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# *SURFACE WATER MANAGEMENT AND RURAL DEVELOPMENT A CASE STUDY*

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***Abstract:*** *Peoples in the developing countries like Bangladesh are in crisis of essentials—food and water, shelter, energy and health. Agriculture is the most suitable way of food security and socio-economical growth for the agrarian country from immemorial. It's dependent on water thus well-organized water management is the key in support of rural—socio-economic development. Small Scale Water Resources Development Project (SSWRDP) of LGED Bangladesh is contributing significantly to surface water resources development, agricultural production and socio-economical advancement with ecological balance. To evaluate the impacts of SSWRDSP the research takes an eclectic approach, using both quantitative and qualitative methods in information gathering. It reviews relevant external secondary data sources and internal SSWRDSPs field data. Primary sources included extensive field visits, household survey and beneficiary and Water Management Cooperative Association interviews of a specific sub-project that made positive impact on agriculture in reducing local poverty. Transcripts of field visit, field notes, and relevant literature are analyzed on the basis of themes, patterns and data's of interrelationships among those that addressed the research goal. This paper describes the augmentation of surface water management for agriculture and thereby rural employment generation complying participatory water management process with its future prospect.*

***Keywords:*** *Participatory approach; surface water management; rural development.*

## INTRODUCTION

The contribution of the water resources development to economic productivity and social well-being is not usually appreciated up to that extent, although all social and economic activities rely significantly on the proper uses of water especially for agricultural purposes. As populations and economic activities grow, many countries are rapidly reaching conditions of water scarcity or facing limits to economic development (UNCED, 1992). Water demands are increasing rapidly, with 70-80 per cent required for irrigation and thus effective implementation and coordination mechanisms for water resources management in agricultural sector is required (Huu & Facon, 2001). To face the challenges of water management impediment participatory

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approach could be adapted, although local and community-based water management seems to be an old idea, however its time has come again (Brooks, 2002). For too many years, the role of local people has been, if not totally disregarded and at least downplayed, the developing world may not suffered from any failure to see water as a problem (Lange & Kleynhans, 2007). The water projects of the first several development decades fell short of their original promise and the main reason for that, technical solutions to water scarcity were designed to mould social and cultural factors rather than the other way around (Belton & Stewart, 2002). Only in the last decade it is recognized that, if efforts to improve the management of water supply are to be successful, not only must they be technically sound and economically feasible, they must also deal directly with poverty alleviation, local empowerment, and ecological safeguard (Lange & Kleynhans, 2007).

Bangladesh agriculture sector is contributing about 20.16% in its GDP while its input in employment of local labour force is more than 43.60% (BBS, 2008; BBS, 2009). This simple statement indicates the consequence of the sector in the rural economy of Bangladesh. Agriculture sector of the country, as elsewhere in the Globe, is dependent on the water resources (Brooks, 2002). For Bangladesh, the significant variation in temporal and spatial availability of water resources is a major obstruction to agriculture sector from immemorial (Osman & Qaium, 2011). In respect of water availability, Bangladesh have the benefit of tropical monsoon climate with two prominent seasons; the dry (November-May) and the monsoon (June-October) (Islam, 2000). Total average annual rainfall of the country is about 2360 mm with spatial variation of 1665 mm in the south-west to 3194 mm in the north-east region of the country. Average rainfall of the monsoon season is about 2154 mm while the figure is about 206 mm for the dry period (Ravenscroft, 2003a; Rashid, 2009). More rain in the monsoon is coupled with high stage in all the rivers spreading throughout the country. Flood occurs in some wet monsoons when inundation exceeds the tolerance limit causing catastrophic damage to life, property and livelihood (Siddiqui, 2000). Even in the flood event, part of the country, especially the south-west and the north-west, may suffer from drought. On the other hand, less rainfall in the dry season is accompanied by low stage in the rivers causing acute shortage of water for domestic use and especially for agriculture (Ravenscroft, 2003b; Palma, 2010). Thus, water management both in the dry and wet season become primary concern with proper exploitation and allocation of water resources for the agrarian economy of this low-lying deltaic floodplain (Chowdhury, 2010). To address this situation, government of Bangladesh realizes the improvement of ancient stakeholder's participation in irrigation. And thus formulated National Water Policy (BNWP) and adopted Integrated Water Resources Management approach to make the water resources management projects sustainable to get long term benefit in socio-economic development especially at local level (MoWR, 1999). Government has given the principal responsibility to Bangladesh Water Development Board (BWDB) and to the Local Government Engineering Department (LGED) for large and small scale water resources development activities throughout the country (MoWR, 1999; ICID, 2000).

**Local Government Engineering Department (LGED) and its Involvement**

The Local Government Engineering Department (LGED) Bangladesh started its activities in the in the early 1960s and got involvement in increasing farm/non-farm production through surface

water management by implementing Thana Irrigation Project (TIP) (GoEP, 1962). With the objectives as of TIP, LGED started Canal Digging Programme (CDP) in 1979 to de-silt sediment filled channels to boost-up water storage capacity of channels for irrigation and fisheries and re-excavate 3, 276 km khal, 429,597 pond and 382 hydraulic structures (IWRMU, 2008a). In parallel to CDP, under Rural Employment Sector Programme (RESP), LGED initiated small-scale water resources development schemes to increase agricultural production and rural employment generation during 1986-1996 and executed 60 small-scale schemes covering 20,530 hectares of cultivated land benefiting 51,230 farm families (MPIUS, 1998: RESP, 2000). The projects were implemented excellently with local users (Faruqee & Choudhury, 1996). Moreover, to provide dry season irrigation facilities especially in the coastal belt LGED first implemented two rubber dams in Cox's Bazar district in 1995 (IWRMU, 2008b). Although all the projects was implemented with full participation of local people but the projects does not benefits up to the mark due to lack of institutional framework and capacity building of the projects maintenance and management committee and lack of integration of different disciplines. Taking lessons from the past LGED started Small Scale Water Resources Development Sector Projects (SSWRDSP) with full participation of local people that benefits from the delivery of water-related services; participation of local government institutions; and by integration of different disciplines, departments and ministries; in conformity with the institutional capacity building of the project committee and National Water Policy (NWP) (MoWR, 1999; MoWR, 2000). Because, an integrated approach is needed since decisions about water are multi-facetted; water is value weighted as a finite resource with economic values and as a public good with normative values (Gleick, 1998; Hermans, Gerardo & Mahoo, 2006; Warner, 2006). To improve the socio-economic condition through farm/non-farm production by efficient using of surface water the SSWRDSP in light of IWRM approach started in 1995 (LGED, 1995).

