

**DEUTSCHE GESELLSCHAFT FUER  
TECHNISCHE ZUSAMMERBEIT (GTZ)**

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**PROMOTION OF THE USE OF RENEWABLE ENERGIES (PURE)**

**IDENTIFICATION & ASSESSMENT OF THE APPLICATION POTENTIAL OF  
SOLAR PHOTOVOLTAIC WATER PUMPING INITIATIVE (PVP)  
IN BANGLADESH**

***EXECUTIVE SUMMARY OF FIELD VISIT REPORT - I***

***08 August 2006***

INTERACTIONS WITH

BANGLADESH AGRICULTURAL RESEARCH INSTITUTE (BARI)

BANGLADESH RICE RESEARCH INSTITUTE (BRR), GAZIPUR



LOW-COST DRIP IRRIGATION OF TOMATO (AT BARI) PROVIDES 5 X HIGHER YIELDS (90 MT / ha)

**VISIONS :**

***“Plug your Drinking Water Supply to the Sun”***

***“Green Pumping for a Greener Bangladesh”***

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**GTZ-PURE**

## **ACKNOWLEDGEMENT**

The Consultant acknowledges with deepest thanks the excellent cooperation extended by the team of professionals, led by Dr. Md. Syedul Islam, Principal Scientific Officer (PSO) and Head of Farm Machinery & Postharvest Technology Division, BRRI for a very fruitful interaction. Thanks go to all other members of the same Division at Bangladesh Rice Research Institute (BRRI), who interacted with the author and exchanged ideas, experiences, especially to Dr.-Ing. M. Mahfuzur Rahman, Senior Agricultural Engineer, Engr. Abdur Razzaque Akanda, SSO and Engr. Md. Abdur Rahman, SSO of the same Division at BRRI, for their valuable inputs in interactions on the subject and providing many relevant information/data and for further introducing the author to the Irrigation & Water Management (IWM) teams at BRRI and also Bangladesh Agricultural Research Institute (BARI).

The cooperation extended by Dr. Sattar, CSO & Head, IWM Division of BRRI, Dr. Kshirode Chandra Roy, CSO & Head, Farm Machinery & Postharvest Process Engineering Division, BARI and Dr. Serajul Islam, PSO and Head, IWM, BARI are specially acknowledged. Discussions with them enriched the author's knowledge in the area of irrigation and water management as it is being practiced in Bangladesh and for identifying and highlighting the areas opportunities by increasing the overall irrigational and hence, also the energy efficiency in the agricultural sector, which provided further inspirations to the author in the PVP Initiative Study - Stage 1A.

The author uses this opportunity to acknowledge GTZ-PURE's supports which made these field visits possible in connection with the PVP Initiative, which will help in obtaining practical feedback through such field visits - both from top professionals, as well as from the grassroots levels who make things happen. Such interactions will be optimally utilized for evaluation and assessment of the potential of the use of PVP in the Final Report and assist in making recommendations on the project, its formulation, design and eventual implementation.

## 1.0 BACKGROUND

This Interim Field Report (II) has reference to GTZ-PURE's assignment under Contract No. 83001737 and Project No. 022129100100 - Promotion of the Use of Renewable Energies, whereby the **Stage-1A Works** (Inception/Study Phase) are required to be performed, as per the Terms of Reference (TOR), to identify and assess the potential of **Solar Photovoltaic Pumping (PVP) Initiative in Bangladesh**.

To perform the said Stage 1A tasks, the Approach Methodology of the Proposal on PVP Initiative (Section 7.0 - A and B of the Proposal) included both primary and secondary data/information collection/feedback for situation analysis of both the Piped Safe Drinking Water Supply and Irrigation for Agriculture in rural areas through field visits and interactions with appropriate institutions/individuals/ engaged in application-oriented 'pilot projects' and also large scale sustainable/commercial operation.

A series of Field Visits were first performed in areas of North Bengal, especially areas covering Bogra, Natore, Rajshahi and other 'Barind' areas of Bangladesh, where rainfall is minimum ('semi-arid' zone) and the agricultural outputs are highly dependent on **Irrigation**. The programme philosophy and the highlights of outcome of these major visits vide a more comprehensive report entitled: "*Executive Summary Report on Field Visits*" dated 20 July, 2006, submitted to GTZ-PURE by the Consultant.

