increase output per unit area. In a field study in 1999, it was observed that per ha Taka 29,280 (US$540) was required in double lifting irrigation area to produce modern variety of rice crop in the winter season (Fig. 2). The production cost for the same crop was Taka 26,680 (US$490) per ha in single lifting irrigation area. The irrigation charge accounted for 30.4% of the crop production cost in the double lifting area and 14.0% in the single lifting area.

LGED entered into a formal lease agreement with WMCA to take full responsibility for the O&M of the irrigation system. The purpose was to ensure that sufficient ownership of subproject infrastructure had been established and to create a basis on which the O&M responsibilities would become that of the local stakeholders. The lease agreement was signed in 1999, one year after physical construction had been completed to allow for a trial O&M period during which defects were identified and rectified. LGED managed staff, local stakeholders and union council members received training under the capacity building program to establish and nurture WMCAs that have the capability and the interest to undertake long-term and sustainable O&M of the irrigation infrastructures. The WMCA management committee prepares annual O&M plan and budget and mobilizes local resources for the O&M costs. The agricultural sub-committee prepares and implements annual crop production and water distribution plans. The O&M sub-committee is responsible for the implementation of annual plan and collection and utilization of O&M funds. Annual O&M fund collection was Taka 400,000 (US$6,100) in 2005. LGED delivers comprehensive training programs with improved training materials to WMCA management committee, agricultural and O&M sub-committees and general members including beneficiary farmers.

Per hectare production cost for irrigated winter rice (modern variety) production

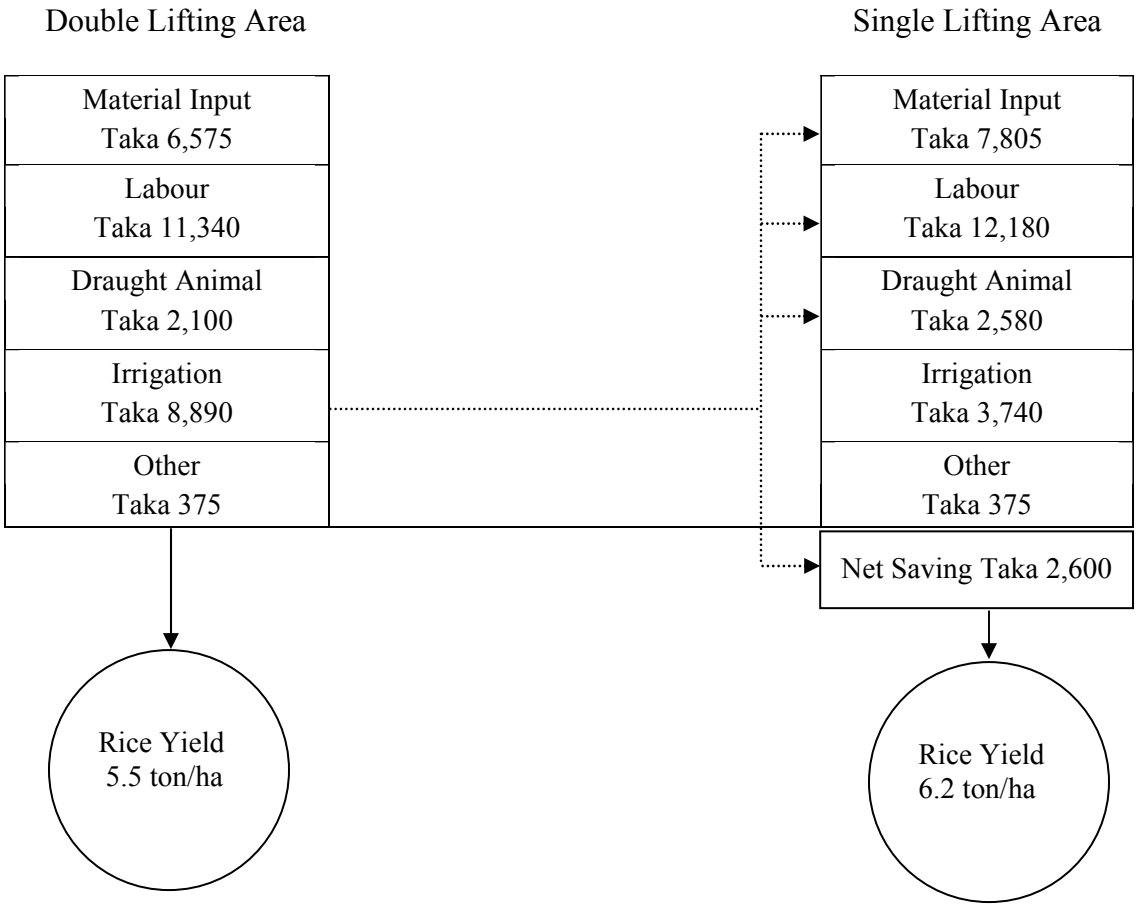

Figure 2. Impact of reduced irrigation cost on the input uses and yield level (broken line shows use of the surplus money available for the reduction of irrigation cost)
1Taka=US$0.016

Field study in 2005 showed that about 66.4% of the rice growing area was provided with supplementary irrigation in the monsoon season and 35.2% in the pre-monsoon season. Annual cropped area has increased by 278 ha and crop intensity by 50.0%. LGED supports subproject beneficiaries to adopt improved farm practices through on-farm training and demonstrations by the Department of Agricultural Extension. Field level extension workers of the Department of Agricultural Extension support WMCA in preparing and implementing annual crop production plan and monitoring of irrigation water uses. The irrigation development with the application of improved farm practices and use of high-yielding modern varieties contributes to increase rice production. Area under modern rice varieties increases in the monsoon season for the supplementary irrigation and in the winter season for the improvement of conveyance capacity of the canals. The irrigation also contributed to increase average rice yield levels by 2.1 ton/ha. Crop production is now more diversified with 41.0% of the total crop area under non-cereal compared to 18.0% during the pre-subproject period. Annual cereal production increased from 2,065 tons to 3,215 tons. The non-cereal production increased to 3,220 tons from 375 tons. The

number of farm households now use irrigation water is 2,260 compared to 1,389 during the pre-subproject period. The increased crop production provides additional employment opportunity. Irrigation development has doubled the farm labour wage rate. The subproject is now well-known as '*Bwishwa Khal*' (universal canal).