The BNWP has given the mandate of implementing flood control, drainage and irrigation (FCDI) projects having command areas of 1,000 ha or less to increase the crop production and employment generation and thus improvement of local socio-economy (MoWR, 1999). The first SSWRDSP completed 280 sub-projects covering 165,000 hectares of cultivates land that benefits 142,000 farm families in 37 districts (IWRMU, 2008c).The main objectives of the SSWRDSP is to enhance agricultural production to take effective steps in poverty alleviation through improving surface water resources management in different regions of the country (Rahman, Rahman & Rahman, 2007). With the success and gathered experience from SSWRDSP-1 LGED started the 2nd phase of SSWRDSP covering larger areas in 61 districts of the country in 2003(LGED, 2001). The 2nd phase of the project is completed in 2010 (LGED, 2010a) and implements 300 sub-projects covering 163,000 hectares of cultivates land that benefits 154,000 farm families. The 3rd phase has started in 2010 in the name of Participatory Small Scale Water Resources Sector Project (PSSWRSP). PSSWRSP is implementing throughout the country with an aims to develop 300 new and to rehabilitate 160 existing sub-projects (LGED, 2010b). It could be mentioned that another SSWRDSP funded by JICA also implementing by LGED from 2008 covering 15 districts of greater Mymensingh, Sylhet and Faridpur having a plan to implement another 300 sub-projects (LGED, 2010c). Monitoring of the completed 580 Sub-projects of the SSWRDSP shows increasing trend in cereal and non-cereal crop production. The increased crop production is due to increased irrigation land and increased cropping intensity in the subproject area and that intensity generates more employment in the

respective area. Most of the irrigation schemes have multiple objectives, such as flood control, water drainage, environmental protection, crop production, fisheries development and employment generation.

## OBJECTIVES

(a) To surface the initiatives of the Local Government Engineering Department (LGED) in rural development through surface water management with participatory approach.

(b) To present the state of the art of the participatory surface water management process in sustainable socio-economic development by increasing agricultural production and thereby employment generation in the rural Bangladesh.

(c) To evaluate SSWRDP subproject on overall socio-economic development at rural level through agricultural activates, using surface water with efficient and sustainable manner.

## METHODOLOGY

A detailed and systematic approach was followed to achieve the objectives of this study using two methods. First a broad review of external secondary data sources associated with the topic that included water and crop production, irrigation, gender and development, employment generation, surface water management etc. and internal SSWRDSPs which includes the sub-project based field data obtained for formulation, implementation, and performance evaluation of SSWRDSPs were made. Pre-project data were compiled from sub-project appraisal reports while the monitoring and evaluation data were drawn from the Management Information System (MIS) unit of IWRMU, LGED and various project reports. Field information was fetched through befitting exercise supported by the SSWRDSPs and the IWRMU of LGED collected the post-subproject data after completion of the subprojects.

Methodology of the study also involved two tier exercises. Firstly, information of the pre-status of the sub-projects areas were drawn from relevant published materials and field records and secondly the post-status of the sub-project areas from data obtained from MIS unit. Primary sources included extensive field visits, household survey and sub-project beneficiary and WMCA interviews. Field workers of Non Governmental Organization (NGO) were involved in the surveys and interviews. As the author is a fulltime employee of LGED and posted in the IWRMU as a Senior Assistant Engineer (Operation and Maintenance) and also in-charge MIS unit of IWRMU, LGED, got opportunity to involve in every steps of sub-project maintenance and management activities. Transcripts of field visit, field notes, and relevant literature were analyzed on the basis of themes, patterns and data's of interrelationships among those that addressed the research goal.

## PARTICIPATORY APPROACHES IN SSWRDP

Sustainable production can be defined as the production which should meet the needs and desire of the people without negotiating with the natural resource for the next generation (Roome, 2002). In this light, Participatory approaches in the way of Integrated Water Resources Management (IWRM) for agriculture can be focused as the most sustainable eco-friendly farming

for agricultural and thus socio-economic development. Because the IWRM confirm the three —e are economic efficiency in water use; equity in recognising water as a basic right; and environmental and ecological sustainability (Julia, 2009). LGED is very much careful about sustainable surface water management by ensuring stakeholder participation, forming Water Management Cooperative Association (WMCA) and by providing training such as crop diversification, institutional capacity building for the management and maintenance of subprojects (MoWR, 2000). It has developed a very innovative framework of stakeholders participation to confirm economic efficiency in water use; equity in recognising water as a basic right; and, environmental and ecological sustainability (LGED, 2009).

### Framework of Participation

The overall participatory process in subproject development adopted by the LGED is a combination of two parallel but interrelated processes:

- "Institutional" involving software elements and
- "Technical" involving hardware elements

Sub-project implementation is participatory and the whole cycle of subproject development process is sub-divided into four distinct stages as presented below (Figure 1) (LGED, 2009).