**This Field Report (II)** presents the interactions and data/information collections and the highlights of outcome/findings of such interactions with two other very related major institutions which, although R & D based, would also be quite appropriate in connection with the PVP Initiative of GTZ-PURE - Stage-1A, Bangladesh - the **Bangladesh Rice Research Institute (BRRI) and Bangladesh Agricultural Research Institute (BARI)**. These institutions are both nationally and internationally reputed and known for their commendable R & D activities and proto-type development works in the agricultural sectors in general and irrigation and pre and post harvest agricultural machinery in particular. In fact, the results of works of these two institutions are replicated/extended to the Farmer level by the large number of agricultural extension teams/centres, located all over the country.

## 2.0 RATIONALE BEHIND SELECTION OF BRRI AS AN INSTITUTION FOR INTERACTIONS RELATED TO PVP INITIATIVE OF GTZ-PURE

There had been the key reasons for selection of BRRI and BARI for interactions and data/information collections in connection with this study :

- Bangladesh Rice Research Institute (BRRI), (founded in Bangladesh, following the model of the International Rice Research Institute - IRRI of the Philippines), is engaged in conducting R & D works and Pilot/Prototype Model development in the following areas related, but not limited to :
  - **Water Management and Irrigation Requirement of Rice and Scopes for Conservation of irrigation water** (and hence irrigational energy use) for Rice Cultivation.
  - The R & D works and activities of BRRI (on inputs, including irrigation & water requirements, farm machineries/post harvest/bio-processing, agro-economic economic/financial evaluations) are **specifically centered around Rice**.
  - Field Research activities and findings on the **effects of flooding type irrigation vis-à-vis optimum irrigational water requirement** of BRRI. It would be interesting in connection with the use of PVP, since it has been established by BRRI that a large quantity of Irrigation water is wasted in Rice cultivation and the usual practice of over-flooding and keeping too much of standing water than required, which rather decreases the crop yield.
  - Issues and Research on the **Use of Low Lift Pumps (LLPs), Shallow Tubewells (STW) and Deep Tube-wells (DTW)** in Bangladesh are also being handled by the Farm Machinery & Postharvest Processing Technology Division of BRRI.
  - **Coordination with the Irrigation Department of BARI, RDA and Barind for transferring the results of their R & D Works** related to Rice, Rice-related Irrigation and Water Management for setting up of semi-commercial model or 'proto-type ventures' for their eventual further commercial based field testing and replication.

- **Use of Renewable Energies** (presently limited to Bio-mass) and the Energy Efficiency and Conservation in the rural/agro-energy sector and related issues, especially works related to the optimization of Rice Husk use through design of Efficient Rice Husk Boilers - an area where GTZ-PURE is already working with BRRRI and has recently very successfully conducted a national interaction for working out a 'road map' in this direction.
- **BRRRI is entitled to enter into cooperation for projects funded by foreign Governments** through appropriate Agreements. Although the projects undertaken by BRRRI are not as 'action-research oriented' (i.e. not Semi-Commercial/Commercial type projects) as conducted by RDA, Bogra or Barind, this institute conducts the technical/R&D works on new agricultural technologies and/or evaluate emerging agricultural technologies, tests and standardizes them and works in close cooperation with agricultural extension centres for their replication for reaching the technologies developed to the Farmer level.

## 2.1 INTERACTIONS WITH BRRRI TEAM

The Consultant interacted, with the following teams at BRRRI & BARI :

### (A) Irrigation & Water Management Experts:

- Dr. M. A. Sattar, CSO & Head, Irrigation & Water Management (IWM) Division of BRRRI
- Engr. Md. Abdur Razzaque Akanda, Senior Scientific Officer, Irrigation & Water Management Division, BRRRI

### (B) Agricultural & Post Harvest Farm Machinery Experts at BRRRI

- Dr. Engr. Md. Syedul Islam, Principal Scientific Officer (PSO) & Head, Farm Machinery and Post Harvest Technology Division, BRRRI
- Dr.-Ing. M. Mahfuzur Rahman, Senior Agricultural Engineer, Farm Machinery & Post Harvest Technology Division, BRRRI
- Engr. M. Abdur Rahman, Senior Scientific Officer, Farm Machinery & Post Harvest Technology Division, BRRRI

#### 2.1.1 HIGHLIGHTS OF DISCUSSIONS & FINDINGS OF INTERACTIONS WITH BRRRI

The Mission of the GTZ-PURE on the PVP Initiative, when explained by the Consultant - both verbally and through the letter of introduction issued by Mr. Eric Otto Gomm, Coordinator, GTZ-PURE, Bangladesh, was very well-received by the team at BRRRI. The increasing importance of "Synergy between Energy, Water and Agriculture" to accelerate the country's overall development through poverty reduction, especially through use of a Renewable Energy Source - the Sun, as the ultimate 'power house', was explained by the Consultant as the vision. The team showed keen interest in the PVP Initiative of GTZ-PURE and offered their technical cooperation ('Pre-Pilot'/Prototype Testing), if and when required at any stage.

