PROJECT REPORT

WEAP
WATER-USE EFFICIENT AGRICULTURE PRACTICE

FOR CLIMATE CHANGE ADAPTATION IN KALIGANJ, JHENAIDAH, BANGLADESH

JFGE
Japan Fund for Global Environment
Japan.

SPA
Share the Planet Association
Japan

SBF
Sonar Bangla Foundation
Bangladesh

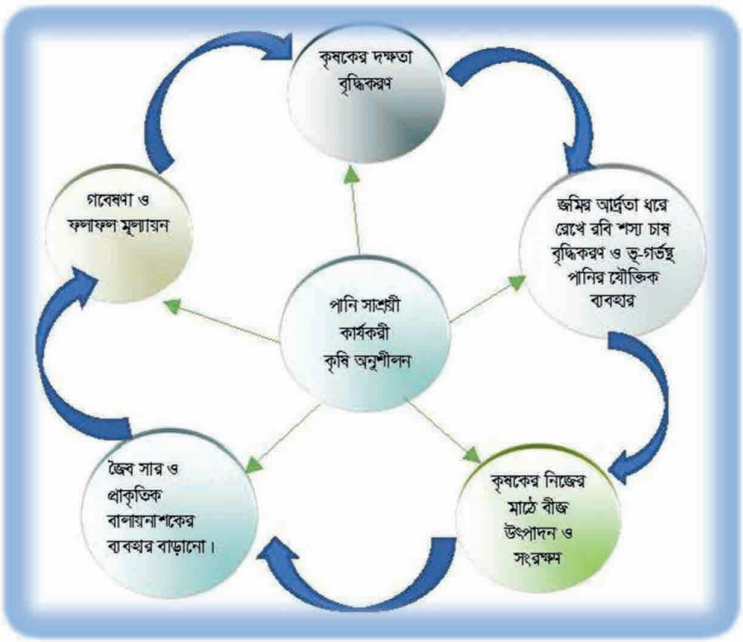
October 2021

PROJECT

ON

WATER-USE EFFICIENT AGRICULTURE PRACTICE (WEAP)

for climate change adaptation



WEAP
Conceptual Framework

Prepared by

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Reviewed by
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Implemented by
Soner Bangla Foundation, Bangladesh
In cooperation with
Share the Planet Association, Japan

Financed by
Japan Fund for Global Environment, Japan

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WATER-USE EFFICIENT AGRICULTURE PRACTICE (WEAP)

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Reviewed by

TSUTSUI Tetsuo,
Share the Planet Association.

Result discussion session with

IRRI and BRRI representatives,

BRRI Regional Station, Habiganj, Bangladesh

23 November, 2021

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Preface

Of late, we commemorate Bangabandhu's birth anniversary and the golden jubilee of independence. The dream of Father of the Nation, Bangabandhu Sheikh Mujibur Rahman had always been to see self-independent Bangladesh - free of hunger, poverty and exploitation. In order to translate his dream into reality, the present government put utmost efforts to sustain food and nutritional security of its large, dense and ever-growing population.

Hon'ble Prime Minister, Sheikh Hasina's government is agriculture friendly; all sectors including agriculture have achieved remarkable success under her able leadership. Government is providing various incentives to grassroots farmers to boost and sustain agricultural production. Sonar Bangla Foundation, among NGOs, deserves to be mentioned who are supplementing and complementing to the government efforts. The Executive Director of SBF, Mr. Shibu Pada Biswas, has already implemented education, child development programs etc., now, they are making famers self-dependent by taking various appropriate agricultural development initiatives.

Our country's groundwater level is going down day by day. As a result, irrigation becomes crucial and a costly input of production. I understand Japan Fund for Global Environment (JFGE), in cooperation with Share the Planet Association (SPA), is supporting the WEAP project implemented by Sonar Bangla Foundation to develop farmers with various kinds of training, digging small ponds at land corner and promoting water saving technologies; many farmers succeed by this project.

So far, I know this project period is about to an end. I understand this project has a lot of learnings and thought-provoking directions of deescalating groundwater use and to supplement/complement our Hon'ble Prime Minister's plan for agricultural development as well. I would like to thank JFGE and SPA for supporting our farmers, and on their behalf, I am also requesting JFGE to extend the project through Sonar Bangla Foundation with a view to achieving the Sustainable Development Goals together.

Joy Bangla, Joy Bangabandhu

Long Live Bangladesh

Anwarul Azim Anar

Member of Parliament (MP), Jhenaidah-4

Govt. of the People's Republic of Bangladesh

16 January, 2022

Government of the People's Republic of Bangladesh
Office of the Upazila Nirbahi Officer
Kaliganj, Jhenaidah

Preface

We understand that Sonar Bangla Foundation (SBF), under its continued development efforts, has implemented a water saving agriculture project in some unions of Kaliganj Upazila under Jhenaidah district.

While the climate change has impacted the planet by its frequent extreme events, the fresh water sources and ground-water aquifers continue to decline in an alarming rate that might threaten agriculture sector in particular, is a great concern nowadays. In the long run, these would have more negative consequences in rural livelihood, environment and Bangladesh economy as well.

To ensure best use of water resources and to minimize its wastage, SBF's timely initiative is praiseworthy by which farmers are getting benefitted, being conscious of efficient use of groundwater for irrigation, innovative farming practices and reduction of cost of production therefrom.

We expect SBF to come up with more innovative ideas to benefit farmers as well as local development; local administration is always supportive to these initiatives that enhance farmer-centered development efforts.

Sadiya Jarin
Upazila Nirbahi Officer (UNO)
Kaliganj Upazila, Jhenaidah
16th January, 2022

Preface

We are pleased to know that Sonar Bangla Foundation (SBF) has implemented Water-use Efficient Agriculture Practice (WEAP) project mainly with the target farmers of two unions- - Sundarpur-Durgapur and Niamatpur under Kaliganj Upazila with the financial cooperation of JFGE, Japan in association with Share the Planet Association, Japan.

We have been experiencing that the groundwater level is declining day by day that put challenges to potable drinking water, sustain crop production and environment. The project is about crop production under various water saving technique(s) and organic farming methods.

We understand that the farmers are benefitted by these methods of crop production; it helps farmers' cost saving farming practices as well as to improve environment. The Department of Agricultural Extension is also inspiring farmers by these methods of crop production through meetings and seminars.

We always stand beside such initiatives that enhance and sustain crop production system.

Shikder Mohammad Mohaimen Aktar
Upazila Agriculture Officer
Kaliganj, Jhenaidah

Preface

We are very pleased to share the final report of the project entitled "Water-use Efficient Agricultural Practices for Adaptation to Climate Change (WEAP)".

This project is funded by the Japan Fund for Global Environment (JFGE) and implemented by the Soner Bangla Foundation (SBF).

The success of this project is the result of SBF's dedicated efforts, as well as local and other agencies such as Union Parishad, Upazilla and District, Department of Agricultural Extension (DAE). Without their cooperation, we could not achieve the result. We would like to express our sincere gratitude to everyone involved.

In order to alleviate the problems of the decline of well-aquifers and climate change throughout the country, it is more important not only to make farmers understand the situation but also to convey economically beneficial farming methods. In that sense, it seems very important that this project proved that the new farming method would bring economic benefits and reduce irrigation water usage to farmers.

Finally, on behalf of the Share the Planet Association, we would like to thank all our partners, especially the farmers who have embraced our project and are trying new initiatives.

Tetsuo Tsutsui
Chairperson, Share the Planet Association
Japan
http://sharetheplanet.jp/

Preface

Sonar Bangla Foundation (SBF) keeps human rights, people's welfare, and good governance pivotal in its development efforts for the people of Kaliganj Upazila under Jhenaidah district since 1998. As a part of its continued development efforts, SBF implemented the WEAP (Water-use Efficient Agriculture Practice) project for local farmers under the financial assistance of Japan Fund for Global Environment (JFGE), Japan.

We experience that less water farming practices have benefitted the farmers both economically and environmentally. Moreover, project's contribution to sustainable food production system is attached with Sustainable Development Goals (SDGs). Therefore, it has supplemented and complemented to the government efforts towards achieving SDGs. With this farming practices, farmers are excited and are eager to step forward with more creative interventions.

We would like to convey our heartiest gratitude to JFGE & Share the Planet Association (SPA), Japan for supporting us financially and technically during the entire project period. We're thankful for our farmers; we are mutually benefitted by the project learning. We would like to thank the officials of local administration including the Department of Agricultural Extension for their cooperation and services during the project period. SBF is, indeed, indebted to JFGE and SPA having been benefitted with the project learning.

Shibu Pada Biswas
Executive Director, Sonar Bangla Foundation (SBF)
Kaliganj, Jhenaidah
www.sbfbd.org/sbf/

Contents

Acronym

ADD	= Additional Deputy Director
AEZ	= Agro Ecological Zone
As	= Arsenic
AWD	= Alternate Wetting and Drying
BADC	= Bangladesh Agricultural Development Corporation
BARI	= Bangladesh Agricultural Research Institute
BARC	= Bangladesh Agricultural Research Council
BDT	= Bangladesh Taka
BRRI	= Bangladesh Rice Research Institute
BSL	= Baseline
CI	= Cropping Intensity
CP	= Cropping Pattern
DAE	= Department of Agricultural Extension
DCML	= Decimal
DD	= Deputy Director
DTW	= Deep Tube Well
EDL	= End line
FGD	= Focus Group Discussion
FID	= Farmer Identification
GDP	= Gross Domestic Product
GHGs	= Greenhouse Grases
IRRI	- International Rice Research Institute
JFGE	- Japan Fund for Global Environment
KG	= Kilogram
LGIs	= Local Government Institutes
LIV	- Local Improved Variety
MT	= Metric Ton
MH	= Medium High Land (MH-1 & MH-2)
NCDs	=Non-Communicable Diseases
NGOs	= Non-governmental Organizations
OM	= Organic Matter
SAAO	= Sub-Assistant Agriculture Officer
SDEM	= Short Duration Early Maturing
SBF	= Soner Bangla Foundation
SPA	= Share the Planet Association
SRDI	= Soil Resources Development Institute
STW	= Shallow Tube Well
T. Aman	- Transplant Aman
UAE	= Upazila Agriculture Officer
UNO	= Upazila Nirbahi Officer (Chief Executive Officer of Upazila Administration)
WEAP	= Water-use Efficient Agriculture Practice

SECTION ONE

Executive Summary

1. Executive Summary

Human activities contribute to the impact of Climate Change. Research[1] reveals that over 99% of our climate change phenomena are anthropogenic, so does greatly impact two most important climate change phenomena i.e., global warming and rainfall patter vis-à-vis pushy extreme events in our planet. Agriculture acts both as a cause[2] and remedy of climate change. This is because that the important GHGs (Greenhouse gases) of agriculture fields are exchanged between agriculture ecosystem and the atmosphere.

Bangladesh ranks fourth in the world rice production occupying about 75 percent of its croplands - an estimated 8.57 million hectares of arable land. Rice being a staple food plays a vital role in the Bangladesh economy by contributing 11% of its GDP[3] so does water needs for its production dynamics. To meet food security needs, rice production can't be reduced/stopped, rather be increased through developing various alternative management globally. These alternative management may alter the dynamics of GHGs, and water needs in the agriculture ecosystem. While rice field is irrigated (in dry season) or goes under water (in wet season), the extent of management system creates anaerobic and aerobic conditions. Anaerobic condition favors emission of methan, which, among other GHGs, trap maximum heat in the atmosphere. Though research[4] reveals that from 1990 to 2019, the total warming effect from GHGs added by humans to the Earth's atmosphere increased by 45 percent the warming effect associated with carbon dioxide alone increased by 36 percent. Whatsoever, predicting impacts of the management alternatives is necessary and becoming crucial for sustainable crop yields vis-à-vis healthy environment.

While our planet's water-needs are raising rapidly, the running-out of potable-water (for drinking) and the non-stop of overuse or misuse of irrigation water continues, putting immense pressure on our groundwater and getting diminished gradually; when ground water is overused - canals, ditches, streams, rivers etc., connected to groundwater can also have their supply diminished. It has become an issue of discourse now-a-days too. Thus, along with changing temperature regime and erratic rainfall pattern, these anthropogenic activities (e.g., overuse or misuse of water) greatly interplay the groundwater recharge simultaneously. Therefore, scientific discussions and research findings put stress on alternative use of groundwater keeping adaptation pivotal and being awake to climate change are of great importance to poise farmers' ability to adjust or cope with the changing circumstances.

The objective of the WEAP project has been discussed under 'WEAP Conceptual Framework'. The framework comprises components and actions of alternative and judicial use of ground water by adjusting farmers' irrigation-scheduling through AWD (Alternative Wetting and Drying) technique or technology; rain-water harvesting through water reservoirs- - an indigenous method of catching and preserving natural water resources (quasi-surface irrigation practice); and Rabi crop inclusive cropping pattern considered as main means of adaptation and the principal construct of WEAP. Apart from those, crop-load carrying capacity of soils, farmers' capacity building were underlying factors for crop yields duly considered in the framework, thereby the adaptation actions help climate actions.

The project titled "Water-use Efficient Agriculture Practice (WEAP)" for climate change adaptation was implemented at 2 unions (lower administrative unit) - - Niamatpur and Sundarpur-Durgapur under Kaliganj Upazila (sub-district) of Jhenaidah district of Bangladesh. The research questions of the project are understandable, yet comprehensive. Rice paddy occupies a lion portion of cultivated lands as Boro-Fallow-Aman cropping patter in the southwest region including the project working area. To secure food for

[1] Published in 'Nature Communication', International Periodical, 2021 [Research conducted at Los Angles University of California, USA].
[2] 13% of Global Worming: World Resource Institute
[3] BRRI (Bangladesh Rice Research Institute), Gazipur, Bangladesh.
[4] U.S. EPA report, 2021 [https://www.epa.gov/climate-indicators/greenhouse-gases]

household, farmers tend to follow the stated monocropping pattern under the cropping pattern both in dry and wet season. Though the area is potential for growing Rabi crops, but farmers' mindset eventually aims at boosting crop yields that favors Boro paddy-rice cultivation on all land types under flood irrigation system during dry season. These results huge uplands get flooded during Rabi season with overuse of groundwater, while at the same time, the low lands bear the burden of excess flood-water run-off and become stagnant. In wet season, Aman rice (in Kharif-II) also needs underground water for seedbed, land preparation and supplementary irrigation during its critical growth stage to avoid draught injury, thus impacts crop yields if not irrigated in time; even it delays Rabi crop cultivation (especially wheat) in agriculture year [5] (of Bangladesh).