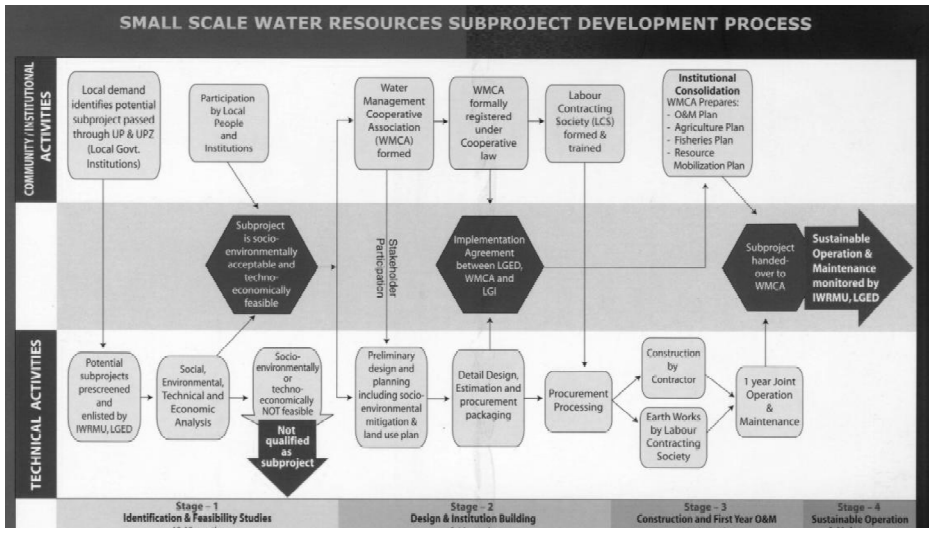


**Figure 1: Sub-project Development Process**

*Source:* LGED (2009)

### Stage 1: Identification and Feasibility

In consultation with local stakeholders, the Union Parishad (Council) kicks off sub-project proposals. The LGED Upazila Engineer submits it to the Upazila Development Coordination Committee for approval. If approved, the proposal is forwarded to the Integrated Water Resources

Management Unit (IWRMU). IWRMU pre-screens the proposal during a multidisciplinary field reconnaissance. This is followed by (i) Participatory Rural Appraisal (PRA) and (ii) Feasibility Study (FS). Each subproject is reviewed and approved by District Level Inter-Agency Project Evaluation Committee (DLIAPEC).

**Stage 2: Design and Institution Building**

Following the approval of DLIAPEC, engineering design and establishment of Water Management Association (WMA) are done along with motivational awareness campaign among stakeholders. Process of establishing WMA is initiated under the legal framework of the Cooperative Societies Act (National Parliament of Bangladesh, 2001). WMA is registered with the Department of Co-operative (DoC) and becomes Water Management Cooperative Association (WMCA). IWRMU undertakes engineering design work in consultation with stakeholders and discusses for their approval. This process concludes in the signing of a formal implementation agreement by the WMCA, Union Parishad and district level engineering in-charge of LGED. To sign the implementation agreement, the WMCA must have achieved (i) enrolment of at least 70% of beneficiary households; (ii) collection of beneficiary contributions equivalent to an annual O&M requirement and deposited in a joint account by LGED and the WMCA; and (iii) approved plans in consultation with people-affected by the environmental mitigation and resettlement (land acquisition) (MoWR, 2000).

**Stage 3: Construction and First Year O&M**

Civil works are tendered to contractor and earthworks awarded to LCS groups comprised of local landless, disadvantaged destitute males and females. WMCA supervises construction through a 7-member committee trained on construction monitoring including one man and one woman from the concern Union Parishad (LGED, 2009). WMCA forms O&M sub-committee and prepares schedule, beneficiary list and maps, and plan comprising operating guidelines, and maintenance and resource mobilization plans. IWRMU 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 having observed the infrastructures performance during the first year of O&M, the sub-project is handed over to the WMCA through a formal lease agreement with LGED (ADB & LGED, 2009). WMCA receives support of agricultural extension and fisheries departments to prepare agriculture and fisheries development plans and to organize training for WMCA representatives who work as liaison extensions to beneficiaries (ADB, 2008).

**Stage 4: Sustainable Operation and Maintenance**

This stage starts after sub-project handover and continues throughout its lifetime. Continuous monitoring and support is provided by IWRMU and other partner agencies. WMCA and O & M Committee receive regular training so that they are able to carry out O & M of the sub-project. WMCA Prepare O & M Plan, Undertakes routine maintenance works and collects O & M fees from direct beneficiaries in proportion to their land area benefited by the sub-project (LGED, 2009).

