SUSTAINABLE FARMER-MANAGED
GROUNDWATER IRRIGATION SYSTEMS

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ABSTRACT

A quiet revolution has taken place in Bangladesh with the introduction of a variety of technologies for abstracting groundwater. These facilities which are primarily Farmer Managed Irrigation Systems (FMIS) have brought irrigation within the reach of millions. The full usefulness of groundwater however, has yet to be exploited. A concerted attack on the challenges of managing the groundwater irrigation systems still remains to be attempted. The problem is compounded by the decreasing per capita grain production and per capita cropped area. The low level of productivity virtually at subsistence level renders FMIS vulnerable to externalities. Prevailing organizational, promotional and support services imposes high risks and heavy managerial responsibility upon FMIS operators far beyond their capability and capital resources.

To move away from traditional agriculture and attract increased investments and the use of resources, four factors must be satisfied; they are:

i) improved and sustainable performance at system level;
ii) improved profitability and production at farm level;
iii) Greater efficiency in the use of resources; and
iv) Overall net benefit.

At the moment too little is attempted to address solutions to the above. There is need to inspire action on the inherent potential of the groundwater irrigation development and transform it into a domestic effort. Strengthening water management institutions by providing support services are also essential to render FMIS sustainable.

Successful development depends on encouraging an interacting system of public and private institutions where investments in areas such as physical infrastructure, research and extension are sustained. Increased attention and efforts must be made to make FMIS investments and productivity viable. To sustain their continued use will depend on resource endowments, institutions, technological changes and policies.

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1. INTRODUCTION

Bangladesh, located in the outlet for three of the largest rivers in the world presents the challenge of a densely settled, rapidly growing and improvised population facing alternating seasons of water surplus and deficiency. It is subjected to the raw power of nature distinctively characterized by their destructive, constructive and necessary elements seen nowhere else. It has a population of 110 millions placing about 12 people per hectare of arable land as compared to 1.3 in the USA. The water regime of Bangladesh has made it one of the most rice intensive agricultural systems in the world. Both nature and farmers have adapted themselves to its unique water regime in many ways. In relation to the basic problem of growing enough food for the increasing population, overcoming the lack of winter rain is far more important than managing periodic natural disasters like floods and cyclones. Growth in grain production is directly related to the availability of irrigation, the indispensable 'platform' supporting all other green revolution inputs.

1.1 RESOURCES

A. Land resource

There are 9.03 million hectare (Mha) cultivatable land in Bangladesh of which about 7.56 Mha are considered irrigable. In 1989 irrigation was extended to 3.1 Mha of which about 1.81 Mha came from groundwater irrigation systems. It has been proposed in the Fourth Five Year Plan that by the year 1995 a total of 4.8 Mha is expected to come under irrigation of which about 3.02 Mha is expected to be extended from groundwater (Table-1).

B. Water Resource

Many in Bangladesh are now aware of the wastefulness of thinking in terms of surface water only rather than the entire water resource, much of which is under ground. Master Plan Organisation (MPO) has estimated that available recharge is in the region of about 21,088 million cubic metres (Mm3) of which about only 8806 Mm3 was withdrawn in 1990 for agricultural purposes. The future development potential from groundwater resource will require the active commitment of the political and engineering establishments in moving away from the historical orthodoxy that the only real water is the water that can be seen on the surface. The slow recognition of the abundance and full usefulness of groundwater, and of the particular challenges of its management, must be counted as one of the constraints on full water development.

2. PURPOSE OF THE PAPER:

This paper intends to support discussion on conditions and problems of sustainability associated with Farmer-Managed Irrigation Systems.
3. GROUNDWATER IRRIGATION SYSTEMS:

Groundwater is extracted from the aquifers through waterwells (locally called tubewells) to meet the irrigation demand as well as to supply for domestic and industrial purpose. These tubewells comes in various types and sizes and could be identified under three categories as follows:

a. Manual Irrigation Pump (MIP)
   i) Hand Tubewell (HTW) ii) Treadle Pump (TP)
   iii) Rower Pump (RP)

b. Suction Mode Tubewell (SMTW)
   i) Shallow Tubewell (STW)

c. Force mode tubewell (FMTW):  
   i) Deep Tubewell (DTW)

The development of Groundwater Irrigation Systems curiously enough was first undertaken when 'large-scale' capital intensive projects were favoured. As a result DTWs preceeded STWs and HTWs were introduced before the Treadle pump. The type of technology chosen have in large measures affected the organization and management of the irrigation systems. With the multiplicity of technology choice and put through a learning process by encouraging 'Hands On' FMIS systems have enabled us to achieve a technological breakthrough. Gradually with the greater diffusion of technology the country has been able to transform its traditional agriculture and also mechanise the riverine transportation system.

Large-scale DTWs were first introduced in the late 1960's modelled after the Comilla Co-operative Movement that stressed farmers' group management on technology, finance and organisation. It was determined that a DTW with 56 litres per second (2 cubicfeet per second) pumping capacity would be appropriate. According to a 1991 survey there are about 32626 DTWs on the ground.