Along with other crop management practices, the overuse of groundwater alone not only untaps crop growth, but also impacts crop yield potential and faster ground water to diminish; impose almost a bulling effect on farmers' economies in terms of water price (as an input cost) as well as market (sale) price of rice. Adding that due to farmers' unjustified installation of STWs and DTWs, bypassing government rules, the tube wells for drinking water become almost inoperative in the dry season in many places of this area. There are incidences of arsenic (As) contamination in water noticed, putting health in place with so much of concerns.

Before the project intervention, we experienced that the farmers had lack of early maturing quality Rabi seeds was a major setback for inclusive (Rabi crops) cropping pattern. So, keeping those views in mind, the project thought about farmers' capacity building on seed production of Rabi crops at their own fields, preservation of seeds at farmers' houses to make them available at peak sowing season. For capacity building, all farmers (300) were trained on WEAP conceptual framework and have their soils tested twice during the project period. One hundred farmers were especially trained on seed production and preservation. The project provided 100 seed drums for seed preservation and arranged supply of quality seeds from BADC (Govt. agency). At the end line (EDL) survey, we observed 91% (91) of the especially trained farmers multiplied and used good quality seeds, 41% (37) sold 1.02 MT (1018 kg) quality seeds of Mustard (BARI- 14), Lentil and Paddy worth BDT. 65,905 in the third year. We also noticed that farmers who used to produce seeds by conventional seed production practice, had their skills developed through WEAP training; 34% farmers' (n=264) capacity for producing relatively good quality seeds was increased from 28% in the baseline; the rate of increase is about 22%. One important observation was that the project introduced BARI-14 Mustard seeds in this area. Now DAE, Kaliganj has expedited distribution of BARI-14 Mustard seeds to farmers of Kaliganj Upazila.

The project residents (n=300), by number and land coverage, increased non-irrigation-reliant agriculture practices during Rabi seasons and diversified crops with Lentil, Mustard, Wheat, Maize, Beans, Summer Tomato etc. EDL data analysis reveals that 83% project residents (249 out of 300 farmers) covered 41% (22,968 dcml) lands under non-irrigation-reliant Rabi crops. The rate of increase is 264% from baseline lands (8,693 dcml). Adding to that >7% (22) farmers shifted their Boro cultivable lands to Rabi crops.

The project began with 200 target residents (farmers). In the second year, 100 new interested residents were added, and the total project residents stood at 300 until third year. So, irrigation water scheduling of 200 project residents had been consistently monitored from first year through third year and the same for 300 residents in third year only. We observed 37-38% reduction of over dependent ground water irrigation by practicing AWD technique. Farmers adjusted irrigation scheduling in dry season rice (Boro rice) cultivation from an avg. 79.47 days on BSL to avg. 49.50 days on EDL. BRRI scientist predicts this would have cut 30-40% methane emission to atmosphere (ibid). However, farmers were able to gain 29% economic balance (cost of water) through this alternative water usage. Similarly, 125 farmers from 125 water reservoirs (small ponds at field corner) were able to irrigate 2,302 days (an average of >18 days per farmer) during the wet season rice (Aman rice) of the project period and for supplementary irrigation on an avg. >8

[5] Agriculture year of Bangladesh refers to growing of crops in a year comprising Rabi and Kharif seasons (Kharif-I &II).

days (total 1,018 days in 3 years) each of the farmers during the project period. Unless otherwise this would have impacted groundwater as farmers are equally dependent on groundwater for seedbed, land preparation as well as supplementary irrigation. The caption of this report is a vivid portrait where a farmer found irrigating 20-22days old T. Aman rice from water reservoir due to shortfall of rainy days and to avoid draught as well.

Change of farmers' economies in this project period is huge. The 300 project residents, individually, increased yearly average income by 123%. Individual farmer's yearly average income was BDT. 159,220 at EDL than that of yearly average BDT 129,752 at BSL. This income-increase also took WEAP components into account and were analyzed in detail inside.

Apart from that, the project had synergic and spillover effect. National and local print and electronic media (14) portrayed synergic effect. It was evident that a total of 204 non-target residents (surrounding the target residents) were befitted; 123 from Rabi farmers, 67 from over dependent ground-water-irrigation farmers and 14 farmers who dug out water reservoirs by themselves.

Government Agriculture Officials, Upazilla Administrator (UNO), Public Representatives (Member of the Parliament) quoted WEAP practice as step forward towards achieving desirable environment. Government officials are also citing this practice in training, seminars and discussion with farmers and wider audiences. Government Fisheries Department distributed fish fingerlings to farmers' water reservoirs and regularly inspected farmers' fields. During the project period, officials of Agriculture Extension (DAE), extended visits to farmers' fields too. WEAP farmers are satisfied by seeing physical attendance and timely advice of DAE officials in the fields. DAE, Kaliganj, has started promoting Rabi crop cultivation and demonstrating plots to inspire farmers to cultivate more Rabi crops and suggested farmers to practice AWD for commercial and profitable agriculture.

Finally, it can't be unwise to say that the target residents demonstrated their skills as well as achievement of project outcome. Thus, the value of money has been utilized properly under the project; before interventions, farmer virtually did nothing on climate actions. With this achievement, project residents put forward suggestions to the development thinkers for escalating reduction of groundwater and attain a new height through developing pipe irrigation system, more inclusive cropping patterns including non-irrigation reliant early maturing and short duration Aus and Aman rice varieties (new) developed by BRRI and research institutes; the approach will keep biodiversity viable and enhance climate actions through means of adaptation.

SECTION TWO

Project Background : Setting the context

2. Project Background : Setting the context

Bangladesh ranks fourth in the world rice production after India, China and Indonesia occupying about 75 percent of cropland, an estimated 8.57 million hectares of arable land. Rice is a staple food plays a vital role in the Bangladesh economy by contributing 11% of GDP (Bangladesh Rice Research Institute).

Agricultural fields play an important role on greenhouse gas (GHGs) budget. GHGs such as- Carbon di-oxide (CO2), Methane (CH4), (N2O) etc., are exchanged between agriculture ecosystem and the atmosphere; the plant uptake atmospheric C02 for photosynthesis and the agricultural ecosystem including activities of soil microorganisms release CO2 to the atmosphere as their respiratory byproduct[6]. Rice is grown both wet and dry conditions. When rice field is irrigated (Boro rice in dry season) or goes under water during Aman (in wet season), it produces CH4 which trap maximum heat in the atmosphere than other GHGs. So, application of water to rice field or heavy down pour (during dry even wet season) creates anaerobic condition (on standing water at rice field) favoring emission of CH4 while under dry condition, plowed paddy field produces N20 which is also a dangerous greenhouse gas that also trap heat. Thus, for food security needs, rice production needs to be increased through developing various alternative management globally. These alternative management may alter the dynamics of C, N, and water in the rice ecosystems. Predicting impacts of the management alternatives on C and N biogeochemical cycles is becoming crucial not only for sustainable crop yields but also environmental safety.

The "Green Revolution" using groundwater irrigation, pesticides, chemical fertilizers, and high yielding varieties of rice spread to Bangladesh since seventies. Before that, rice was grown in the rainy season, and beans, millet, rapeseed, vegetables, rabi crops etc., were traditionally grown in the dry season. Rabi crops could restore the fertility while contributed to biodiversity and nurtured diverse food cultures for producers and consumers. Though, with the beginning of dry season rice cultivation, the long-awaited rice self-sufficiency has been achieved, but poses new problems - - the vulnerability of producers' lives; the impact on environment; land is exhausted due to continuous cropping, and similarly yields cannot be expected even with increased use of chemical fertilizers year by year. Looking at the income and expenditure balance of rice cultivation, expenditure as against percentage of yield is found increasing making it difficult to say that rice cultivation is profitable agriculture. Contrary to that, the heavy use of chemical fertilizers and pesticides have destroyed ecosystems and introduced monoculture, also making it difficult for producers to obtain a variety of foodstuffs. It is said that the poorer the population, the higher the proportion of carbohydrates in the diet of Bangladeshis, which causes many non-communicable diseases (NCDs) such as diabetes. These phenomena make farmers' lives unstable.

The excessive use of pesticides and chemical fertilizers, on the other hand, limit earthworms or microorganisms that decompose organic matter in the soils due to multiple throws of pesticides. Now, chemical fertilizers don't play significant in yield increase as of before, and the cost of irrigation water and the expenditure for securing chemical fertilizers have put pressure, in term of cost of production, on the lives of farmers. In recent years, it has become difficult to secure irrigation water due to the decline of the underground aquifer.

In rural settings of Bangladesh, domestic water is generally obtained from wells. However, a phenomenon has occurred in which arsenic and nitrogen compounds are dissolved in groundwater due to excessive use of ground water. In addition, there is a problem of health damage to the human body caused by ingesting these from drinking water of residents. There is need to build sustainable agriculture system that doesn't burden the environment, taking into account of various aspects such as securing safe water, restoring soil environment and biodiversity, sustainable water use, and health of residents.

However, there are very few practical examples-

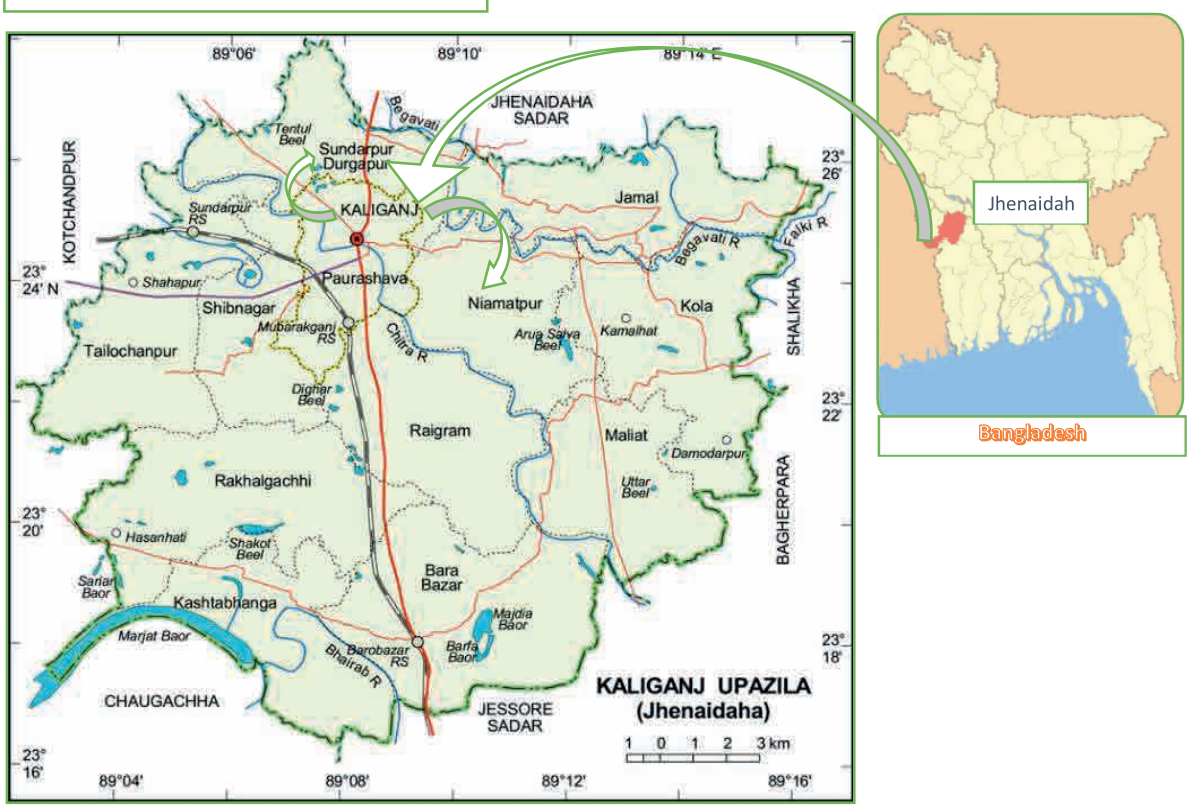
[6] (Harazono et al., 2000; Miyata et al., 2000; Baten et al., 2001; Campbell et al., 2001; Harazono et al., 2001. 2002; Kim et al., 2002; Miyata et al., 2005).

(1) Reduction of overdependent ground water irrigation in dry season cropping.
(2) Lack of knowledge and supply of crop seeds for agriculture practices that do not rely on irrigation.
(3) Few agriculture practices that don't rely on irrigation.
(4) There is no interaction between farmers who do not rely on irrigation.
(5) There are few practical reports or data for dissemination such as economic benefit for farmers on the above.