## DARIAPUR SUBPROJECT (SP25288) UNDER SSWRDP OFLGED: A CASE STUDY OF RURAL DEVELOPMENT

### Sub-project Background

Dariapur subproject is placed in Jhilim union under sadar upazila of Chapai Nawabganj district, besides the left bank of Mahananda River, a Barind area in Bangladesh. It is is bounded by Sihrampur-Dariapur LGED road on the North, Jhikra-Sihrampur LGED road on the East, Chapai Nawabganj district boundary on the South and Godagari-Chapai Nawabganj national highway on the West (HCL, 2007). The soil in the subproject area is silty clay and the land elevation varies from 18.60 m PWD to 20.12 m PWD within the subproject (DMCAL, 2009). The surface water of Mahananda River is the main source of irrigation water. Local farmers formed a co-operative society named "Dariapur Sech Prokolpo" in 1973, and they developed an irrigation system which receives water from Mahananda River by using 4 no. of electrically operated pumps (engine capacity 15HP-30HP). Existing irrigation system was consists of rectangular canal of 1280m with 125mm brick wall, earthen canal 4450m, underground pipe canal 550m, 4 nos. aqueduct of total length 85m, 6 nos. road crossings of total length 60m and 2nd lifting arrangement to irrigate about 50 ha (DWMCAL, 2009). Water is lifted from Mohananda River to the sump on its bank and supplied to the field using the existing canal system which was mostly damaged. An existing pond was used as reservoir for 2nd lift. Typical section of brick canal is width 950mm and depth 450mm and earthen canal was bed width 600mm and depth 450mm trapezoidal section with 1:1.5 side slopes. Surface water in the River is available for irrigation throughout the year as stated by the locals. The total irrigation coverage at present was about 128 ha as reported by the local people including 50 ha in the 2nd lift. There are 4 Nos. of DTW (Deep Tube Well) of BMDA (Barindra Management and Development Authority) (The Daily Independent, 2011a) at different locations of the subproject area but local people do not use the DTWs of BMDA irrigation water as the cost is too high and the ground water is harmful for the agricultural land. The existing irrigation system becomes unworkable due to old infrastructures and lack of proper maintenance. About 30% of lifted water was being lost due to seepage and failure of earthen canal as informed by the local farmers. 2nd lifting area of about 50 ha become more costly due to a significance loss in the old damaged irrigation canal and evaporation loss in reservoir pond used as sump for 2nd lift. The subproject area is subjected to very low rainfall as it is under semi arid climatic region. The topography of the area is undulating. Due to such environment agricultural activities are limited to small area. Water was lifted by LLPs to irrigate agricultural land through the non-registered society named "Dariapur Sech Prokolpo". Details of the existing system were:

- Damaged brick Irrigation Canal (about 1280m);
- Earthen Canal (about 4450m);
- RCC aqueducts 4 nos (one no. of length 55m constructed in 1973, 10m, 10m and 10m);
- Sump and Pump Shed (1 No. for 4 Nos. of pumps with total HP 75);
- Road Crossings 60m (6 nos, 8m, 3m, 23m, 10m, 8m, 8m);
- Buried pipe line dia 300mm (550 m) (MIS, 2011).

**Subproject Concept**

The local farmers believe that construction of buried pipe will minimize the loss of irrigation water, increase the command area and reduce the cost of the subproject. Also in the buried pipe system cost of irrigation would be uniform to all in the subproject. Conveyance of irrigation water was the main problem in the subproject area, which reduced coverage and yield. Local farmers would like to irrigate their land with surface water as in past experiences they found it less costly and it can keep the land fertile. Since the existing canal system requires major rehabilitation which will be very costly, the locals proposed buried pipe irrigation system to include new area in addition to the existing area under irrigation (DWMCAL, 2009).The original proposal of the local people forwarded by the Executive Engineer Chapai Nawabganj was for a CAD (Command Area Development) subproject with a gross area of 344 ha and net benefited area of about 320 ha, intended to reduce excessive loss of irrigation water, improve the irrigation facilities and increase the command area. The beneficiaries proposed for construction of buried pipe conveyance system of about 7.675 km (LGED, 2007). The proposed subproject concept was reviewed and revised by the technical team of House of Consultants Limited (HCL) through site visits from the 27th June, 2007 onwards (HCL, 2007). A planning discussion meeting was held at subproject site with beneficiaries, advisory consultant member, PMO Engineer, Sadar UZ Engineer, Asst. Engineer and Socio-Economist, SSWRDSP-2, Chapainawabganj on 16 September 2007. The planning concept was finalized after details discussion ((MIS, 2011)). Details of the proposed interventions are listed below:

- Construction of buried pipe main line (about 3175m);
- Construction of buried pipe branch line (about 3000m);
- Construction of sump (6.1m x 2.75m);
- Riser (Alfa-Alfa valve) for field supply of water (27 nos.);
- Subproject gross area: 310 ha;
- Subproject net benefited area: 290 ha;
- Subproject type: CAD (Command Area Development) (MIS, 2011).

Due to existing insufficient canal x-sectional area, length and complex maintenance problems, all the existing 4 pumps could not be operated at a time. As a result irrigation coverage and yield are much below the expectation. Construction of properly designed RCC buried pipe canal system with appurtenant structures including a header tank of required size could minimize conveyance loss and facilitate irrigation round the clock to increase irrigation coverage and yield of crops to the optimum.

**Development of Water Management Association (WMCA)**

Local community was very wholehearted about the subproject development and fulfilled all conditions required before signing implementation agreement. The Dariapur Sech Prokolpo got legal shape by registering with the Department of Cooperative. The sub-project

benefited area is about 290 hectares belonging to about 585 farm families. The community arranged the amount of Tk 2,24, 430 in 2007 as O&M fund and deposited to an account jointly operated by the WMCA Chairman and LGED Executive Engineer Chapai Nawabgonj. By the date of signing the implementation agreement the association enrolled about 939 members where as the existing member was only 30. Construction of the structure commenced in 2007, completed in 2008 and functioned in the same year. The community is highly benefited from by reducing water loss, increasing command area and there by minimize irrigation cost. Different training were arranged and provided to the WMCA members so that they become capable in undertaking O&M of the completed infrastructure. IWRMU LGED still providing regular training to the member of WMCA and O&M committee member to improve their performance in planning of O&M and undertaking routine maintenance works and in collecting O&M fees from direct beneficiaries in proportion to their land area benefited by the sub-project. The WMCA has purchased 0.23 ha of land and constructed an office building.

### Implemented Components

The following components for the Dariapur subproject were finally implemented with the cost indicated in Table 1.