Some key information on current activities of BRRRI in the Irrigation and Water Management sector and Farm Machinery use, related to Rice Cultivation, such as the use of Low Lift Pumps (LLPs), Shallow Tube-well (STW) and Deep Tube-well were discussed. The following data/information were collected/checked back with BRRRI, which will act as professional feedback in preparing the Stage 1A Final Report on the PVP Initiative :

- Current (updated) on the **number of Low Lift Pumps (LLPs)** for Surface Water Irrigation, commonly termed 'Power Pumps' (as cited in the national statistical publications and handbooks as 'Power Pumps' is confusing, since all non-traditional, i.e. mechanically-driven (diesel), as well as E-motor driven pumps, technically speaking, are power pumps Their updated number as quoted by BRRRI experts currently stand at : **100,000 units** in the country
- Update on the number of **Shallow Tube-wells (STW)** operating in the country : **1.15 million units**
- Update on the number of **Deep Tube-well (DTW)** in the country : **37,000 units**

The discussions with both the IWM Division and the Farm Machinery & Postharvest Technology Divisions of BRRRI revealed that the following interesting issues :

- the country is consuming about **40% of the imported High speed Diesel (HSD)** in the agricultural sector the rest 60% is used in the national Transport sector. However, a smaller part is consumed also by Power Tillers, whose number is presently estimated to be over 50,000 units.
- the maximum consumption of HSD is accounted for by **over 1 million** units of Low Lift Diesel Irrigation Pumps (LLPs) and also by the over 100,000 units of Shallow Tube-wells (STWs).
- the Power Tillers (used for land tilling), whose numbers are increasing, are replacing the Bullock Power for land tilling. These Power Tillers, along with HSD-driven rural transports, consume less than 5% of diesel fuel used in the agricultural sector (i.e. less than 5% of the 40%)
- In most cases, the use of **diesel-driven Irrigation Pumps** are tied up with **frequent break-downs** during the irrigation season. The **resulting crop losses** (due to such break-downs) may be in the range of **20-30%**.
- **the maintenance cost** of the small diesels may be as high as **12-15%** of the Capital Cost for the small Engines.
- the **smallest sizes of diesel-fuelled Irrigation Pumps in the market are in the 4 H.P. range**, for which fuel consumption is on the high side (estimate by Consultant of about 180 gm per B.H.P.-hr. was endorsed by the team, as found by the Consultant from the field and from RDA/Barind sources.
- the **Irrigation cost for Boro Rice** is reported to be low in national statistics, it may be higher than Tk. 5000/- acre for 90-100 days (1 crop Rice Irrigation). The annual DTW costs with large command areas (>25 hectares) go over Tk. 100,000/- per 100-day season per DTW in draught/semi-arid areas of Bangladesh and/or seasons with low rainfall.
- **the current capital cost for Diesel Engine in the smallest (4 H.P.)** range is of the order of **Tk. 10,000 - 12,000/-** per unit in the market.
- the small Diesel Irrigation Engines, suffer from **frequent injection pump failures**. Although their theoretical life is considered to be about 10 years (max.), practically, the Farmers need to buy a new Engine at every 5 to 7-year intervals, especially those who rent the engines for irrigation and operate more continuous hours.
- while appreciating the PVP Initiative and the (long) **life-cycle advantage of PVPs**, when explained by the Consultant, the **BRRRI Team endorsed this to be true, but requested, at the same time, to find some financial mechanism** so that the Farmers/Groups of Farmers can access the relatively high initial capital barriers of PVPs.
- the interaction revealed that the 'sister institute' - **BARI**, located just beside the BRRRI campus, is conducting development works mostly in the area of **non-Rice Crops**, i.e. **Vegetable/Fruits and other high-value crops**.