The project location

The project is located at Kaliganj Upazila of Jhenaidah district (= prefecture) under southwestern part of Bangladesh (Figure-1)

Figure-1: WEAP Project Location



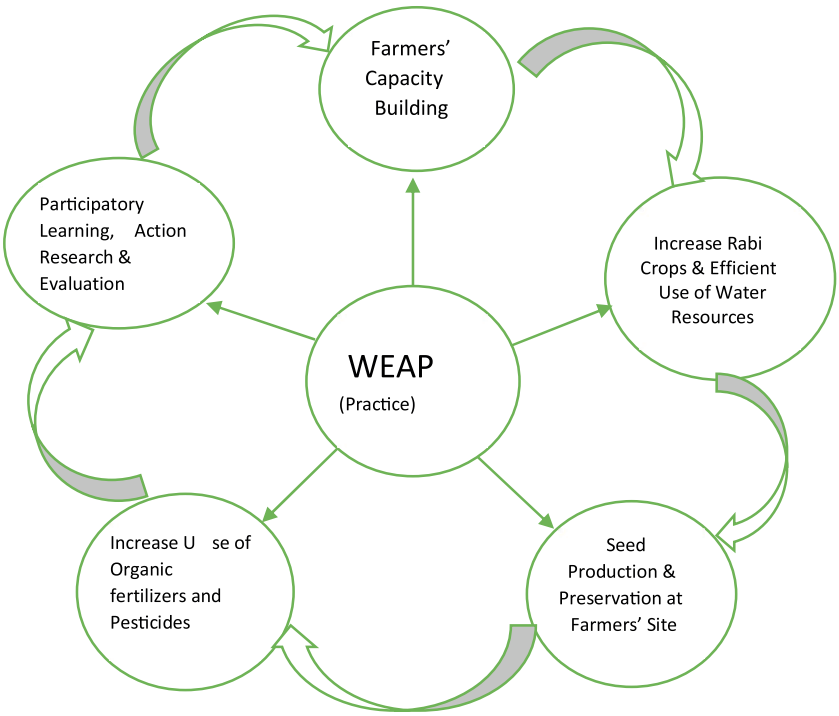
The project area has vast plain lands predominantly with agriculture and rice cultivation being pivotal in agriculture practice. Nine rivers flow through the prefecture causing occasional flooding during the rainy season. Once, rivers had been crowded with fish, but later, fishing drops sharply due to pesticide spraying and overfishing. In recent times, many of them become minuscule, loses connectivity with their distributaries, and gets dried gradually. In addition, farmland is changing to residential and commercial lands by nearly 1% every year, and farmers who want to increase production in limited farmlands must use high (cost) inputs such as- pesticides, chemical fertilizers at larger amount and flood irrigation to increase rice yield and improve quality. In the dry season, rice cultivation by groundwater irrigation has become commonplace, resulting in the deterioration of the local environment, including a decrease in the aquifer of groundwater.

While soil texture being very fine (loamy/clay), including mainly calcareous dark grey floodplain and calcareous brown floodplain soils, is good for Rabi crops such as pulses, oilseed, vegetables (winter) and

spices like turmeric, onion, garlic etc., so does favor for cereals e.g., Aus, Aman & Boro rice, wheat & maize; cash crops like - banana, mango, sugar cane, betel vines, and ornamental crops. But lack of availability of quality Rabi crops seeds of different varieties limit crop diversification.

The annual rainfall is lowest and most variable, and the summer temperatures are generally the highest having a range of maximum annual mean temperature between 37°c and 41°c and the mean annual rainfall ranges from 1,467 to 1,537 mm. While some highland soils in the region are moderately well drained, a significant area is also poorly drained found during heavy monsoon rainfall even at late winter are subject to cause huge damage to both late winter Rabi crops and early summer vegetables. Water table is generally raised during heavy rainfall periods and flood-level fluctuates both within the rainy season and from year to year according to rainfall intensity and erratic weather pattern and/or climate variability. The groundwater level is the highest (about 2 m below ground) in September and then gradually decreases to lower alarming levels in March. During the period, many drinking wells remain inoperative in some places due to rampant and unfair use of ground water by DTWs, STWs etc.

The project focuses on 300 farmers living in two unions (the lower administrative unit in Bangladesh: an average population of about 30,000) in Kaliganj Upazilla (subdistrict), Jhenaidah district, to address the negative aspects of modern agriculture that has gone too far since the 'Green Revolution'. Practicing agriculture through efficient use of water resources (WEAP Conceptual Framework, below) is a new agricultural method to increase farmers' resilience. This involves drilling a water reservoir in part of a relatively lowland rice field (>3% of arable land) in the region to escape from agriculture (dry season rice cultivation) that relies too heavily on irrigation water. Cultivate rice crops or alternative crops such as-legume, oilseed (mustard, sesame, etc.), wheat, vegetables, etc. that do not rely too much on irrigation. In addition, they practice "Inada aquaculture" where they fish carp fish there (125 households). In the middle and highlands, the farmer aims to relocate from rice cultivation to legumes, oil seeds (such as mustard and sesame), wheat, and vegetables (assuming 100 households).



WEAP Conceptual Framework

WEAP Conceptual Framework' expects to help -

1. the use of groundwater is suppressed to increase the water retention capacity of the soil.
2. the fertilizer is agitated by fish farming and the use of chemical fertilizer is efficiently distributed to the soil; and
3. by practicing different farming methods in a complex manner, it is expected that farmers will teach and cooperate with each other, and as a result, a naturally occurring regional cooperation system will be established and the purpose of this project is to be built-up therefrom.

The technology and knowledge proposed as environmentally friendly farming methods are led by local NGO Sonar Bangla Foundation (SBF), and planning training for administrative staff and farmers with the support from DAE staff of the Kaliganj Upazila under Ministry of Agriculture.

In the second year and beyond, the perspective will be extended to other areas, and the aim is to exchange farmers and share experiences with the aim of building a network of farmers and NGOs that are implementing similar activities in Bangladesh. In addition, the results of such agricultural practices will be quantified as much as possible and will be announced to government and research institutions (third year).

Brief activities of the project

①. Organizing farmers' groups (organizing groups into villages, unions and counties) and baseline survey.

The challenge at the business location is that the long-term farming practices that have been run at the household level have created a cumulative environmental burden. Therefore, first of all, understanding the current situation and working on agricultural practices that do not rely on irrigation as proposed in this project is the key to reducing the environmental burden at the local level. In this project, farmers' group will be formed with farmers who wish to participate, and this group will take the initiative not only to practice agriculture without resorting to irrigation, but also to apply the knowledge and skills obtained through learning and practice to local residents (farmers) to interact with each other.

②. Training of farmers' group members and supply of necessary seeds and materials.

Provide training to organize groups on the conservation of the natural environment needed to produce more food, as well as the ecosystem impact of single cropping and the benefits of increasing the variety of crops.

This project aims to break away from monoculture practice, with an aim of preserving groundwater and restoring the local ecosystem. Specifically, some of the agricultural crops that do not require much water compared to dry season rice cultivation and have been cultivated in business sites long since e.g., legumes, oil seeds (mustard, sesame, etc.), wheat, vegetables, etc.) will selected. Provide seeds (100 hard-to-find) to the target people (100 people) and try to cultivate them in business locations. At the business site, soil productivity is a concern, so large harvests cannot be expected for several years, but the soil will be gradually fertilized by supplying earthworms (Red worm) to produce organic fertilizers, and farmers be suggested to raise green manuring crops to improve soil health.

As there are lack of short duration and early maturing seeds for growing Rabi crops in particular, the project expects to make it available from government offices/research institutes for interested farmers (for at least 100 farmers) to purchase.

③. Practice of agriculture without relying on irrigation

(Assuming 125 households in the middle and lowlands: 70 households in first year and 30 house in second year and 25 households in third year will dig a reservoir.

In middle and lowlands, a reservoir is dug in one corner of rice-producing fields (about >3% of cultivated land) to store surface water such as rainwater. Reservoirs not only increase the water holding capacity of the soil, but also drain excess water from the fields. By installing a reservoir, it is also possible to cultivate rice and crops other than rice in dry season and wet season. In addition, rice farming (which has been practiced in modern Japan) can provide sufficient nutrition without using chemical fertilizers and pesticides will be introduced. Fish droppings will help growing microorganisms in rice field-reservoir. The microorganism that grows in this way may produce organic matter, which is also the nutrient of rice, and nourish the rice field. Fish along with vegetables on the bank of reservoirs can help farmers getting household nutrients as well.

Deterioration of underground aquifers is largely due to excessive irrigation. By recovering a wide variety of crops that have been cultivated for a long time in the area, it is possible to restore ecosystem and restore soil water retention. For this purpose, the government agencies will provide excellent varieties and teach them how to provide containers for preservation and how to preserve them.

④.Evaluation and dissemination of community participation

The project will observe the growth of cultivated land by the members of the farmers group who practice agriculture without irrigation and evaluate the water-use efficient practice. The farmers will also monitor yield comparison. Furthermore, local NGO (SBF) and agricultural extension officers (administration) will work with the farmers' groups so that the results obtained through the practice can be disseminated to other residents (farmers) mainly by the farmers' groups.

Dissemination to society, network, and business monitoring evaluation. The results of the project and the practice of agriculture that does not rely on irrigation will be introduced to agricultural institutions and the mass media, thereby increasing the ripple effect of the project. It will also connect farmers' groups to local agricultural administrations and other NGOs to encourage them to provide the support they need. Share the Planet Association, which currently has a similar business in the prefecture, will aim for further synergies through comparisons and exchanges with its achievements.

⑤. This project will have a three-year plan, with a mid-term evaluation in the second year and a terminal evaluation in the third year. The mid-term evaluation will also receive feedback from farmers' groups, related government departments, and NGOs, and reflect this in their third-year efforts as needed. We will also share the practices of these initiatives and network NGOs in Bangladesh that perform similar activities.

⑥. Response status based on the contents pointed out in the intermediate consultation

Regarding the weaknesses of the local side, such as disseminating the results to the local community and disseminating them to society, we plan to use the media and other means mainly for the government. We also recognize that focusing on this area is a very important part of our role. In addition, we will strengthen the government's efforts to transfer the ownership of the business (we recognize that it is difficult in practice, but we will continue our efforts).

SECTION THREE

Project Yearly (Activity)
Achievement

3. Project Yearly (Activity) Achievement

3.1. Project Title

WATER-USE EFFICIENT AGRICULTURE PRACTICE (WEAP)

3.2. Project Period

1 April 2018-31 March 2021 (Extended up to 31 March 2022 due to COVID-19)

3.3. Project Goal

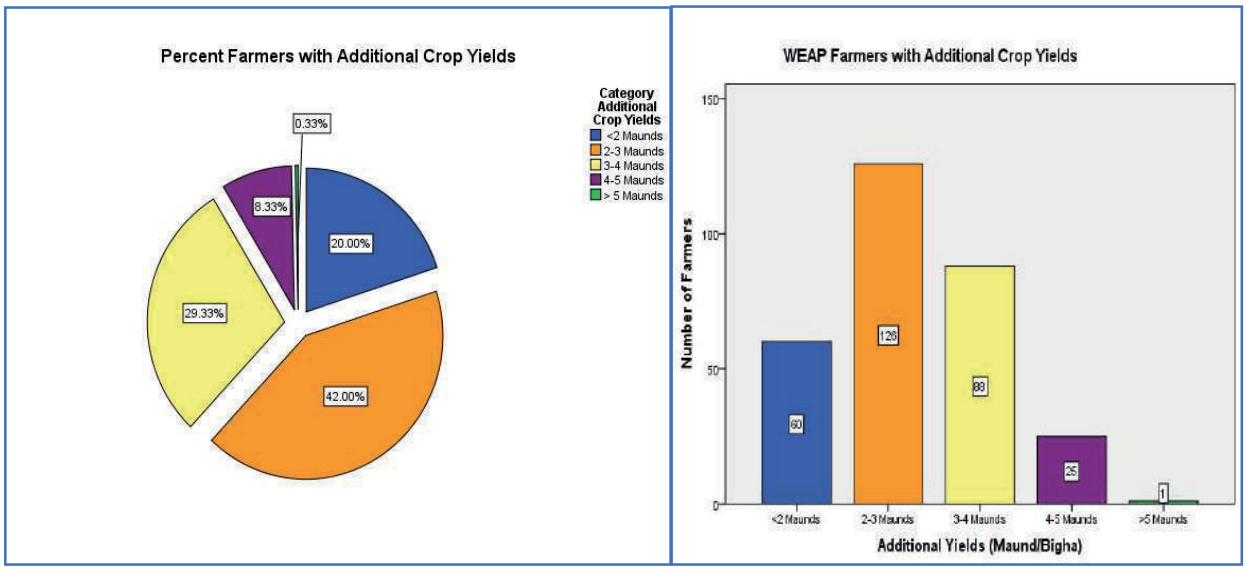
Yield per unit area and economic balance between agriculture that does not rely on irrigation and conventional farming economic balance is improved

ⓐYield per unit area: 90% or more, economic balance 100% or more

ⓑAt the end of the 2021 project (Based on sampling survey of practitioner farmers))

3.3.1ⓐ&ⓑ: Yield per unit area

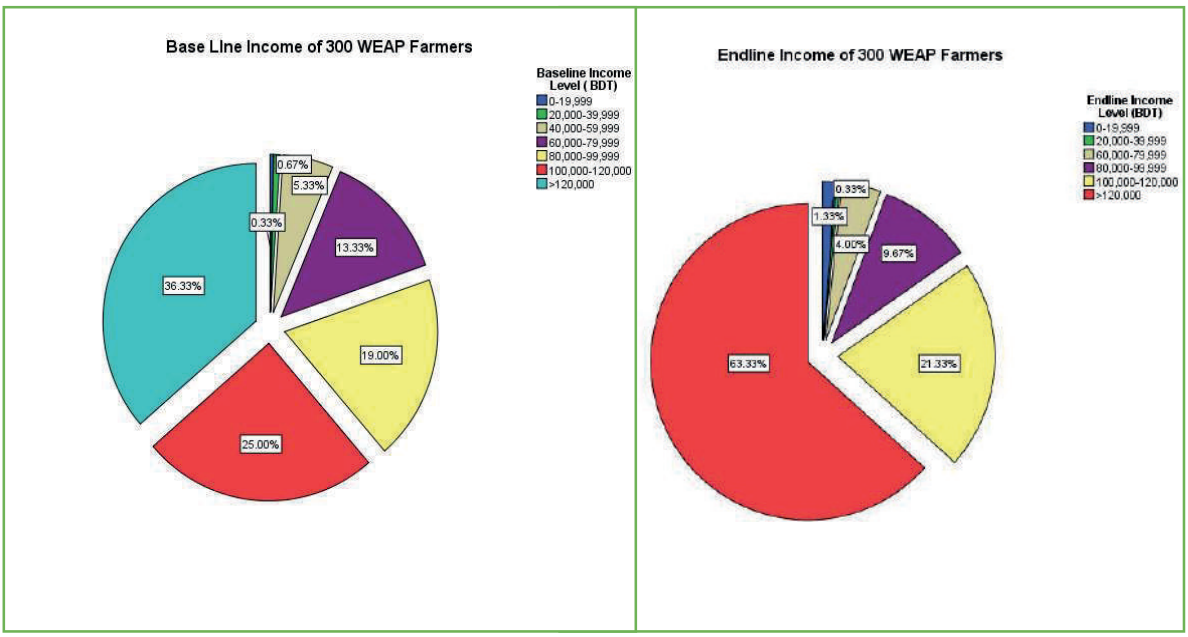
The additional crop yield per unit area (Maund/Bigha:1 Maund=0.04MT; 1 Bigha=46 decimals) of individual farmer was increased on an average 3.37 maunds at varying percentage (Figure below) of 300 farmers. The average crop yield of 300 farmers' end line was average 33.8723 maunds/bigha than that of 30.5054 maunds/bigha at baseline. So, yield increase is 111%.