**Table 1**
**Implemented Component**

| *Name of Works* | *Size/Length (km)* | *Estimated cost (Tk)* | *Implementation Cost (Tk)* | *Physical progress %* |
|---|---|---|---|---|
| RCC U-Drain | 1.191 | 3038371 | 3,038,371 | 100 |
| Buried Pipe Irrigation System | 6.175 | 8239036 | 10,540,048 | 100 |
| O & M Shed | 9.0mx5.0m | 435439 | 490,880 | 100 |
| Header Tank | 6.1mx2.6m | 347491 | 401,072 | 100 |
| Total cost and progress | 12,060,338 | 14,470,371 | 100 | |

*Source:* Author (2011).

## SUBPROJECT IMPACT

RCC U-drain, Buried pipe system and Header tank minimize the loss of water transfer for irrigation and consequently increases the command are under this subproject. Under the mitigation measure it also increases the fish production to some extent and thus generates the employment opportunity at rural level.

### WMCA Operation and Management (O&M) Activities

The water management association has showed a unique role in self sustaining operation, maintenance and water management activities. They have mobilized local resources through field water distribution tariffs and spent in yearly routine O&M activities. The association spent different amount of money in different year (Table 2) in maintaining and developing field irrigation distribution networks. Only in one year WMCA established that they are capable enough to raise fund for the operation and maintenances of their subproject.

**Table 2**
**Budget and Expenditure for O & M Activities**

| *Year* | *Fund at Hand (Tk)* | *Budget Estimate (Tk)* | *Actual Expenditure (Tk)* |
|---|---|---|---|
| 2008 | 235,324 | 15,116 | 14,305 |
| 2009 | 355,442 | 8,654 | 7,550 |
| 2010 | 4 75,430 | 12,600 | 12,510 |

*Source:* Author (2011).

## Crop Production

Participatory water resources management in the sub-project area has generated local enthusiasm for water resources system to increase the crop production. Farmers, fishers, landless and women access to information and their influence on the sub-project O&M have increased. This has created opportunity to increase crop production in the completed sub-project areas. A major contributing factor to the food production is the expansion of cropped area. Due to sustained use of conserved water, the irrigation area increased about significantly Table 3.

**Table 3**
**Cropped area (hectare)**

| *Study Year* | *Monsoon* | *Winter* | *Total* | *% increment* |
|---|---|---|---|---|
| 2008 | 190.1 | 102.2 | 292.3 | — |
| 2009 | 256.0 | 132.5 | 388.5 | 32.9 |
| 2010 | 285.0 | 172.5 | 457.5 | 17.8 |

*Source:* Author (2011).

Assurance of timely water irrigation water supply without loss increases cropping intensity with the use of high-yielding variety (HYV), increased cultivated areas and raises per hectare yield levels. The increased rice area increases rice production significantly (Table 4).

**Table 4**
**Pre- and Post-subproject crop production**

| *Study* | *Cereal Crop Production (tons)* | | | *Non-cereal Crop Production (tons)* | | |
|---|---|---|---|---|---|---|
| *Year* | *Pre-Subproject* | *Post-Subproject* | *% Increment* | *Pre-Subproject* | *Post-Subproject* | *% Increment* |
| 2008 | 1,032.0 | — | — | 127.0 | — | — |
| 2009 | — | 1,745.9 | 69.1 | — | 207.0 | 63.0 |
| 2010 | — | 2,488.0 | 42.5 | — | 287.0 | 39.3 |

*Source:* Author (2011).

Improved water management by the beneficiaries has also resulted in the diversification of crop with the increase in cereal and non-cereal production (Table 4). The access of the rural poor has improved through share cropping and increased land productivity. The farm labourers benefit from more labour demand and higher wage rate.

## Fish Production

Some farmers started practices of fish production during Aman season in moderate to low paddy fields where water logging exists for 3-4 months. Mirror carp, Tilapia and Thai barb are practicing and thus increasing fish production to some extent (Table 5).

**Table 5**
**Impact on Fish Production (Tones)**

| *Study Year* | *Pre-Subproject* | *Post-Subproject* | *% increment* |
|---|---|---|---|
| 2008 | 17.5 | — | — |
| 2009 | — | 19.0 | 8.6 |
| 2010 | — | 22.0 | 15.7 |

*Source:* Author (2011).

## Employment Generation

Employment generation is a crucial need for Bangladesh and government is taking different programme to generate employment with the objective of providing the short and long-term employment among local level people to enable households to better cope with vulnerability (WB, 2010). The employment opportunity related to Dariapur SSWRDSP sub-project earthworks is provided to local landless people. The landless person includes poor women for labor contracting societies (LCSs). Implementation of this sub-project under SSWRDSP provided labourers temporary employment opportunities for 25840 people (Table 6). The poor landless segments have better employment opportunities in construction and maintenance works of irrigation schemes (ICID, 2006).

**Table 6**
**Labour Employment during Subproject Construction**

| *Name of Works* | *Size/Length (km)* | *Cost* | *Labour Employment (thousand person)* |
|---|---|---|---|
| RCC U-Drain | 1.191 | 3,038,371 | 5.42 |
| Buried Pipe Irrigation System | 6.175 | 10,540,048 | 18.82 |
| O & M Shed | 9.0mx5.0m | 490,880 | 0.88 |
| Header Tank | 6.1mx2.6m | 401,072 | 0.72 |
| Total labour employed per day during construction | | | 25.84 thousand |

*Source:* Author (2011).

Expansion of cropped area has significantly contributed to labour demand. ICID (International Commission on Irrigation and Drainage) stated the projection of employment up to 2020 shows that until then agriculture will continue to be the major source of employment by absorbing over 40% of the labour force (ICID, 2000). Higher use of modern inputs raises the demand for rural labourers, since crop production is rarely mechanized in the Bangladesh (Quasem 2002). Labour requirement also increases in fisheries production (Table 7).