STWs entered service more unobstrusively in the mid 1970's but has come to reserve its place as a first in the choice of technology. STW suited the enterpreneurial urge of the farming community because it was considerate on costs and relatively more manageable than a DTW. A 1991 survey estimated that there are about 2,05,262 STWs on the ground.

To make irrigation available to small and marginal farmers HTW were first introduced in the early 1970's. Subsequently, Treadle and rower pumps which were far superior than HTW and also cheaper were introduced. By 1990 Orr, Islam and Barnes estimated that over 9,00,000 manual irrigation pumps were in operation. The rapid pace and size of growth demonstrated the unsatisfied demand for small irrigation equipment which have proven to be more controllable and affordable and stressed farmers entrepreneurship.

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4. **Sustainability of Groundwater FMIS:**

Historically, groundwater irrigation systems contrary to misconception was the result of vibrant public-private partnership. While authorisation of resources had been the domain of the public sector, the management at the farms level had always been absolutely with the enterprising farmers. This is a unique example of privatisation of long before it became a fashion. The partnership had encouraged various forms of supply, ownership and management of the irrigation systems at farm level, they are:

1. Public supply and ownership, private management;
2. Public supply private ownership and private management;
3. Public supply NGO ownership-private management.
4. Private supply private ownership and private management.

Despite massive thrust in creating facilities for groundwater irrigation systems, per capita grain production (Fig.1) and per capita cropped area (Fig.2) are decreasing. The low level of productivity virtually at subsistence level is not so much because farmers lack dynamism and motivation. It is because the prevailing organizational, promotional and supporting service for practising modern agriculture imposes high risk and heavy managerial responsibility upon FMIS operators far beyond their capability and capital resources. The low level of research and technical support and inadequate marketing facilities have made them reluctant to intensify and diversify crops. The smallness and fragmented nature of their holdings, a legacy of semi-feudal agrarian system have also discouraged farmers from utilizing modern farm machinery (ISPAN, 1989). Against this backdrop some of issues that concerns sustainability of the FMIS needs examining:

4.1 **Management Organization:**

The ownership and management trend through the years have inexorably put the FMIS to take on responsibilities for which they are not quite prepared. Inspite of a variety of management styles, there is no clear winner because all of them are subjected to externalities quite beyond their control. Reduced credit, high energy costs, equipment pricing, groundwater regulations and cost of produces all have a dampening effect rather than a productive effect.

4.2 **Resource Management:**

MPO's action research findings have clearly delineated exclusive mutual zones for suction mode and force mode zones, but with the inability of any control over siting of facilities for STWs three differing scenarios are becoming more probable:

i. STWs enroaching on existing DTW command area;
ii. Entire zones of STW areas lowering water tables to the point that everybody pays excessive energy costs of pumping;
iii. DTWs sunk in STW areas lowering water tables to a point that only DTWs are viable and force the suction mode out of operation.

iv. Excessive/unregulated pumping affecting social/ecological environment.

A reasonable legal framework that can be enforceable is clearly necessary to delineate STW-DTW zones and also maintain a sharp edge over aquifer management initiatives continuously.

4.3 WATER MARKET

According to water market study (BAU, 1986) it was found that the market however imperfect was competitive and reasonably efficient. There was ample opportunities to seek to support the water market through institutions. It recommends taking positive actions to promote access by the poor to credit and water markets to allow them to compete on fair terms with the already well endowed.

4.4 EQUIPMENT MARKETING:

The private trading of irrigation equipment though limited to STWs is largely the effect of duty free import of small engines intended for agricultural use. This tariff facility has in practice encouraged foreign dumping of low-cost small diesel engines (in some cases) while suppressing local assembly and which are used extensively for marine and industrial purpose too. Consequently, traders are not required to direct their services to cater to information, repairs and O&M aspects of irrigation equipment. Although FMIS have little to expect anything tangible from traders there is however a real need for an efficient support service sector.

5. ACTIVITIES TO SUSTAIN FMIS:

Of all the challenges confronting Bangladesh perhaps none is more focal and urgent than creating an environment and a policy framework to encourage sustainable farmer managed groundwater irrigation systems. The four factors required to be addressed are:

i. improved and sustainable performance at systems level.

ii. improved profitability and production at farms level.

iii. greater efficiency in the use of resources.

iv. overall net benefit at national level.

5.1 Farms level:

Farms attitudes are shaped mostly by the desire to ensure food security and increasing prosperity and was mould by the public-private partnership involved in developing groundwater irrigation systems. The most significant element inherent in this partnership was the evolving sense of social roles. While FMIS undertook farms management the public sector assistance in terms of price support, O&M support services and arranging credit was imperative. This partnership can cater to the
heightened expectation from the farming community as defined by generating more jobs, profits, systems revitalization and generally improve quality of rural life. Some of the activities required to be initiated are:

a) ensure favourable pricing of equipment and produce;
b) improve drainage/water conveyance system;
c) improve farm land command area to assist mechanization;
d) educate and provide training to introduce modern farm practices;
e) protect the environment; and
f) provide sustained investment.