3.3.2ⓐ&ⓑ: Income balance

The end line (EDL) survey of 300 target residents (farmers) individually has increased yearly income by 123%. The individual farmer's yearly income was an average BDT. 159,220 at EDL than that of BDT 129,752 at BSL. This income increase takes WEAP components into account at end line. WEAP components trigger farmers'

income balance that include profit from increased Rabi crop yields; additional crop yields and irrigation cost balance from Boro rice; supplementary irrigation cost balance from Aman rice from water reservoirs; sale proceeds from vermicomposting; saving balance by the recommended use of chemical fertilizers; and fish culture and vegetable growing on the dikes of water reservoirs. The data has been computed together and presented below with income range at varying percentages.



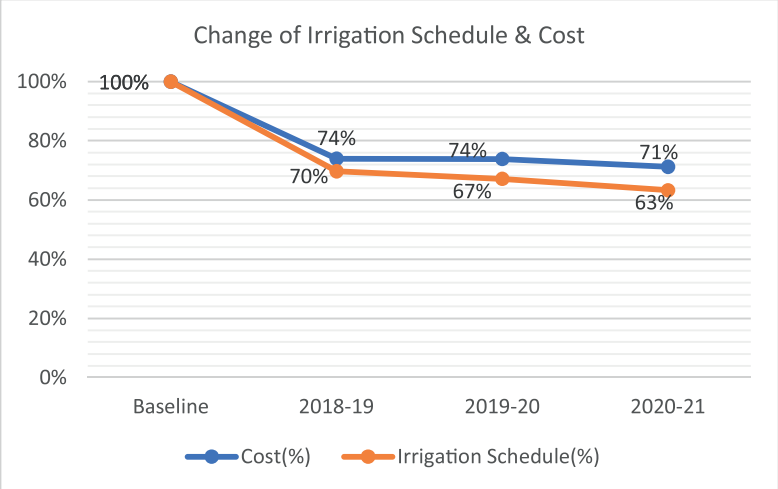
3.4. Outcome

Agriculture that does not rely on irrigation is practiced, and the results are shared and established by local farmers.

Outcome achievement (Actual Value)

The project residents, by number and land coverage, have increased non-irrigation-reliant agriculture practices during Rabi seasons and diversified crops with Lentil, Mustard, Wheat, Maize, Beans, Summer tomato etc. EDL data analysis reveals that 83% project residents (249 out of 300 farmers) have covered 41% (22,968 dcml) of farmers' total lands (54,411 dcml) under non-irrigation-reliant Rabi crops. However, the rate of increase is 264% from baseline lands (8,693 dcml).

The project residents also reduced the number of water scheduling of over dependent ground water irrigation practice in dry season Rice cultivation from an avg. 79.47 days to 49.50 days. So, three hundred project residents reduced 37-38% (Figure below) over dependent ground water irrigation in succession. Farmers could able to gain 29% economic balance (water cost) also through this alternative water usage.



Change of Irrigation Schedule and Cost				
Level	Baseline	2018-19	2019-20	2020-21
Cost(tk.)	3,631	2,678	2,673	2,578
Irrigation Schedule	79	55	53	50
Cost (%)	100%	74%	74%	71%
Irrigation Schedule (%)	100%	70%	67%	63%

In addition, 14 print and electronic media published coverage and articles on the project, stating that farmers earned additional income. At the union meeting held at the end of the year, farmers informed good harvest of a new variety Mustard (BARI-14) introduced in this project. It was developed by the National Agricultural Research Institute a few years ago), and this variety had been used since the latter half of the rainy season of project second year. It is cultivated after Aman Paddy in a short period until the dry season. A big gathering of WEAP farmers and local residents arranged at the end of second year. In the gathering, farmers informed the audience that this project had a great harvest. At the same time, farmers informed the government officials that they were getting economic benefits from the project and requested government officials for support of other high-quality seeds of Rabi crops that could be grown in different short periods.

The session was attended as many as 247 farmers, and no one expressed any negative impact or dissatisfaction with the project. Rather, it was announced that it was a good harvest due to additional irrigation from the water reservoirs (ponds) for Aman and dry season rice cultivation by the water-saving through Alternate Drying and Wetting methods (AWD) method.

From March 2020 to June 2021, there were visit restrictions due to covid. Even then, DAE officials regularly visited business sites and used to exchange WEAP information, organized training courses too. NGO- PSUS and their farmers visited the business sites, interacted, and interested on WEAP technology to spread in Chuadanga area, another district of west part of Bangladesh.

Flayers

A total of 3 flyers- - -WEAP Concept, Vermicompost and Organic Pesticide were prepared and distributed. Due to high demands, 'WEAP Concept' copy was reprinted. Copies of flayers have been distributed to LGIs, NGOs and project farmers and non-target farmers of Jhenaidah district and other district. Vermicompost flayer helped farmers' sale of vermicompost to other farmers too.

Yearly Activity Achievement

Activity- 1: Organization and survey of farmers' groups

Initial Activity Plan 1 st year

1-1. Organizing farmers' groups

(1) Village group (20)

(2) Union Group (2)

(3) County group (1)

1-2. Baseline survey

1-3. Kick-off meeting (SBF, Share the Planet)

Output (target) 1st year

1-1. 20, 2, and 1 farmer groups are formed in villages, unions, and counties, respectively.

1-2. Agricultural yield and balance before implementation are transcribed.

Year 1 Achieved (Including actual Output)

1-1. Organizing farmers' groups

(1) Village group (20) → 20 groups were formed as planned, with a total of 242 farmers participating more than planned. The planned 200 people started their activities, but gradually added 100 farmers who wanted to participate.

(2) Union group (2) → 10 groups in each union (minimum administrative unit) formed a union group with two unions.

(3) County group (1) → A county group, union of two unions, was formed as scheduled.

1-2. Baseline survey → Compared with the criteria of group members, such as the land holding area and family composition of farmers in the activity area, to use as basic data for selecting members and to measure the results after the completion of the project A survey was conducted to examine the system.

1-3. Kick-off meeting (SBF, Share the Planet) → All staff members were gathered to discuss the purpose, plan, and implementation schedule of the activities closely. Due to the delay in the first half of the project (April-May), the original plan schedule was reviewed (due to delay in project approval from NGO-related bureaus), and the coordination with the government and the status of group formation were reviewed. Figured out.

Initial Activity Plan 2 nd year

1-1. Organizing farmers' groups (new: 100 people / existing: 200 people)

* 100 new people will be placed in the group established in the first year.

1-2. Data collection and input for 100 new households

1-4. Creation of video recording of activity status

1-5. Union Farmers Group Meeting (once for each union)

* The status report and information sharing will be conducted for each Union Group, and common issues will be discussed.

Output (target) 2 nd year

1-1. 100 new members join the farmers' group.

1-2. New household data is input.

1-4. The activity status is recorded in the video.

1-5. Union Farmers Group Meeting is held in each Union.

Year 2 Achieved (including actual output)

1-1: 100 new members joined the 20 farmers' group. Besides these, about 48 farmers outside project farmers are interested to learn this practice. They participate in different project activities by themselves.

1-2: New 100 farmers' data was surveyed under BSL and input is duly given for comparative analysis of achievement;

1-4: The video recording was dropped after budget review;

1-5: Union farmers' group meeting was held.

1-4. Creation of video recording of activity status;

1.5 Six Monthly Coordination Meeting (Each union 2) with Union Farmers Group (at Union Level) to take collective decision, problem solving and networking

1-4. 1-4. A video is be created and distribution process is going on. -
1-5. Four (4) Six monthly Coordination Meeting is held Coordination meeting is held in 2 unions.

Year 3 Achieved (including actual Output)

1-4. Video report is prepared and distribution and telecast on the Electric media is ongoing;

1-5. Union farmers' group held 4 coordination meeting (Six monthly). In the meeting, farmers leaders, LGIs representatives and Govt. Agriculture department were present there. These representatives have stake to know and feed to govt. report what is actually going in the field i.e., project activity, achievement, challenges and to exchange ideas, possible solution to farmers' situation (including crop diseases, soil and crops health, economic balance by growing profitable crops etc.,), extending govt. support services to the farmers etc. A total of 265 WEAP farmers (out of 300) received various support services from the government like- various other training, seeds (Maize, Summer tomato etc.), fish fingerlings for rain-water harvesting ponds (Reservoir). Three government departments (Social service, health, agriculture) participated at union farmers' gathering last year and a helpful relationship were built up between Local DAE and Farmers.

(Activity2) : Training of farmers' groups (training)

Initial activity plan 1st year

2-1. Agricultural training without relying on irrigation (25 people x 4 batches = 100 people: 2 days)

2-2. Seed production training for planting conversion cultivation (25 people × 1 batch = 25 people: 1 day)

2-3. Activity 2-1 Distribution of new varieties of seeds, storage containers, earthworms, and Azolla to participants in the practical training (farmers)

2-4. Field observation session

Output target 1 st year

2-1. More than 90 people have completed the training.

2-2. All 25 people have completed the training.

2-3. Seeds will be distributed to all participants.

2-4. Field observation sessions are held.

Year 1 Achieved (including actual output)

2-1. More than 90 people have completed the training. → Completed training with the participation of 104 people (trained by prefectural agriculture bureau chief, county decree, county agriculture officer, union agricultural extension officer)

2-2. All 25 people have completed the training. → Training is completed with the participation of 25 people (under the attendance of members of parliament from the region, receiving training from county agricultural officers and agricultural extension workers)

2-3. Seeds will be distributed to all participants. → Distributed mustard seeds (BARI14) obtained from the Bangladesh Agricultural Research Institute to 14 farmers. Distributed seed fir containers and earthworms / azolla on schedule (100 households).

2-4. Field observation session → End of dry season planting (February)

Initial activity plan 2nd year

2-1. Agricultural training without relying on irrigation (25 people x 8 batches = 200 people: 2 days)

2-2. Seed production training for planting conversion cultivation (25 people × 1 batch = 25 people: 1 day)

2-3. Activity 2-2 Distribution of seed and storage containers (25 people), earthworms and Azolla (70 people) to participants of the seed production training (farmers)

2-4. Field observation session (twice a year, 2 unions)

* Local residents gather at the farm to observe the growth of the crop.

* Invite not only local farmers but also agricultural extension workers / union chairmen.

2-5. Soil improvement workshop

2-6. Agricultural follow-up training without relying on irrigation (25 people x 2 batches = 50 people: 1 day)

Output (target) 2 nd year

2-1. More than 250 people have completed the training, counting from the first year.

2-2. All 25 people have completed the training.

2-3. Seeds will be distributed to all participants.

2-4. At least one person from a 90% group participates. Several government officials are participating.

2-5. Cooperation from soil inspection agencies has been obtained.

2-6. All target participants (50) complete the training.

Year 2 achieved (including actual output)

2-1: 300 farmers have completed training on WEAP and 50 farmers for follow-up.

2-2: 25 farmers also have completed seed training. 50 farmers (Y-1 & 2) have produced and preserved seeds of lentil, Mustard, different pulses, Maize and wheat; of them 11 farmers sold seeds to WEAP and Non-WEAP farmers;

2-3: A total 444 kg (205 kg to Sundarpur and 239 kg to Niamatpur) of quality Rabi and Rice seeds from BADC have been to 80 WEAP farmer.

2-4: 100% group participated in a total of 4 field observation sessions in 2nd year conducted by government 2 Agriculture officers, Additional Director, Plant Protect (District), SAAO, Fisheries officers and solved farmers field level problems related to insect infestation and disease control for Rabi crops, crop growth and yield potentials for all field crops, soil management issues etc.

2-5: Senior Soil scientist from Jhenaidah district has visited twice in the field and discussed in two gathering of almost all project farmers. A total 287 farmers (out of 300) have tested their soils and found deficient in organic matter less than standard. Farmers were advised for soil improvement measures. Results are yet to come;

2-6: Agriculture follow up training to 50 farmers (GAP farmers) help them renewing of practice through learning and sharing from the training with Agriculture Officers. Among the WEAP farmers they are advancing in Rabi cultivation by land amount, also other WEAP practices.

Initial activity plan 3 rd year

2-2. Seed production training for cropping conversion cultivation (25 people x 2 batches = 50 people: 1 day)

2-3. Distributing new varieties of paddy, seeds, and storage containers to practitioners (farmers)

2-4. Field observation meetings (twice a year, 2 unions)

* Local residents gather at the implementation farm and observe the growth of crops.

* Invite not only local farmers but also agricultural extension officers / union chairmen to ask for advice and ask other farmers for their needs and wishes.

2-5. Soil improvement workshop

2-6. Agriculture follow-up training that does not rely on irrigation

(25 people x 2 batches = 50 people: 1 day)

Output target 3 rd year

2-2. All 50 farmers have completed the training.

2-3. 50 farmers who received the above training will use the seed storage container to store seeds. Upon request from all target farmers, high quality seeds are purchased from BADC and distributed to farmers at cost.

2-4. Four times of observation meetings are held, and various advice is given from the administrative officer to the farmers.

2-5. More than 50 farmers will participate in the workshop and soil analysis of 10 or more samples will be conducted.

2-6. All 50 farmers have completed the training

Year 3 achieved (including actual output)

2-2. All 50 farmers completed the training. All 50 farmers o this year and previous 50 farmers have produced seed for own use, some of them sale the preserved seed to the market and other farmers. Total 100 farmers can use his own produced paddy, lentil and Mustard seed for cropping. According to the revealed data, Total 7481.4 kg seed (Paddy, mustard, lentil, maize) were produced by the trained 100 farmers in three years.