**Table 7**
**Labour Employment in Crop and Fish Production**

| *Study* | *Crop Production* | | | *Fish production* | | |
|---|---|---|---|---|---|---|
| *Year* | *Pre-Subproject* | *Post-Subproject* | *Increment (%)* | *Pre-Subproject* | *Post-Subproject* | *Increment (%)* |
| 2008 | 10,516 | — | — | 178 | — | — |
| 2009 | — | 16,825 | 60.0 | — | 228 | 28.1 |
| 2010 | — | 19,855 | 18.0 | — | 258 | 13.2 |

*Source:* Author (2011).

An estimated one-third of this labour force is employed full time, remainder for 10 days in a month throughout the farming period (MIS, 2011). More than that tree plantation along the U-drain provides employment opportunities for destitute women.

### Income Generating Activities Through Microcredit

The WMCA members received training on microcredit with help of IWRMU and started a microcredit programme alongside the water management and disbursed an amount of at Tk 3,455,000 by the year 2010 to an estimated 483 persons of which 313 are male recipients and 170 are females of which already realized Tk 1,898,000. The income-generating activities empower the poorer members of the community (The Daily Independent, 2011b). These activities includes distribution of loan for small enterprises such as tailoring, beef fattening, poultries, handicraft etc. these activities changes the lives in the project areas as found by survey. The impact of microcredit could be realize from the example of the pre and post status of livestock and poultries (Table 8).

**Table 8**
**Status of Livestock and Poultry**

| *Study* | *Livestock (in-house in number)* | | | *Poultry (in-house in number)* | | |
|---|---|---|---|---|---|---|
| *Year* | *Pre-Subproject* | *Post-Subproject* | *% increment* | *Pre-Subproject* | *Post-Subproject* | *% increment* |
| 2008 | 390 | — | — | 8145 | — | — |
| 2009 | — | 547 | 40.3 | | 12,136 | 49.0 |
| 2010 | — | 671 | 22.7 | | 14,503 | 19.5 |
| *Study* | *Livestock (number of farm)* | | | *Livestock (number of farm)* | | |
| *Year* | *Pre-Subproject* | *Post-Subproject* | *% increment* | *Pre-Subproject* | *Post-Subproject* | *% increment* |
| 2008 | 0 | — | — | 0 | — | — |
| 2009 | | 3 | 100 | | 5 | 100 |
| 2010 | | 6 | 100 | | 9 | 80 |

*Source:* Author (2011).

During survey a number of individual member of the association were interviewed who has received credit from WMCA, as example is Ms Kabirunnesa, a widow of 36 of Dariapur under Sadar Upazila of Chapai Nawabgonj district was a destitute woman, only four years ago her husband, a mason left this world leaving her with two children, Azim and Alim. Bad times engulfed her after untimely death of husband. But fortune smiled on her. She became a member of the Dariapur water management cooperative society and took loan Tk 5000 under its poverty reduction programme. With that loan she started her struggle as a tailor, within a short time she refund and again took Tk 10,000, she bought another sewing machine and extends her business and now she is owner of six goats, constructed semi pacca house and sanitary latrine in her house.

### Environmental Activities

Dariapur WMCA has also taken environmental awareness building among the project area. They campaigns against anything which have negative impact on the environment such as uses

of fire wood in kilns, uses of open latrine etc. They have taken so many programme to enrich the environment such as tree plantation (Table 9).

**Table 9**
**Shows Environmental Activities**

| *Subject/activities* | *Existing in year 2008* | *Post-project in 2010* | *% increment* |
|---|---|---|---|
| Tree plantation | 1000 | 10300 | 30 |
| Arsenic free tube-well | 20 | 30 | 50 |
| Arsenic test performed | 50 | 80 | 60 |
| Sanitary latrine | 40 | 70 | 75 |
| Waste management and organic compost production | 20 | 30 | 50 |
| Drain cleaning | 05 | 10 | 100 |

*Source:* Author (2011).

## Gender Development Activities

To comply the National Gender Policy, Participatory Water Management Guideline and the SSWRDP implementation guide line; WMCA have to ensure the woman participation in all respect. WMCA taken awareness build up programme to increase the woman participation which is reflected in the Table 10.

**Table 10**
**Incremental Woman Participation**

| *Year* | *Total members* | *Male* | *Female* | *% Increment (female)* |
|---|---|---|---|---|
| 2008 | 470 | 390 | 80 | — |
| 2009 | 870 | 578 | 162 | 102.5 |
| 2010 | 939 | 615 | 324 | 100.0 |

*Source:* Author (2011).

Table shows that the participation rate increased significantly after completion of the subproject in the year 2009-2010.

## Education

Due to positive change of living the number of not school going children decrease significantly (Table 11). This change indicates the socio-economic development significantly.

**Table 11**
**Shows Decreasing Rate of Not School Going Children**

| | *No of girls above age 5 is not going school* | | | *No of boys above age 5 is not going school* | | |
|---|---|---|---|---|---|---|
| *Study year* | *Pre-Subproject* | *Post-Subproject* | *% decrease* | *Pre-subproject* | *Post-Subproject* | *% decrease* |
| 2008 | 154 | — | — | 140 | | — |
| 2009 | — | 125 | 18.8 | — | 115 | 17.9 |
| 2010 | — | 85 | 32.0 | — | 75 | 34.8 |

*Source:* Author (2011).