## 2.2 INTERACTIONS WITH BARI TEAM

The team at BRRRI endorsed the idea of the Consultant that for the evaluating the opportunities of PVP in Bangladesh, it would most interesting to interact with the team of Irrigation and Water Management (IWM) Experts of Bangladesh Agricultural Research Institute (BARI), who conducts R & D works, **related to Non-Rice Crops, i.e. Vegetables, Fruits and other high-value Crops**. Interaction with the following team of BARI was made, following the meeting with BRRRI professionals :

- Mr. Kshirode Chandra Roy, Chief Scientific Officer & Head, Farm Machinery & Post-Harvest Process Engineering Division
- Dr. Md. Serajul Islam, PSO and Head, Irrigation and Water Management (IWM) Division

### 2.2.1 HIGHLIGHTS OF DISCUSSIONS/INTERACTIONS WITH THE BARI TEAM

The following are the highlights of the discussions/interactions made with the BARI Team :

- On being explained the Mission by the Consultant, Dr. Kshirode Chandra Roy, CSO appreciated the PVP Initiative of GTZ-PURE and explained that BARI has concentrated more on the irrigation use of water on the high-value agro-produces, like :
  - Year-round Tomato
  - All other Vegetables
  - All kinds of Fruits (Banana, Mango, Lichi, Ananas etc.) that are grown in Bangladesh

The BARI, amongst others, is conducting development works on **Drip Irrigation** and has been able to achieve significant increase in **yields of Tomato**, which would suit for irrigation with even the smallest sized PVPs, or in integration with a rural water supply system, as the additional demand for water would be small. They have been able, for example, to **increase the yield of Tomato by about 5 folds, i.e. from 18 MT/hectare (national average) to 90 MT/hectare, using low-cost drip irrigation methods**, developed by them (see **Photographs in Annexure** of this report).

As per opinion of the BARI experts, **continuous, low volume irrigation at the 'root-zone' of plants is not only water conserving, but increases the yields by several folds**, as water is reached exactly to the area where it is required. The low-cost gravity-fed Drip-Irrigation method, using PVC/PP hoses, with locally developed low-cost plastic-injection molded 'emitters' (Tk 1/unit) is awaiting replication at the farmer level all over Bangladesh and BARI would welcome any possible co-operation of GTZ-PURE with PVP Initiative to test and develop commercial pilots to apply the same for Tomato, other Vegetables, Fruits, especially Citrus Fruits etc. When explained the advantage of PVPs in storing water in small to medium-sized central overhead tanks (Gazi Tank type) also for night use (when the sun is not shining and feeding its by gravity through the drip-arrangement, developed by BARI, the team expressed their positive views on PVP's potential, since such an irrigation arrangement would require a minimum of attention and with a float-valve arrangement, water could be continuously fed to a number of 'sub-tanks' from a central storage tank of only a few hundred to few thousand litres capacity, as per the water requirement of the Vegetable/Plants and the size of the drip-area/cultivation.

The works of BARI have indicated that on the average, irrigation of almost every fruit/vegetable like Tomato and Fruits, including Banana and Mango, **results in impressive increases in yields** and may double, triple or increase by even **5 folds** as they have found in case of tomato. Such high yields and the good value of the non-rice crops have the potential to off-set the relatively higher initial (capital) costs of the PVPs in a single season, after which there will no energy (fuel) costs and very minimum maintenance costs per year over the 25 - 30 year life-cycle of the panels and the pumps. The costs of locally developed drip-irrigation set up are very minimum (hoses with 1 mm holes at required intervals and low cost barrels with a central tank, compared to the return every season's output will provide.

A whole range of Information/data on increase in yields of various fruits and vegetables were collected from BARI, which will be very useful in assessment and evaluation of the PVP Initiative of GTZ-PURE and designing an appropriate project.

**Dr. Roy, CSO, BARI** further informed that in the early to mid Eighties, he **had the opportunity of testing a small Solar Photovoltaic Pump of 0.1 cu-sec. capacity** developed by an Ex-World Bank hydrologist for irrigation of small holding sizes (often less than 1 acre per Farmer), typical of this sub-continent. He had reportedly replicated the same in Orissa, India. It may be mentioned, that the Consultant (author) had also been involved, being commissioned by the Ministry of Science & Technology (S&T), Government of Bangladesh, as the then Renewable Energy Advisor, to test the same small **PVP (1982/'83)** at the premises of Institute for Fuel Research & Development (IFRD), along with Dr. M. Eusuf, the then Head of IFRD (now Senior Fellow and Head, Energy Division, Bangladesh Centre for Advanced Studies, BCAS). The positive findings on robustness and continuous working of this PVP was exchanged with Dr. Roy. The Government did not go further, as Bangladesh, during the Eighties, was not really prepared to integrate RE seriously into the mainstream energy.