2-3. 50 farmers who received the above training, used seed storage container to store seeds. Upon request from all target farmers, high quality seeds are purchased from BADC and distributed to farmers at cost price. Farmers get best quality seed with actual price than the market through the project.

2-4. Four times of observation meetings were held, and various advices were given from the administrative officer to the farmers.

2-5. 50 farmers participated in the workshop and soil analysis of 300 samples were conducted and 184 samples were re-tested for asses the difference. Fertilizer cost of every land are decreased around 500 BDT (avg 473.66).

In 3rd year 100 farmers preserved seeds and saved seed cost which were supposed to purchase from the market; 38 farmers sold 2069 kg (1273 kg in 3rd year) seeds at market and earned healthy profit there from it.

2-6. 50 farmers participated in Agriculture follow-up training and disseminated WEAP message to the Locality.

(Activity 3): Farming practices thar don't rely on irrigation

Initial activity plan 1 st year

3-1. Excavation of reservoir on cultivated land in the middle and lowlands (half the cost from the project) (70 households)

3-2. Support for practical seed production for conversion and cultivation (low and high altitudes)

3-3. Dry-season rice cultivation on cultivated land where reservoirs have been drilled (100 households)

Output (target) 1st year

3-1. 70 households have completed excavation at the end of the fiscal year.

3-3. The extension officer of the Agriculture Bureau attends the observation party.

Year 1 Achieved (including actual output

3-1. 70 households have completed excavation at the end of the fiscal year. → Completed excavation of 70 ponds of 70 households

3-2. Of the 200 households, 155 households have land only in the lowlands and do not have land in the highlands. The remaining 45 households in the mid-dry season planted 42 non-rice cultivated farmers.

3-3. The extension officer of the Agriculture Bureau attends the observation party. → On January 26 and 27, 60 farmers were attended by the Agricultural Officer and the Agricultural Extension Officer of Kaliganj Upazilla.

Initial activity plan 2 nd year

3-1. Excavation of reservoir (Inada aquaculture) in cultivated land in the middle and lowlands (45 households)

3-2. Practical support for planting conversion cultivation in middle and highlands

3-3. Practical support for dry season rice cultivation on cultivated land where reservoirs have been drilled

Output (target 2nd year

3-1. 45 households have completed excavation at the end of the year.

3-2. Dry season rice cultivation is implemented in 70 households.

3-3. At the end of the year, rice farming will be implemented in 90 households, including the first year.

Year 2 Achieved (including actual output

3-1: 30 households have completed excavation of 45 decimal land (1.5 decimal/household). At the end of second year, a total of 100 households have excavated a total of 115 (70+ 45) decimal lands. Data analysis reveals that 83 (out of 100; 17 farmers could not complete excavation at the onset of dry season) farmers implemented dry session rice cultivation.

3-2: All 100 households already started rice farming.

Initial activity plan 3 rd year

3-1. Reservoir (rice farming) excavation on cultivated land in the middle and lowlands (25 households)

3-2. Seed production practice support for planting conversion cultivation (low and highlands)

3-3. Implementing dry season rice cultivation on cultivated land with excavated reservoir (100 households)

Output (target) 3rd year

3-1. total 125 households' excavation is finished, 25 in 3rd year.

3-2. Dry season rice cultivation is implemented in 100 households.

3-3. At the end of the project period, rice farming is carried out at 100 households, including the first and second years.

Year3 achieved (including actual out[put]

3-1. 125 households' excavation is finished but yet to ready for dry season rice cultivation until rainy season to come in 2022;

3-2. Dry season rice cultivation has been implemented in 100 households (year-1 & 2 (and benefitted therefrom in terms of water saving cost, planting conservation cultivation etc.

3-3. At the end of the year and with the extended period, dry rice farming will be carried out at 125 households, including the first- and second-years' reservoirs.

(Activity 4) : (Evaluation and dissemination of community participation)

Initial activity plan 1 st year

4-1. Farmers' group meeting (held every other month for each village)

4-2. Workshop for Union Group Leaders

4-3. Orientation for Union

4-4. Orientation for County Administration

Output target 1 st year

4-1. A total of 96 village-level meetings are held (6x20 = 80% of 120).

4-2. 48 out of the 60 expected participants will participate (80%).

4-3 and 4-4 Local residents other than the 200 target farmers have expressed their desire to participate.

Year 1 achieved (including actual output)

4-1. A total of 96 village-level meetings were held (6x20 = 80% of 120) → All 120 meetings were held.

4-2. 48 out of the 60 expected participants will participate (80%) → attended by county chair, attended by union chair, county agriculture officer, county agriculture secretary (3), 60 farmers participated

4-3 and 4-4 Local residents other than the target 200 farmers have expressed their wishes to participate. → In the orientation for the county administration, members of the parliament elected by the county, county ordinances, county agricultural officers, county fisheries officers, and county cooperatives. The meeting was held with government and other newspaper media. There was also participation from residents other than the target, and 46 people later decided that they would definitely participate in the group.

Initial activity plan 2 nd year

4-1. Farmers' group meeting (held every two months for each group)

4-2. Workshop for Union Farmers Group Leaders

4-5. World Food Day (10/16) and World Water Day (3/22) (Discussion and Rally)

4-6. Workshop for County Farmers Group Leaders

4-7. Experience exchange study tour between farmers (within the activity area)

4-8. Experience exchange study tour between farmers (outside the activity area)

Output (target) 2 nd year

4-1. A total of 96 village-level meetings are held (6x20 = 80% of 120).

4-2. 48 out of the 60 expected participants will participate (80%).

4-5. Over 100 participants each.

4-6. The district level meeting is held once a year.

4-7. Experience exchange study tour (within the activity area) between farmers is carried out.

4-8. Experience exchange study tour (outside the activity area) between farmers is conducted.

Year 2 achieved (including actual output)

4-1: All scheduled meetings were held. Not only target farmers but also neighboring farmers who were not targeted participated in the meeting, spread knowledge, and interacted with each other. All this contributes to the spread of irrigation and independent agricultural practices.

4-2: Workshop for Union Farmers Group Leaders was held at Niamatpur Union on 23rd and 24th March 2020. The meeting was attended by 247 targeted farmers and 22 non-targeted farmers in the Sundarpur-Durgapur Union and Niamatpur Union. DC and UNO and citizen representatives (members of parliament, council chairs), senior officials of the Department of Agriculture Extension, soil scientists, representatives of four NGOs, bank managers, and locals. Administrative staff, local police chiefs and journalists participated in the conference. The county office and the county agricultural extension office also exhibited two booths. Government authorities and NGOs visited 16 booths of the project and participated in discussions with farmers to promote the project.

4-5: More than 100 participants participated in each event and rallies around the county office.

4-6: Workshop to connect the farmers' group leader and the county office. As a result of the workshop, fisheries officers were promised to provide training to pond household farmers on aquaculture at the beginning of the rainy season for aquaculture of rapidly growing fish. Agricultural officials want to take the initiative in promoting the sale of earthworm compost produced by farmers while maintaining high-quality earthworm compost. The county council chairman appreciated the initiative of farmers to implement groundwater irrigation reduction practices and said that they would take appropriate measures to reduce

the cost of irrigation and owners of wells. The fisheries officers and the youth development officers visited our fields and said they wanted to talk to the pond farmers.

4-7: The project farmers and staff were sent as a study tour to a similar activity site in the vicinity where Share the Planet is doing, and their experiences were shared. They introduced, among other things, know-how for producing high quality seeds, practices for water-saving rice cultivation (Alternate Drying and Wetting methods), especially methods for minimizing dependent groundwater irrigation by adjusting the irrigation schedule.

4-8: In addition to the above, I visited BARCIK (NGO) in Shatkhira and RDRD (NGO) in Rangpur to learn about various agricultural techniques and share my own agricultural practices.

Initial plan 3 rd year

4-1. Farmer group meeting (held bimonthly for each village)

4-2. Union Farmer Achievement Presentation Workshop

4-5. World Food Day (10/16), World Water Day (3/22), Agriculture Day (11/15) (Discussion and Rally)

4-6. County Peasants Union Annual Meeting (Discussion with Administrator)

4-7. Farmer's Experience Exchange Study Tour (within the area of activity)

4-8. Experience exchange study tour between farmers (outside the activity area)

Output (target) 3 rd year

4-1. A total of 96 village-level meetings will be held (6 × 20 = 80% of 120 times).

4-2. More than 250 farmers participate.

4-5. More than 100 people each participate.

4-6. District level meetings are held once a year, and 35 representatives of farmers talk with the government officials.

4-7. Experience exchange study tours (within the area of activity) between farmers are conducted to obtain new information.

4-8. Experience information exchange study tour between farmers (outside the activity area) is conducted, and new information is obtained.

Year 3 achieved (including actual output)

4-1. 100% (120) village level meeting held up to March 14 2021; Farmers were able to mutually exchange WEAP experiences case by case in different meetings and benefitted by cross-fertilized experiences and shared learning were disseminated among non-WEAP farmers too; Increased Unity of farmers to get government incentives and available services, to get Easy access to information of available government services.

4-2. Union Farmers Apex workshop is not held until now due to COVID-19 related govt restriction; It will not be held because of the pandemic situation.

4-5. Day Observation >300 farmers were present in each of the Day-observation events, Farmers raised their voices against deprivation and rights to the LGIs and the elected public representatives and put forwarded memorandum (about rights & deprivation) to Agriculture department, UNO and Upazila administration (chairman, vice chairman & female vice chairman);
4-6. Upazila level meetings held with 35 representatives/leaders of WEAP farmers. The leaders thanked government officials for extending support services like- training, providing fish fingerlings & seeds, paying

field inspection and feedback more than before. Of these issues apart, farmers claimed dishonest behavior (cheat weight) of supply chain/market chain intermediaries/traders/millers during sale of paddy, sale of fake chemical fertilizers and insecticides by the retailers etc. Upazila administration conducts mobile court to stop these malpractices. The leaders also requested more support services including sale of farmers'' produced vermicompost etc.

4-7. Two experience-exchange study tours (within the area of activity) held for farmers to obtain new information. Separate reports were provided before.

4-8. Study tour to RDA, RDRS and Lokoj (outside the WEAP activity area) held, and new information experienced by visiting in the new areas such as Less water Irrigation practice by underground pipe irrigation system from RDA and RDRS; The farmers of RDA and RDRS also shared their bed system irrigation that is more water use efficient and cost-effective practice too. Farmers of Lokoj (an NGO in south west Bangladesh) shared with WEAP farmers how to cultivate summer vegetables than paddy which requires very less water but more profit than rice.

Initial activity plan 1 st year

5-1. Experience exchange in Bangladesh

(FAO, Agricultural Extension Bureau, BADC, BARI, BRRI, AID, BARCIK, other research institutions, etc.) *

* Staff visit other organizations to learn about the activities of similar businesses.

Output (target) 1 st year

5-1. There have been cases where a group or individual who interacted visits a business site more than once.

Year 1 achieved (including actual output)

5-1. There has been more than one visit to the business site by groups and individuals who have interacted with each other. → In December, project staff (3) and farmer leaders (7) visited BARCIK on an experience exchange tour. We also visited BADC (Bangladesh Agricultural Development Corporation) in Jessore District. He also reported on activities to Bangladesh Agricultural University, FAO Bangladesh Office and Japan Office, and requested further cooperation.

Initial activity plan 2 nd year

5-1. Experience exchange in Bangladesh

(BADC, BARI, BRRI, SRDI (Soil Research, Dhaka University, Agricultural University, NGOs (BARCIK and AID, RDRS, UTTARAN, ALRD's partners), etc.))

5-2. Production and distribution of flyers for organic farming (3000 copies)

5-3. Installation of sign boards for rice cultivation (100 locations)

5-4. Interim evaluation and fixed-point observation

* Fixed-point observation here means recording the growth status of varieties introduced in the project using a drone as an image (this can be performed if the business site is approved).

Output (target) 2 nd year

5-1. There have been cases where a group or individual who interacted visits a business site more than once.

5-2. A flyer for organic farming is produced and distributed.

5-3. Inada aquaculture sign boards can be installed at more than 90 locations.

5-4. Interim evaluation and fixed-point observation by drone did not be conducted.

Year 2 achieved (including actual output)

5-1: Visited BADC, BARI, BRRI, SRDI, BAU, BARCIK, RDRS by project staff , representatives from Share the planet Association several times and sharing WEAP practice and future cooperation and exchange visited.2

5-2: Flayer on Organic fertilizer is drafted and under process in printing press;

5-3: Aquaculture signboard has been prepared in 100 locations

5-4: Since the project is numerically managed, a system is in place to manage the situation of each farmer. On the other hand, with regard to fixed-point observation by drone, it was found that considerable administrative work would be required for the Bangladesh Aviation Law and carry-on, and there is a possibility that it may not be authorized, so the introduction of the drone including the dispatch of experts was postponed.

A media conference was held, and eight newspaper companies interviewed about this project for wider spread.

Initial activity plan 3 rd year

5-1. Information exchange and information transmission in Bangladesh

(DAE, Research institute, LGIs, University, NGO, etc.)

5-2. Production and distribution of flyers for organic pesticides

5-5. Encouraging journalists (information dissemination)

5-6. Engaging journalists (field coverage)

5-8. Final evaluation

Output (target) 3 rd year

5-1. There is more than one case of visiting the business site from a group / individual who has interacted.

5-2. Flyers for organic pesticides are prepared and distributed

5-5., 5-6. Activities are introduced in multiple media such as TV, radio, newspapers, and magazines. 5-6. Engaging journalist: Field visit, and workshop are held with the print and electric media journalists. Journalist have visited 2 union and attend Informing workshop.

5-8. Terminal evaluation is carried out and the results are summarized in a report.

Year 3 achieved (including actual output)

5-1. During the stipulated period, there were visit restrictions due to covid. Even then, NGO- PSUS and their farmers visited the business sites, interacted, and interested on WEAP technology to spread in Chuadanga area, west part of Bangladesh. DAE officials regularly visit business sites and used to exchange WEAP information with farmers during govt. organized courses.

5-2: Flyer on Organic Pesticide has been prepared and distribution is started among DAE, Farmers, Locality.