## DISCUSSION

Rural development basically aims at development of socio-economic condition of rural community. The main objectives of rural development programmes are to poverty alleviation, reducing unemployment and to give additional employment to people living in the rural areas with due consideration of environmental aspect (Bhatia & Rai, 2004). The overall socio-economic development is positively associated with agricultural development and the agricultural development is dependent on the sustainable use of surface water especially for water scarce country like Bangladesh. From survey it is found that although the "Dariapur Sech Prokolpo" established in 1973, the project was not functioning well due its insufficient irrigational infrastructural facilities, proper management and due to the legal framework of the water association. After formation of WMCA with legal support and providing adequate infrastructural facilities with participatory approach and getting ownership of WMCA of the subproject, the command area of the project increased. The undisturbed irrigation water supply increased the crop production per hectare. An increase agricultural facility generates the employment opportunity significantly. Consequently local peoples inspired to join with WMCA and thus the number of WMCA member increases significantly which facilitates in forming their significant capital. As they received proper training on poverty elevation through the SSWRD subproject they have started microcredit programme and thus changing their lives. Environmental awareness developed through SSWRD, makes them capable and inspired to address the environmental issues. Overall change of their lives also showed positive impact on the education. Sustainable agriculture integrates three main goals—environmental health, economic profitability, and social and economic equity (UC SAREP, 2011). This has focused in the Dariapur SSWRD subproject.

## RECOMMENDATIONS

- Other organizations who are engaged in agriculture extension should follow the participatory approach like SSWRDSP of LGED to make the project effective for sustainable development.
- Local wisdom combined with theoretical knowledge could be the social engineering practices in resolving unique water resources problems which can bring over all development in rural Bangladesh as well as in other developing countries.
- More projects like SSWRDP need to be taken with the aims of improving the living conditions of the people in poor rural areas and of reducing income disparity.
- Water resources development for agriculture and rural development should be considered of strategic importance for economic growth, by efficiently using the existing irrigated area and developing new areas wherever possible, by promoting more SSWRDPs.
- This approach of integrated water management can be followed by others.

## CONCLUSION

More water is demanded from all sectors. Since water is an important resource for many economic activities and many people are involved in water resources management. The demand of water is increasing due to population growth and consequent expansion of irrigation and services. In the case of agriculture, the water consumption is about 80 per cent of the total demand which

reflect the competition for water from other sectors and points to more serious water shortages in agriculture. Many areas are facing water shortages especially for agriculture during dry season however it also wasting irrigation water for insufficient irrigation infrastructures. This situation hampers crop production, resulting unemployment at the rural level. Dariapur SSWRDP subproject project is a good example of participatory as well as integrated surface water management system. They are integrated into the mainstream of economic production system. The participation increased the chances of generating local enthusiasm for the maintenance of infrastructures. The sub-projects reflect the type of impact LGED has had on many communities throughout Bangladesh within the subprojects established under SSWRDSP. The paper demonstrated that sustainable water management practices can bring food and social security for the poor in rural Bangladesh. It also concluded that the assessment of impact of SSWRDP should be given due importance in the future planning and development programmes.

## LIMITATIONS OF THE STUDY

Some limitations were identified. Firstly, most of the secondary data was gathered from government and non-government organisations; therefore, data accuracy and data management systems of those institutions may have influenced the study. The sample of respondents chosen was selected randomly who might not have enough experience to respond properly, may have affected the results.


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### *References*


ADB (2008), Participatory Small Scale Water Resources Project: Operation & Maintenance Study, Dhaka: ADB.

ADB and LGED (2009), Small Scale Water Resources Support Strategy and O & M Manual, Dhaka: LGED.

Belton and Stewart T. J. (2002), Multiple Criteria Decision Analysis: An Integrated Approach. London: Kluwer Academic Press.

Brooks, D. B. (2002), *Water :*Local-Level Management. Ottawa: International Development Research Centre.

Bhatia, V. K. and Rai, S.c. (2004), Project Report: Evaluation of Socio- Economic Development in Small Areas. New Delhi: Indian Society of Agricultural Statistcs.

BBS (Bangladesh Bureau of Statistics) (2008), Preliminary Report of Agri Census, Dhaka, BBS.

BBS (Bangladesh Bureau of Statistics) (2009), Statistical Pocket Book 2009, Dhaka, BBS.

Chowdhury, N. T. (2010), Water Management in Bangladesh: An Analytical Review, *Water Policy,* 12 (2010), 32-51.

DWMCAL (Dariapur Water Management Cooperative Association Limited) (2009), Poverty Reduction Planning Book (Original in Bengali), Chapai Nawbgonj, DWMCAL.

GoEP (Government of East Pakistan) Planning, Administration and Execution of Works Programme, (IV/NDO-39/62/1213 (180) dated Dacca, the 25th September, 1962).

Faruqee, R. R. and Choudhury, A. Y. (1996), Improving Water Resource Management in Bangladesh. South Asia: The World Bank.

Gleick, P. (1998), The Human Right to Water: Water Policy 1. Washington, D.C.:Island Press.

Huu, L. T. and Facon, T. (2001), From Vision to Action: A Synthesis of Experiences in Southeast Asia. Bangkok: Food and Agriculture Organization.

Hermans, L. M., Gerardo, E. H, and Mahoo, H.F (2006), Building a Mosaic of Values to Support Local Water Resources Management. *Water Policy,* 8 (5), 415-434.

HCL (House of Consultant Ltd.). (2007), Second Small Scale Water Resources Development Sector Project: Dariapur CAD Subproject. Dhaka: HCL.

Islam. M. A. (2000), The alluval plains of Bangladesh. In A. A. Rahman., S. Huq. & G. R. Conway (Eds.), Environmental Aspects of Surface Water Systems of Bangladesh. (pp. 45-50). Dhaka: University Press Limited.

ICID (International Commission on Irrigation and Drainage) (2000), ICID Strategy for Implementing Sector Vision: Water for Food and Rural Development and Country Position Paper. Hanoi: ICID.

ICID (International Commission on Irrigation and Drainage). (2006) Water for Food, Hanoi: ICID.