Dr. Roy further introduced **Dr. Md. Serajul Islam**, Principal Scientific Officer (PSO) & Head, Irrigation & Water Management (IWM), BARI, with whom further discussions were continued on the low-cost drip-irrigation developed by them. The cost idea for the drip-irrigation system was given at about Tk. 3000/- per hectare, which is quite cost-effective compared to the value of the crop (e.g. for Tomato: Tk. 10/-kg average at farm x 90 MT/hectare, i.e. 90,000 kg/hectare- = **Tk. 900,000/- per hectare**). The great advantage of drip-irrigation, Dr. Serajul Islam, further explained, lies not only in conserving energy, but in conserving fertilizers too, as this is mixed (dosed in small required quantities) with water into the elevated drip-tanks for gravity feeding. The scope of using liquid organic fertilizers (e.g. effluent from Bio-gas) is also given by the drip-technique.

The meeting at BARI ended with visit of the **'Pilot Farm' within the BARI Campus, where their drip-irrigation is being tested and standardized** for their eventual replication through agricultural extension offices (see Photographs in Annexure).

The author concluded the interaction meetings with all expert members of BARI and BRRI on the 8<sup>th</sup> of August with thanks at a concluding tea and refreshment session, kindly organized by Dr. Syedul Islam, Principal Scientific Officer & Head of Farm Machinery and Post Harvest Technology Division, BRRI, Gazipur.

## **ANNEXURE**

Some Selected Photographs on Interactions of the Consultant  
with  
**Bangladesh Rice Research Institute (BRRI)**  
**Bangladesh Agricultural Research Institute (BARI)**

**INTERACTIONS OF THE CONSULTANT WITH A TEAM OF EXPERTS AT  
BANGLADESH RICE RESEARCH INSTITUTE (BRI), GAZIPUR**



The Author with the **Farm Machinery & Postharvest Technology Division Team** of Experts at BRI headed by **Dr.Engr.Md.Syedul Islam** (3<sup>rd</sup> from left), **Dr.-Ing.Mahfuzur Rahman**, Sr.Agricultural Engineer (Bioprocessing) (1<sup>st</sup> from right) The other members present in the interaction meeting with BRI were : **Engr. M Abdur Rahman**, Senior Scientific Officer and **Md. Ahiduzzaman**, Scientific Officer



The Farm Machinery & Post-harvest technology team introduced **Dr. M. A. Sattar**, Chief Scientific Officer (CSO) (right), **Irrigation & Water Management Division (IWM) Division**, who is one of the key Experts related to Rice Irrigation in the country and known for his national research and expert contributions to Water Optimization. Dr. Sattar showed keen interest in the PVP Initiative of GTZ-PURE and made some key observations on the large water wastage that is normally practiced in flooded rice-irrigation and pointed out the enormous opportunity in conserving water (and hence also energy) used in rice irrigation to the extent of 20 - 30%

**INTERACTIONS WITH TEAM OF EXPERTS AT  
BANGLADESH AGRICULTURAL RESEARCH INSTITUTE (BARI), GAZIPUR**



**Mr. Kshirode Chandra Roy**, Chief Scientific Officer (CSO) and & Head of Farm Machinery & Post Harvest Process Engineering Division of BARI, appreciated the PVP Initiative of GTZ-PURE, showed keen interest and discussed with the Author that in the early Eighties, **he was associated in testing a 0.1 cusec Solar Photovoltaic Pump at BARI** which was developed by an ex-World Bank Irrigation expert and given to Bangladesh for testing. Results were quite encouraging.

[It may be mentioned that the author, as the then Advisor to the Hon'ble State Minister for Technology - Dr.Engr.R.A. Ghanai for RE issues, tested the same Solar Pump. together with Dr. M. Eusuf, the then Head, Institute for Fuel Research & Development, IFRD]

**LOW-COST DRIP IRRIGATION BASED 'FLAGSHIP PROJECT'  
AT BARI. GAZIPUR**



**Dr. Md. Serajul Islam** (right) showing the low-cost Drip-Irrigation Pilot Project at BARI Test Plot. The Tomato yield has been successfully increased from the national average of 18 Mt/hectare to 90 MT/hectare (5 times)