5.5- Print and Electronic media journalist paid visit to WEAP project area and activity is done. Workshop with the Journalist has been done in the extended project period. By this workshop, print and electronic media has highlighted the project impacts; Leading English Newspaper published the impact news and National television channel telecast telecasted the WEAP Impact news.

5.8- Data collection for terminal evaluation is done, DAE officials, Upazila Fisheries Officer have visited WEAP area as a part of evaluation process.

SECTION FOUR

Project Evaluation: The data analysis, interpretation and result demonstration

4. Project Evaluation: The data analysis, interpretation, and result demonstration

About some basic data of Baseline (BSL) and End line (EDL)

Project farmers were identified as 300 target residents (farmers) from baseline (BSL); 200 farmers in the first year (2018-19) and 100 farmers in second year (2019-20). These farmers were classified by arable land holding(size) (Table-1) according to Agriculture Survey, 2005 of Bangladesh Government. Accordingly, we see that the Poor and Marginal farmers are >53% (Figure 1) that constitute a major portion of the project target farmers. Apart from that, there are also a sizeable of small and medium farmers. Land types (Figure-2) of these farmers comprise Low (LL), Medium High (MH) and High land (HL)). In Bangladesh, 29% land is classed as Highland (HL) and is above normal annual inundation. Lands under inundated between >1.2m and 3m (even >3 m as very low) is known as Lowland (LL) and such lands occupy 7.6-9% of the total land area. The Medium High land is in between the above two, ranges from 0.3m to 1.2m inundation during wet season and it has 3 classes- - - MH-1, MH-2 and ML together occupy 46-47% of the total land surface.

Data analysis reveals that 60% of the target farmers' age is in between 21- 50 years (Median= 46); 74% of the target farmers have primary and secondary level of education (38% under primary, 31 % secondary level, 4% Bachelor level of education); none of them are found either service holder or day laborer. It means that they do farm only on their own lands. In the baseline, farmers informed that they were devoid of basic government services such as, lack of newer technology, non-availability of early maturity quality seeds, lack of advice during crop infestation, know-how to reduce cost of production, lack of fair price of their produces etc., for that they had been gradually losing their interest in farming. We experienced that the project supplied one short duration Mustard variety (BARI-14) was effective enough to increase farmers' income; it was developed by BARI long ago, but we see, after the project intervention, DAE, Kaliganj has taken initiative to spread this variety among farmers recently and farmers are happy too. Some government services have been improved like- frequent physical attendance in the field and advice over phones. WEAP farmers are now prioritized by the LGIs on service delivery such as, newly introduced seeds of BARI-14, summer tomato, summer onion, pulses (black-gram, lentil), enforcement from government side to (chemical) fertilizer dealers to sell vermicompost at their retail shops, government purchase (paddy, vermicompost) from WEAP farmers etc. Besides that, local fisheries department provided fish-fingerlings free of cost and paid regular visit to WEAP farmers who owned water reservoirs (ponds).

PIC: Short duration BARI-14 Mustard

The Alternating Wetting and Drying (AWD) technology was developed by IRRI, Philippines long ago but farmers didn't know about it before the project interventions. DANIDA-BGD intervened rainwater harvesting (like water reservoir) in this region (and FAO in elsewhere) decades back but didn't spread among farmers. The EDL data revels that all farmers are satisfied of being associated with WEAP project. 34% farmers now can produce good seeds at their own farm as against 28% of the BSL while open market seeds purchase has been reduced from 55% (BSL) to 53% EDL. One hundred farmers who were trained on seed production earned a profit by selling seeds of Lentil, Mustard, Paddy [Subhollata, BRRI Dhan 50 (Banglamati or Basmati)] in 2020-21 apart from seeds consumed by their own farms to keep their production on going. Farmers always kept eye on rainwater for land and seed bed preparation. It was also learnt from discussions with the farmers that almost all Transplant Aman (T. Aman) growing farmers had to use underground water for supplementary irrigating during its critical growth stage, but now water reservoirs (ponds at lands) are meeting their needs by replacing groundwater irrigation.

Figure-1: Percent Category of WEAP Farmers

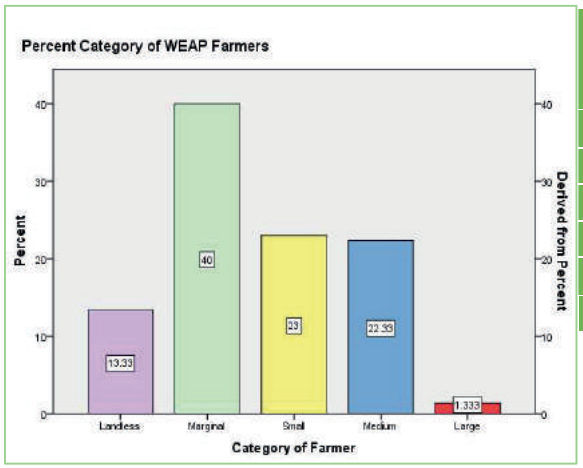


Table-1: Farm Size Structure of WEAP Farmers

WEAP Farmers' Category & Farm Size (in Acre; 1Acre=100dcml)	Number of Farmers	Percent
Landless (0.00 to 0.49)	40	13.3
Marginal (0.50 to 1.49)	120	40.0
Small (1.50 to 2.49)	69	23.1
Medium (2.50 to 7.49)	67	22.3
Large (Over 7.50)	4	1.3
Total	300	100.00

Figure-2: Land Type of WEAP Farmers

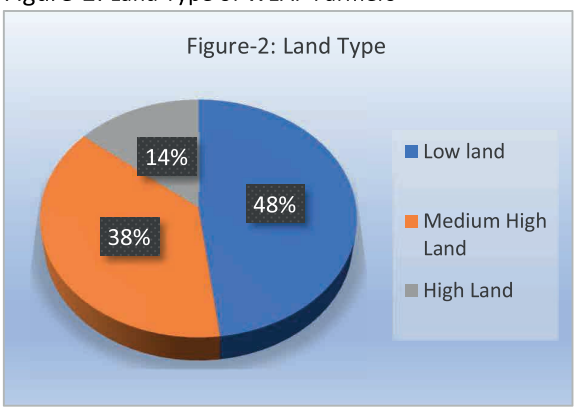


Table- 2: Land Type and Amount (dcml)			
Total Lands	Low	Medium High	High
56,411	27,068	21,711	7,632
100%	48%	38%	14%

4.1. Change of Rabi Farmers and Lands (under Rabi Crops) Over the Years

WEAP farmer produce & preserve seeds

The 300 project residents, by number and land coverage, increased non-irrigation-reliant agriculture practices in dry season. Data analysis reveals that 83% of project farmers (249) increased 41% [Ref. 4.1 (a, b)] of the total cultivated lands (22,968 dcml out of 56,411 dcml) under Rabi crops; it is 264% from baseline farmers' lands (8,693 dcml) brought under coverage of practicing non-irrigation-reliant Rabi crops. A total of >7% (22) farmers shifted their Boro cultivated lands to Rabi cultivation in the third year of the project. The project farmers individually earned avg. BDT. 25,087 by selling Rabi crops and from seed sale avg. @BDT. 1,781 of 37 farmers who earned in total BDT. 65,905 by selling 1,018 kg pulse and oil seeds.

4.1(a). Change of Rabi Farmers

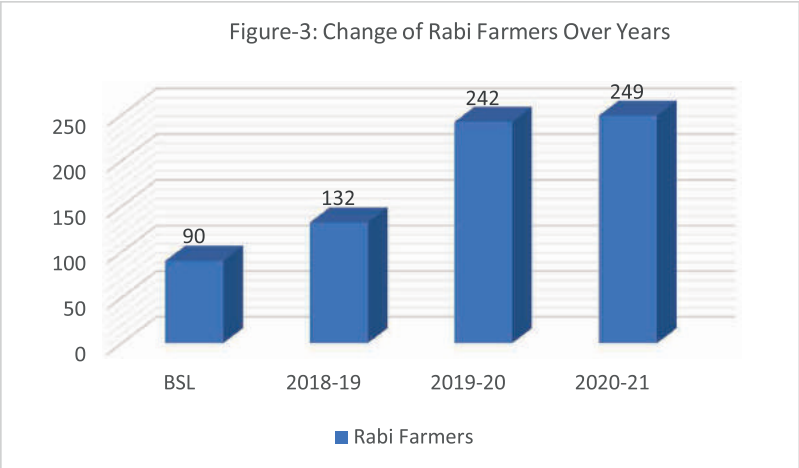


Table-3: Number and Percent Rabi Farmers

BSL	2018-19	2019-20	2020-21
90	132	242	249
45%	66%	81%	83%

4.1(b). Change of Farmers' Rabi Crop Lands

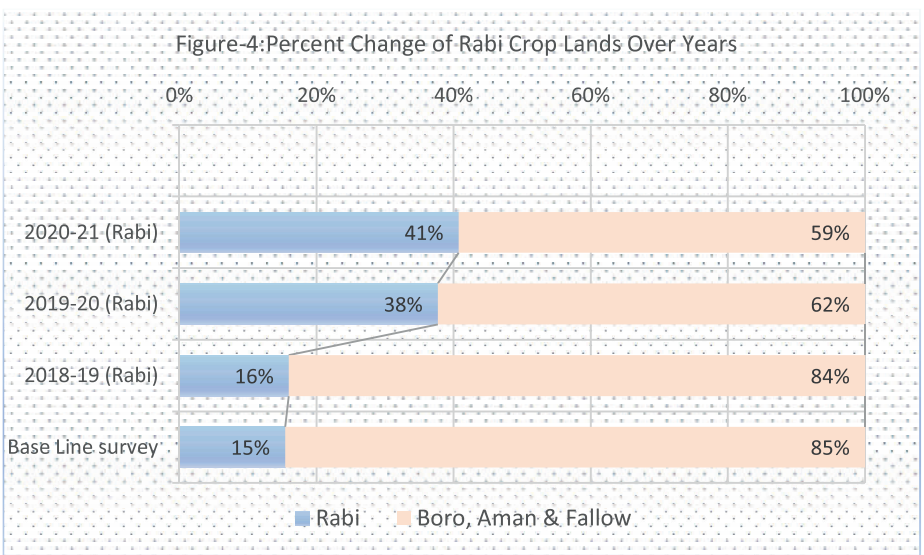


Table-4: Rabi Crop Land s

Particulars	Land (dcml)	% Increase
Baseline (BSL)	8,693	15%
2018-19	9,007	16%
2019-20	21,257	38%
2020-21	22,968	41%

4.2. Change of Irrigation Schedule and Cost Over the Years

The 200 project residents (n=200) had been consistently monitored in 3 years and were able to reduce irrigation water by 37% [Figure-5(a)]. In second year, 100 new farmers entered, but they were late in adopting AWD technique. However, in 3rd year, 300 farmers followed AWD [Figure-5(b) and Table5(b)]. So, at EDL we observed 37-38% reduction of over dependent ground water irrigation and number of irrigation scheduling from an avg. 79.47 days on BSL to avg. 49.50 days [(Table-5 (a)] on EDL in dry season rice (Boro rice) cultivation. However, farmers were able to gain 29% economic balance or cost saving from water individually an avg. BDT. 1,728 at EDL with the adjustment of Irrigation schedules through AWD technique and using water measuring tools (PIC). In fact, all farmers didn't follow the water measuring tool.

4.2(a). Figure-5(a): Change of Irrigation Schedule and Cost

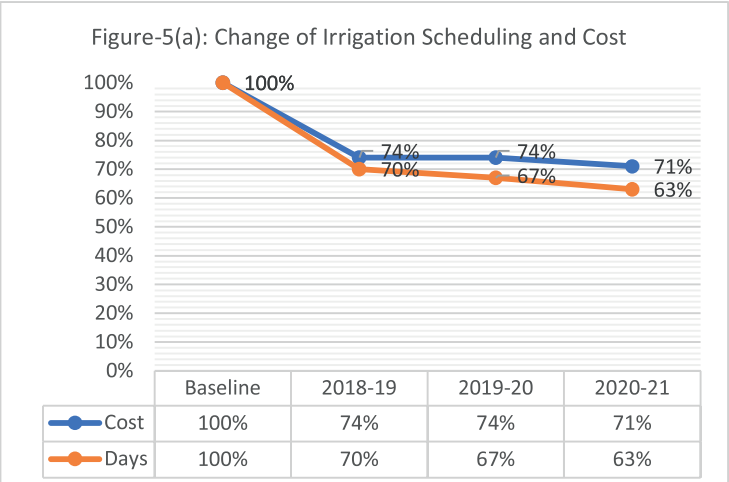


Table-5(a): Change of Irrigation Schedule and Cost

Level	Baseline	2018-19	2019-20	2020-21
Cost(tk.)	3,631	2,678	2,673	2,578
Irrigation Schedule	79	55	53	50
Cost (%)	100%	74%	74%	71%
Irrigation Schedule (%)	100%	70%	67%	63%