IWRMU (Integrated Water Resources Management Unit, LGED) (2008a), Canal Digging Programme (CDP: 1979-1996). *http://iwrm.lged.gov.bd/cdp.php.* [accessed 04 June. 2011]

IWRMU (Integrated Water Resources Management Unit, LGED). (2008b), Rubber Dam Project: (1999-2004). *http://iwrm.lged.gov.bd/rubber-dam.php* [accessed 03 June 2011].

IWRMU (Integrated Water Resources Management Unit, LGED). (2008c). First Small Scale Water Resources Development Sector Project (1995-2002). *http://iwrm.lged.gov.bd/idpsswr.php* [accessed 03 June 2011]

Julia, K. (2009), Public Participation in Integrated Water Resource Management: Villages in Lao PDR and the Mekong River basin. Unpublished thesis for the Degree of Master of Environmental Studies,Waterloo: University of Waterloo.

LGED (Local Government Engineering Department) (1995), Project Proposal: Small Scale Water Resources Development Sector Project (SSWRDSP). Dhaka: LGED.

LGED (Local Government Engineering Department) (2001), Development Project Proposal for Second Small Scale Water Resources Development Sector Project. Dhaka: LGED.

Lange, W. D. and Kleynhans, T. E. (2007), Towards More Inclusive Long-term Bulk Water Resource Management. Agrekon, 46 (3), 371-397.

LGED (Local Government Engineering Department) (2007), Dariapur Command Area Development Subproject. Chapi Nawabgonj, LGED.

LGED (Local Government Engineering Department). (2009), Activities at a Glance: Small Scale Water Resources Development. Dhaka: LGED.

LGED (Local Government Engineering Department). (2010a), Project Final Report: Second Small Scale Water Resources Development Sector Project. Dhaka: LGED.

LGED (Local Government Engineering Department). (2010b), Development Project Proposal for Participatory Small Scale Water Resources Sector Project (3rd Phase). Dhaka: LGED.

LGED (Local Government Engineering Department). (2010c), Revised Development Project Proposal for Small Scale Water Resources Development in GreaterMymensingh, Sylhet and Faridpur Areas. Dhaka: LGED.

Loans From Cooperative Society Makes Kabirun Solvent. (2011b, April, 25) The Daily Independent, p. 8.

MPIUS (Management Perspective International and Unnayan Shamannay) (1998), Ending Poverty? The Experience of Noradic Support to IRWP/RESP in Bangladesh. Solna: MPIUS.

MoWR (Ministry of Water Resources, Bangladesh) (1999), National Water Policy, Dhaka: MoWR.

MoWR (Ministry of Water Resources, Bangladesh) (2000), Guidelines for Participatory Water Management. Dhaka: MoWR.

MIS (Management information System) (2011), SP25288, Dariapur CAD Subproject. Dhaka: MIS, LGED.

National Parliament of Bangladesh (2001), The Co-operative Societies Act 47 of 2001, Dhaka: Bangladesh Gazette Press.

Osman, S. M. and Qaium, D. A. (2011), Participatory Water Management in Bangladesh: The State of the Art. Proceedings of the 3rd International Conference on Water & Flood Management (ICWFM-2011). (pp.725-729). Dhaka: Institute of Water and Flood Management.

Palma, P. (2010, October 16), Food Security Faces Stiff Challenge. The Daily Star, p. 1.

Quasem. A. M. (2002), Diversification of Agriculture: A Comparative Study of Three Villages in Bangladesh. Dhaka: BIDS.

RESP (Rural Employment Sector Prgramme). (2000), RESP: Historical Development and Annotated Bibliography, Dhaka, RESP.

Roome, N. (2002), Sustainability, Globalization and Food Production. In P. Milton, M. Hall (Eds.), Proceedings of an International Symposium on the Global Challenge: Sustainable Food Production pp. 52-56, Brighton: BCPC Publications.

Ravenscroft, P. (2003a), Geologocal Background to the Hydrogeology of Bangladesh. In A. A. Rahman. & P. Ravenscroft (Eds.), Ground Water Resources and Development in Bangladesh, pp. 26-42. Dhaka: University Press Limited.

Ravenscroft, P. (2003b), Overview of the Hydrogeology of Bangladesh. In A. A. Rahman and P. Ravenscroft (Eds.), Ground Water Resources and Development in Bangladesh, pp. 43-83. Dhaka: University Press Limited.

Rahman, A., Rahman, T. and Rahman, T. (2007), The Role of Organizations in the Growth of the Rural Non-Farm Sector in Bangladesh: The Case of LGED. Dhaka: Unnayan Shamannay.

Rashid, A. K. M. M. (2009), Climate Change Vulnerability in Bangladesh: Strategic Position of DSK/ DCA in the Field of Climate Change Adaptation Initiatives in Bangladesh. Dhaka, Dustha Shastha Kendra (DSK).

River Water a Boon to Farmers (2011a, April 20), The Daily Independent, p. 8.

Siddiqui, H. M. (2000), Flood control and Drainage Development: Physical Environmental Issues. In A. A. Rahman., S. Huq. & G. R. Conway (Eds.) Environmental Aspects of Surface Water Systems of Bangladesh. (pp. 103-107). Dhaka: University Press Limited.

UNCED (United Nations Conference on Environment and Development) (1992), Agenda 21, the Rio Declaration on Environment and Development, the Statement of Forest Principles, the United Nations Framework Convention on Climate Change and the United Nations Convention on Biological Diversity. Rio de Janeiro: UNCED.

UC SAREP (University of California Sustainable Agriculture Research and Education Program) (2011), What is Sustainable Agriculture? Davis: University of California.

Warner, J. (2006), More sustainable Participation? Multi-stakeholder Platforms for Integrated Catchment Management. *International Journal of Water Resources Development,* 22 (1), 15-35.

WB (World Bank), (2010), Employment Generation Program for the Poorest, *http://web.worldbank.org/ external/projects/main?* [accessed 03 June 2011].