CONCLUSIONS

Involving local stakeholders thorough WMAs in water management is advantageous for three reasons. First, WMAs as local organizations are effective in generating and securing compliance with rules for the use of water which is a common property. Second, WMAs involve local stakeholders in the development of effective water management practices. Third, devolution of responsibilities to the WMAs externalizes O&M expenditures to local communities from the government fund and reduces overall crop production costs by creating conditions in which cooperative, agricultural and other supporting agencies become more efficient and effective through collaboration with beneficiaries.

The WMAs regulate water uses, provide a forum for resolving conflicts among local stakeholders and provide a channel for the representation of on-site and off-site stakeholders groups in the negotiation of water resource use. WMAs mobilize and deploy significant resources, both in cash and kinds that are needed to implement sustainable water resources management. The special nature of WMAs are that they provide a basis for collective actions, which include building consensus about water use problems and needed solutions, seeking and disseminating information about these, coordinating actions, designating rights and responsibilities as well as ensuring accountability. According to Cernea (1993) and Uphoff (1992), self-organizing groups for common property uses management are only one subset of the local organizations that use water resources and form the tapestry of local institutional arrangement. In the subprojects of SSWRDSP, the WMCAs define rules in water resources management and O&M of infrastructures for individuals or groups. Such as monitoring state of water control structures, irrigation and drainage canals, water level, water use benefits and O&M fund collection. Such roles involve applying sanctions for noncompliance with the locally defined rules for water management.

Cernea (1987) found in a study of 25 agricultural projects several years after completion that those which had made an effort to build local organizations such as water user associations, had been able to sustain high rates of return. On the other hand, projects without local organizations had 5-10 times lower rate of return than anticipated. The WMAs that build their experience in working together in the subprojects of SSWRDSP is an important ingredient in the capacity of local stakeholders to manage their affairs successfully without dependence on outside agencies.

REFERENCES

BBS. 2004. Yearbook of Agricultural Statistics of Bangladesh 2001. Bangladesh Bureau of Statistics. Dhaka.

BWDB. 1988, Morphological Features of the Major Rivers of Bangladesh-Part 1, Bangladesh Water Development Board.

Cernea, Michael M. 1993. Culture and Organization: The Social Sustainability of Induced Development. Sustainable Development 1 (2):18-29.

Cernea, Michael M. 1987. Farmers Organizations and Institution Building for Sustainable Development. Regional Development Dialogue 8(2): 1-24.

Chowdhury, Y. A. 1988. Institutional Analysis: BWDB and BADC. Vol. V: Institution. UNDP/ASR. Bangladesh.

EIP. 2000. Learning Lessons: 20 Years of EIP Experience. Early Implementation Project. Environmental Geographic Information System. Bangladesh.

Garrett, J.H.E. 1910. Bengal District Gazetteers: Nadia, Calcutta.

Islam, MA. 1978. The Ganges-Brahmaputra River Delta", Journal of University of Sheffield Geological Society (l).

Islam, M. N. and Q R Islam. 2001. Small Scale Water Resources Development for Flood Damage Control and Floodwater Conservation in Bangladesh. ICID. 1st Asian Regional Conference. Seoul.

IWRMU. 2006. Annual Effect Monitoring and Evaluation Report 2004-2005. Integrated Water Resources Management Unit. LGED. Bangladesh.

Khan H R.1993.Water development activities and their impacts on wetlands. In Nishat, et al (eds.) Freshwater Wetlands in Bangladesh: Issues and Approaches for Management. IUCN:23-32.

Lutz, E. H. Binswangar, P. Hazel and A. McCalla, editors. 1998. Agriculture and the Environment. World Bank. Washington, DC.

Majumdar, B.S. 2005. The information technology-based improved management system for the Teesta Barrage Project. Modernization of irrigation system operations: proceedings of the fifth ITIS. FAO.

MPO, 1991. Evaluation of Historical Water Resources Development and Implications for National Water Plan. Master Plan Organization (now Water Resources Planning Organization). Bangladesh.

Nishat, A. 1988. Large Scale Water Development. UNDP/Bangladesh Agriculture Sector Review.

Rashid, H E. 1991. Geography of Bangladesh, University Press Ltd., Dhaka.

SSWRDSP 2003. Project Final Report. January 2003. Small Scale Water Resources Development Sector Project. LGED. Bangladesh

SSWRDSP. 1994. Feasibility Study. Agrani Irrigation Sub-project (CSP-4). LGED. Bangladesh

Uphoff, Norman Thomas. 1992. Learning from Gal Oya: Possibilities for Participatory Development and Post-Newtonian Social Science. Ithaca, N.Y.: Cornell University Press.

WARPO. 1991. Evaluation of Historical Water Resources Development and Implications for National Water Plan. Water Resources Planning Organization. Bangladesh.

World Bank. 1992. Bangladesh Food Policy Review: Adjusting to the Green Revolution. Volume I: Main Report.