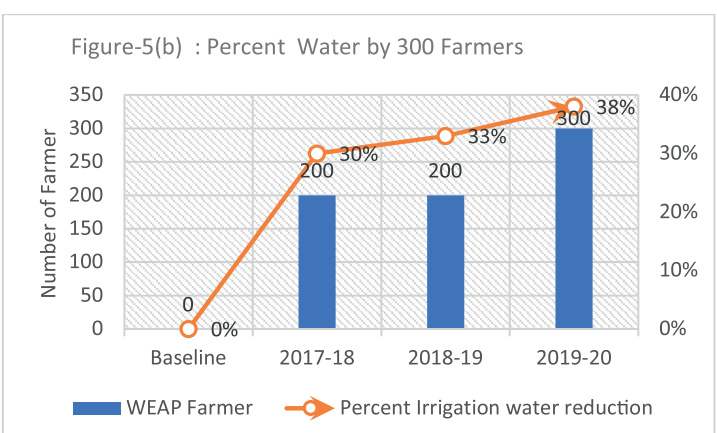


Table-5(b): Percent Water Reduction by 300 Farmers

Baseline	2017-18	2018-19	2019-20
0	200	200	300
0%	30%	33%	38%

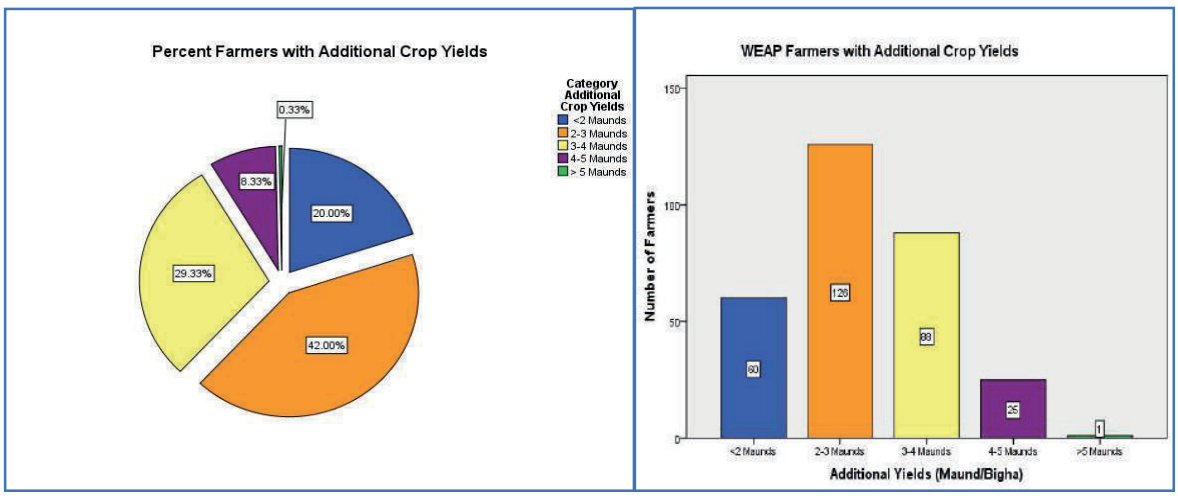
4.2(b). Boro Additional Yields

WEAP farmers received (crop) yield increase per unit area (Maund/Bigha:1Maund=0.04MT;1Bigha=46 dcml) along with the reduction of irrigation water that could enable them getting economic balance individually an avg. @BDT. 3,535 (@1,050*3.366906) at EDL.

PIC: AWD method with water measuring tool

The additional crop yield per unit area of individual farmer was increased an average 3.37 Maunds/Bigha (Sale price @ 1,050 tk./Maund at 14% moisture level) at varying percentage (Figure-6) of 300 (n=278) farmers. The average crop yield of 300 farmers' end line was an average 33.8723 maunds/bigha than that of 30.5054 maunds/bigha at baseline. So, yield increase is 111%. The varieties used were BRRI Dhan 50, and Shubholata. However, SBF staff physically verified the weighing of 10% of farmers' crop yields. The (crop) yield of 10% famers was an average 3.48.

Figure-6: Additional Yield Per Unit Area



4.3. Water Reservoir and Supplementary Irrigation to Aman

4.3(a). Water Reservoir

A total of 125 water reservoirs (ponds) at farmers' land corners (>3% of farmers' Lands) were created by the project in 3 years (70 in yr.-1, 30 in yr.-2 and 25 in yr.-3). The water reservoirs helped increase water holding capacity of soils too. It also helped decrease irrigation scheduling. Water of reservoirs used for seedbed and land preparation as well as supplementary irrigation for Aman rice; growing of fishes and vegetables on dikes, such as- chilies, spinach, bottle ground, bean, tomato, pumpkin, brinjal etc. Farmers produced total avg. 5 MT fishes of different indigenous varieties including cultivated carp supported by Government Fisheries Department with a total fish worth BDT.

PIC: Water reservoir, vegetables on its bank and fish in

956,690 (@ 180-200tk/kg) and total vegetables worth BDT. 259,412 in 3 years. Apart from partly household consumption for nutritional supplement, sale proceeds helped farmer s getting income balance too. Farmers earned individually an avg. BDT. 4,370 and 1,008 from fish and vegetables respectively in one year (3rd year)

PIC: Indigenous variety fishes in the reservoir

4.3(b). Supplementary Irrigation

Similarly, 125 water reservoirs (ponds) were able to irrigate wet season rice (Aman rice) in total 2,302 days: on an avg. >18 days from each of the reservoirs in 3 years in succession. Unless otherwise this would have impacted groundwater as farmers are equally dependent on groundwater for seedbed, land preparation as well as supplementary irrigation for T. Aman rice. The water reservoirs are meeting the shortfall of rainy days vis-à-vis to avoid draught. Supplementary irrigation is important for its critical growth at later stage of maturity. The reservoirs helped each of 125 farmers on an average 8 days (total: 1,018 days) for supplementary irrigation in particular (Figure-7).

PIC: WEAP farmer irrigates Aman seedbed from Water Reservoir (pond)

Figure-7 : Irrigation to Aman Paddy by Water Reservoir

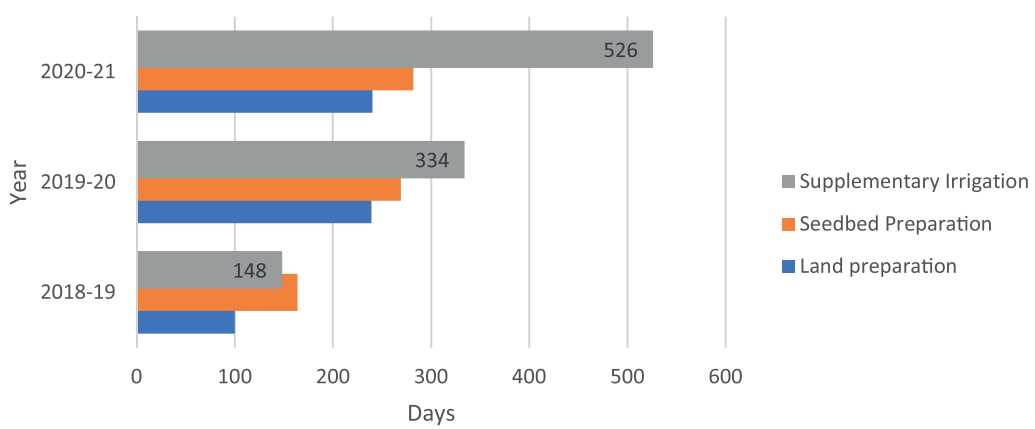


Table- 6: Supplementary irrigation from Water Reservoirs

Particulars	2018-19	2019-20	2020-21
Aman Land preparation (Days)	100	239	240
Aman Seedbed Preparation (Days)	164	269	282
Aman Supplementary Irrigation (Days)	148	334	526

4.4. Vermicompost

Among 300 farmers, 170 interested farmers (Vermicompost producers) were supported with red worm (earth worm) to produce vermicompost (organic fertilizers) at first year and second year. 59% of the vermicompost producing farmers were affected by the cyclone- Amphan in the third year of the project. Of them, some farmers were able to recover fully and resume their productions, some couldn't.

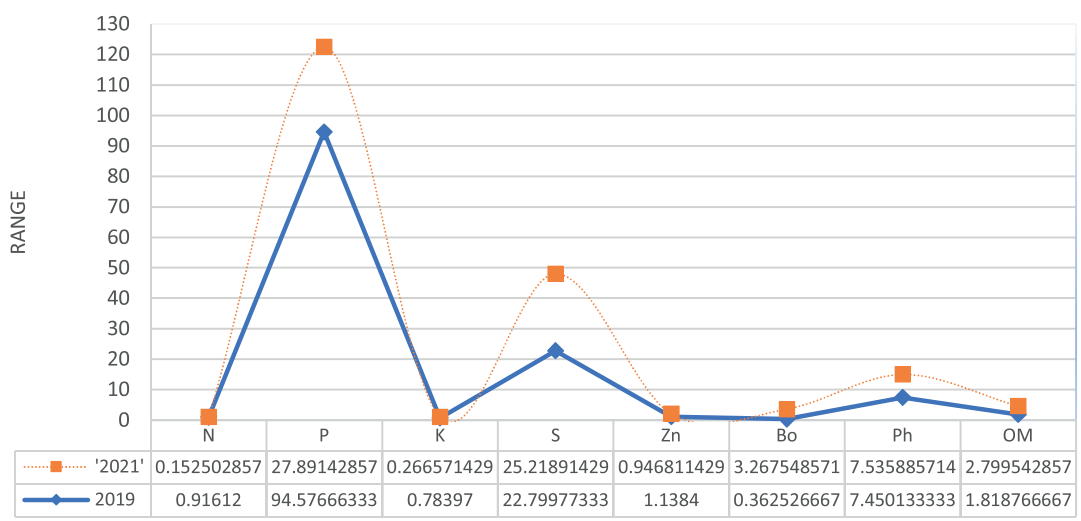
Data analysis reveals that 90% (153 out of 170) of the vermicompost producers were able to produce 435.37kg red worm and 50,704kg vermicompost together worth BDT. 944,390 (Sale price of red worm@1,000tk/kg and vermicompost @10tk./kg) in 3 years of the project.

PIC: A WEAP farmer prepares vermicompost for sale

4.5. Soil Test and Fertilizers Recommendation

Soil test is a key for assessing soil health. The project supported all 300 farmers to have their soils tested twice during the project period: in 2019 and 2021. The test was conducted by SRDI (Government Soil Resources Development Institute, Jhenaidah). The analysis of EDL data of 2021 in comparison with 2019 data fund that there were changes of critical limit of soil major macro and micro nutrients (Ref. Annexure-2) below which crop will suffer (Figure-8), such as- Organic Matter (OM), Soil P^H (P^H), Boron(Bo), Zinc (Zn), Sulphur (S), Potassium (K), Phosphorus (P) and Nitrogen (N). We see the of sign of improvement of Soil health by the improvement of Soil OM, Zn, S, K and P due to fertilizer and diverse crop recommendation to farmers. Some other observations include status of Nitrogen, Bo. The data was checked with SRDI and understood that there was error in Nitrogen level of the 2019 Lab data, also present status yet to improve and as such farmers were advised to increase N level and decrease Bo level as well.

Figure-8: Soil Test Result of 300 Farmers



2021	Low	Optimum	Medium	Optimum	Medium	Very high	Slightly Alkaline	Medium
2019	Error	High	Very High	Optimum	Low	Medium	Neutral	Low

4.6. Change of Farmers' Economies Over the Years

A total of 200 farmers entered as target residents into the first year of WEAP project. Considering huge interest of nearby residents, 100 new farmers entered the project in second year. So, >33% farmers were able to change their economies in 2 years only. Yet, 300 target farmers were able to increase 123% yearly income; so, does 111% yearly expenditure from the baseline. The BSL and EDL data reveals the following graphical representation (Figure-9) of target farmers' economies. However, 4.6 (a,b,c &d) gives further details.

4.6(a). Comparative Analysis of Income and Expenditure of Baseline versus End Line.

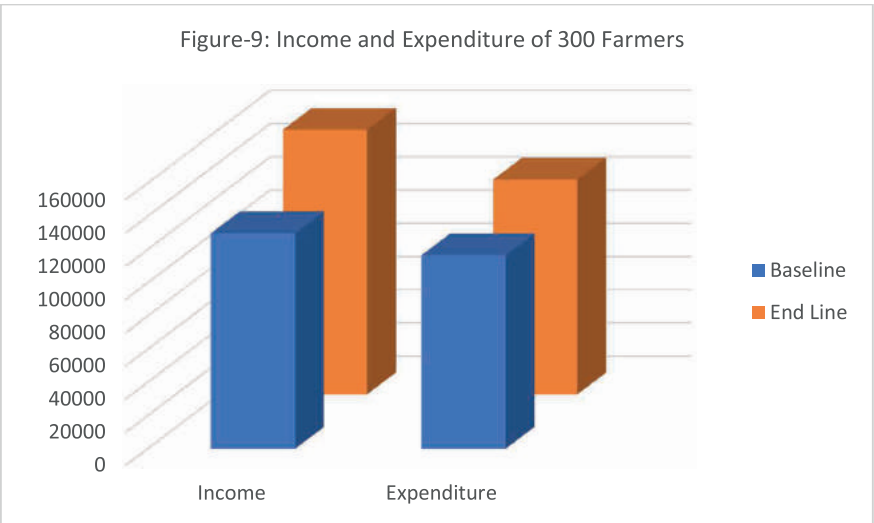


Table-6: Yearly Income and Expenditure		
Particulars	Yearly Income (BDT)	Yearly Expenditure (BDT)
Baseline	129,752	116,462
End Line	159,220	129,298

4.6(b). Income and Expenditure Trend from End Line Data Analysis

The End line data shows an exponential growth of target farmers' income if WEAP farmers continue to follow the WEAP concept.