5.2 SYSTEMS LEVEL

With groundwater estimated to provide greater part of the water to meet irrigation requirements for the next 20 years a massive investment programme by both the private and public sectors is in order according to the National Water Plan (1991). Expected investment is not forthcoming, because of many uncertainties: a) Private sector not yet fully ready (b) public sector withdrawing very fast, (c) supply is not yet ensured (d) price is not stabilized. The slowed investment has meanwhile just about managed to cripple the water well drilling industry and the manufacturing industry. A smooth transition of groundwater development capability from the public to the private sector is essential. Apart from the institutional aspect some of the other activities required to restructure and transform groundwater irrigation systems are:

a) Maintenance of the pace of creating groundwater irrigation systems per year (2500 DTW plus 10,000 STWs per year) according to MPO (1991) should also take into account replacement of worn out units @ 2000 DTW and 30,000 STW per year.
b) Resources for action research to evolve technological innovations to determine most cost effective technologies under different aquifer conditions should be ensured.
c) Land and irrigation system improvement to increase and consolidate command areas under irrigation as well as encourage the use of modern agricultural machinery from tillage to post harvest operations.

5.3 NATIONAL LEVEL

Increasing self-reliance is a oft stated public policy. The potential to achieve self-reliance is most profound in groundwater development than compared to any other resource. The domestic manufacturing industry have the capacity to manufacture/assemble all components of irrigation equipment, the drilling industry have the capacity to invest, mobilise and construct water wells and the services sector is also poised to move in. There is however no coherent initiatives to transform groundwater development industry into a domestic private market domain.
Steps to restructure institutions to bring about required changes, can be considered by taking the following measures:

1) Rationalization of tax and tariff to encourage local manufacture/assembly of prime movers (diesel engines and motors) both in the public and private sectors.

2) Strengthening the water management institutions at Farm level (both seller and buyers) to perform viable water management.

6. **CONCLUSION:**

At the very focal point of groundwater development lies the central issue of improved production and profitability that could render FMIS sustainable. The spark to motivate the farmers to invest more and prosper requires examination of a leading constraint - the historical non-commitment of the decision making elites to the primacy of groundwater. Groundwater development has the potential to be a domestic effort which can take us to the path leading towards self-reliance. Yet this sector is allowed to function marginally proportionate to external aid resources which is understandably kept low. Mobilization of domestic resources is inadequate.

6.1 **RECOMMENDATIONS:**

1. Based on the findings of the National Water Plan a massive groundwater development programme is in order and the effort should attract more public and private investments.

2. Restructuring of Development agencies to handle the Development role as dictated by public-private partnership.

3. Rationalise trade, tax and tariff system and encourage domestic self-reliance in the groundwater-based industries.

4. Strengthen water management institution by providing support as needed.

5. Take measure to develop skills and knowledge at all levels on water and land resource management.

6. Introduce farm land command area high productivity movement with popular/practical slogan.

7. Strengthen the feedback Information System to monitor performance of FMIS.
### TABLE-1

**IRRIGATION: ACHIEVEMENT AND FFYP TARGETS**

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<tbody>
<tr>
<td></td>
<td>Mha</td>
<td>%NCA</td>
</tr>
<tr>
<td>A. Surface Irrigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) BWDB Schemes</td>
<td>0.21</td>
<td>2</td>
</tr>
<tr>
<td>b) Low Lift Pump</td>
<td>0.78</td>
<td>8</td>
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<td>c) Traditional</td>
<td>0.30</td>
<td>3</td>
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<tr>
<td><strong>Sub-Total (A)</strong></td>
<td>1.29</td>
<td>13</td>
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<tr>
<td>B. Groundwater Irrigation</td>
<td></td>
<td></td>
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<tr>
<td>a) STW</td>
<td>1.25</td>
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<td>b) DTW</td>
<td>0.50</td>
<td>5</td>
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<tr>
<td>c) FMTW</td>
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<tr>
<td>d) HTW</td>
<td>0.05</td>
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<tr>
<td><strong>Sub-Total (B)</strong></td>
<td>1.81</td>
<td>19</td>
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<td><strong>Total (A+B)</strong></td>
<td>3.10</td>
<td>32</td>
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**Source:** Fourth Five Year Plan (1990)

**Abbreviations**

- NCA - Net Cultivable Area (9.03 Mha)
- IA - Irrigable Area (7.56 Mha)
- STW - Shallow Tubewell (Suction Mode)
- DTW - Deep Tubewell (Force Mode)
- FMTW - Force Mode Tubewell
- HTW - Hand Tubewell
FIGURE 1
Trends In Per Capita Grain Production Bangladesh Source Statistical Yearbook For Bangladesh 1987

FIGURE 2
Decline In Cropped Area Per Capita In Bangladesh 1975–2005 Source National Water Plan (1985) I Figure 3-2
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<tr>
<td>1.</td>
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