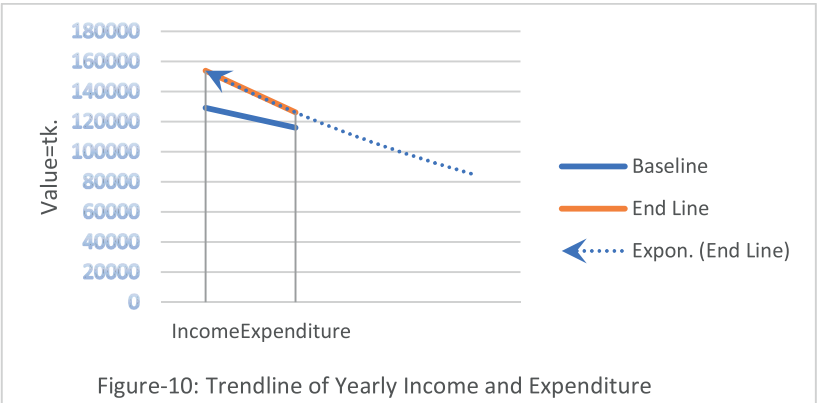
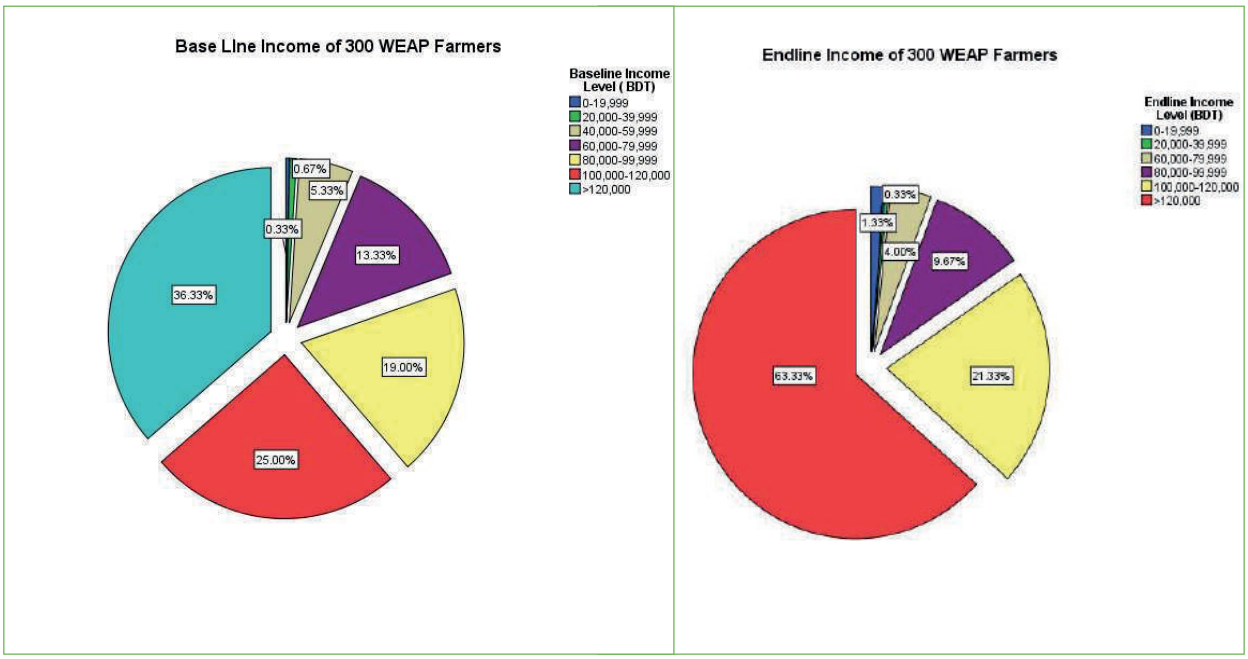


Figure-10: Trendline of Yearly Income and Expenditure

4.6(c). Change of Farmers' Economies: A Comparison Between Baseline and End Line

In Bangladesh, village farmers hardly keep record of their yearly income and expenditure. So, sometimes it makes difference, even cumbersome, in estimating change over the years. It is also interesting to see that farmers always tend to say the least (than the actual) income, may be because of being afraid of government tax or land revenue or else. However, what we had, has been analyzed and observed that individual farmer's yearly average income increase was BDT 29,468 (Table-6) at end line than baseline. However, the income of baseline and end line of 300 farmers were classified in continuous class interva l and analyzed by SPSS software. We see 63% farmers were having modal value BDT >120,000 at End line than that of 25% farmers in the Baseline (Figure -11). We also see income level: BDT. 40,000-59,999 had been merged with upper-level income in End Line than Baseline.

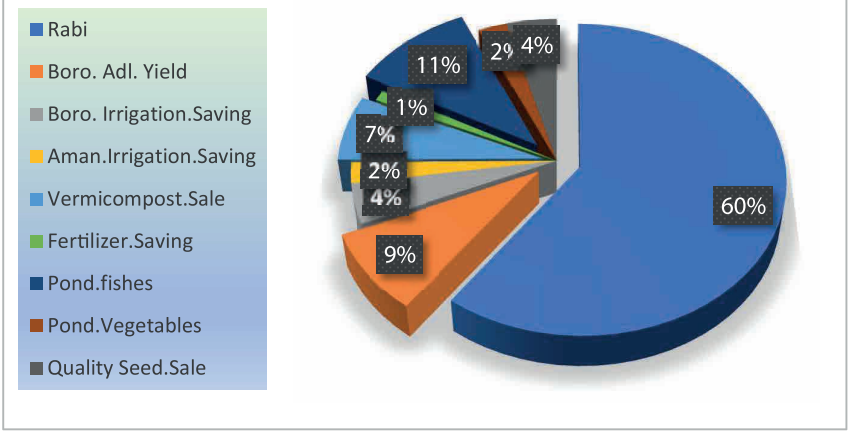
Figure-11: Farmers' Income Comparison Between Baseline and End Line



4.6(d). Income from Categorical WEAP Components

As stated above, we tried to look at what makes the difference with WEAP components that trigger farmers' yearly income balance: ⓐ. profit from increased yields of rabi crops; ⓑ. additional yields of Boro rice; ⓒ. irrigation cost balance of Boro rice; ⓓ. supplementary irrigation cost balance of Aman rice; ⓔ. vermicompost sale proceeds; ⓕ. saving balance of chemical fertilizers; and ⓗ. saving balance from fish culture and ⓘ. vegetables from reservoirs' dykes. So, we observed that the individual farmer's average income from WEAP components is greater than yearly individual farmer's average income (Figure-12).

Figure-12: Percent Income from WEAP



Individual Farmer's avg. Income BDT	Rabi	Boro Adl. Yield	Boro Irrigation Saving	Aman Irrigation Saving	Vermicompost Sale	Fertilizer Saving	Pond fishes	Pond Vegetables	Quality Seed Sale
41,743	25,087	3,535	1,728	911	2,850	4,74	4,370	1,008	1,781
%	60%	9%	4%	2%	7%	1%	11%	2%	4%

And the average income of 300 target farmers' from WEAP components were again classified at different ranges by uneven class intervals and found that 73% farmers had an income range BDT. 10,000-49,999 (Figure-13)

Figure-13: Percent Income Range from WEAP Components

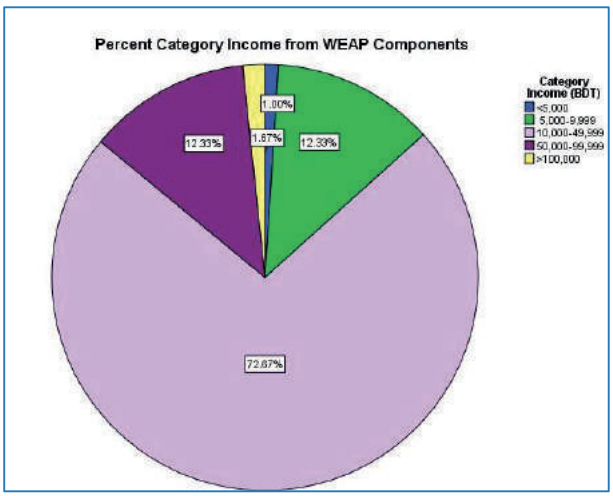


Table-7: Farmers' Income Range		
Farmers	Income Range (BDT)	Percent
3	<5,000	1
37	5,000-9999	12.3
218	10,000-49,999	72.7
37	50,000-99,999	12.3
5	>100,000	1.7
300	-	100

SECTION FIVE

Challenges and Lessons Learned: The way forward

5. Challenges and Lessons Learned: The way forward

①. The project has immensely contributed to the improvement of environment. Even though farmers have reduced 37-38% irrigation water so does 29% cost, but to enhance further reduction of water usage >50% reduction is anticipated through more water-use efficient approaches like- underground pipe, drip irrigation system alone. We experience huge water wastage under conventional earthen-drainage system (e.g., leakage, overflow, absorbed in dry canal, evapotranspiration etc.) that most of the farmers are practicing in this region. If this situation continues, an apprehension of severe drought, famine, loss of crop productivity due to water stress are not unlikely in near future in awake of climate change. This is due to legacy of 'Green Revolution', as many as 50 years back, since then exploitations began.

②. As GHGs exchange between agriculture ecosystem and atmosphere, the water-use efficient practice might have reduced 30-40% emission of methane. One BRRI scientist, who has PhD on it, predicts 30-40% reduction of methane emission is possible under reduction of 37-40% irrigation water. So, water reduction is necessary as much as possible so does methane. Adding to that, there is also a volumetric correlation of irrigation water with arsenic concentration in soil and food crops, thereby human health. In some pockets of this region, the arsenic concentration is beyond the tolerable range. So, the higher the water reduction, the better the dividend likely to be either in environmental perspective or else.

③. This region has high cropping intensity (Region's CI is 263% as against national CI 216%, National Statistics, 2020) as well as high inputs usage, like- fertilizers and pesticides; together impacts 30-40% production cost. So, together with less water practice, safe food production by no use or judicial use and/organically produced fertilizers, pesticides might reduce the cost of production and health, thereby increase income balance. Though safe food price is high in the market, farmers may be able to increase income, thereby keeping agriculture free from the harmful effects of climate change and to reduce health risks. However, safe food production system is a new in this area, some of our farmers already started though, but farmers' engagement in this innovative aspect is more challenging, like- market facilities for its promotion, requiring new skill training and testing of soil and farmers' produces. This has been started in some other places in Bangladesh, even safe food is being exported to Europe. Government (Ministry of Agriculture) has started promoting these initiatives to nearby areas of Dhaka city.

④. Rabi lands get flooded by conventional flood irrigation system during Rabi season in this region. This is a common phenomenon for general farmers in some pockets. Farmers can't choose to cultivate Rabi crops even of being interested to Rabi crops. These results huge uplands get flooded during Rabi season with overuse of groundwater, while at the same time, the lowlands bear the burden of excess runoff flood-water and become stagnant. Though, SBF as a local project holder, took some initiatives in some workplaces and succeeded.

⑤. BRRI has developed a lot of short duration early maturing non-irrigation reliant Aus and Aman rice varieties that are yield potential. Similarly, BARI's Spices Research Centers do so, but extension of these varieties is limited or unavailable to farmers at peak growing seasons. Seed production of pulses, oils and species (may be stated Aus and Aman) can be grown by contract growers (farmers) to make seeds available to farmers. This will help farmers available of high-quality seeds at peak sowing season as well as to increase economic return if seed quality is assured with tagging and labelling by the appropriate government authority, say, Seed Certification Agency, BADC etc. So, this work can be done in collaboration with government agencies. Though the project trained farmers, who produced seeds from the project supplied

stock, partly could able to sell relatively higher price but high-quality seed production and marketing requires more skills that needs government collaboration.

⑥. Cropping pattern has to be Rabi-crops inclusive pattern as stated in many places of the project context. Change of cropping pattern with the inclusion of Aus and short duration Aman is emergent as farmers can't be kept apart from growing of rice. Aus is grown on rainfed condition (during pre-wet season under Kharif-I) that doesn't need underground water, but farmers can't avail the opportunity because of delayed harvest of Boro rice and also non-availability of right seeds at the pick showing season makes the difference. while delay in Aman harvest phases down Rabi crops especially Wheat cultivation. So, short duration Aus and Aman can be introduced, and if farmers can produce these seeds by their own field. Technicalities and appropriate certification can be inspected and managed by government departments under collaborative approach. Summer tomatoes is another promising crop in term of economic return can be brought under the inclusive patter too.

⑦. Soil test needs to be recurrent helps farmers understating the extent of reduction of chemical farmers and necessity of organic fertilizers for their soils as well as to reduce cost of production and income balance. The soil health restoration approach is a key to crop productivity. Any such project requires soil test. Though we have short time experience in this project, but we observe a significant change of organic matter content thereby increased crop productivity of project farmers.

⑧. The project has synergic and spillover effect. As many as 14 local and national electronic and print media portrayed news on the project impacts and outcome. It is evident that sum total of 204 non-target residents (surrounding the target residents) were befitted. Among them, 123 from Rabi farmers, 67 over dependent groundwater-irrigation farmers and 14 farmers who dug water reservoirs (Ponds) by their own initiatives, even some farmers re-excavated reservoirs aiming to hold and retain more water volume of reservoirs for long time and land coverage with crops.

⑨. Fifty nine percent (of 170 farmers) vermicompost producing farmers were affected by the cyclone-Amphan in 2020 (Project 3rd.year). Finally, 10% farmers (170-153 =17) couldn't able to fully recover or resume their productions.

⑩. WEAP project has one important observation. The project introduced BARI-14 Mustard in farmers' cropping pattern for income increase and it happened so. Now, DAE, Kaliganj has expedited the spread of BARI-14 among Kaliganj farmers; the project farmers got some seeds free of cost too.

⑪. Water measuring tools needs to be used by the farmers who adopts AWD technique. AWD technique can be used 3 times during Boro season and the carefulness of measuring tool is essentially constructed with the technique., unless otherwise the results may reverse.

SECTION SIX

Prospects and Recommendations

6. Prospects and Recommendations

With the findings of end line survey, Soner Bangla Foundation (SBF) held several workshops with WEAP farmers and come up with the following prospects and recommendation that will reinforce the present activities by strengthening follow-up, sustain the outcome and introduce new innovations to the development dimensions-

①. For further reduction of water, thereby GHGs, low-cost pipe irrigation system can be introduced to increase further water-use efficiency practice among farmers. It will help avoid overuse or misuse of irrigation water loss due to open (earthen) drainage system. Underground PVC pipe with construction of raisers at field connected with overground flexible pipe is a construct the idea. Underground pipe system can be connected either farmers' STW, DTW or solar driven irrigation system which is eco-friendly also. Low-cost system development is for farmers' affordability and sustainability.

②. The hard reality is that we can't keep farmers away from rice cultivation. We have been experiencing that 83% WEAP farmers already covered 41% of the total lands by Rabi crops, yet systematic cropping pattern (CP) paves the way for systemic phasing down underground water needs. Apart from Rabi (crops) inclusive CP, short duration early maturing (SDEM) crops in Kharif season, such as Aus rice and summer tomato (in kharif-I or pre-wet season) and Aman rice (in Kharif -II/wet-season including seedbed, land preparation and supplementary irrigation through water reservoir) can be a thought-provoking cropping pattern for medium lands, high lands and low lands where applicable. For unavoidable Boro rice for low lands with AWD may be followed through.

As such, after long facilitation, the farmers have suggested following pattern of yearly growing crops-

ⓐ. High land CP (30-35% farmer)

Jute----------Aus (SDEM)----------Rabi Crops (Pulses, species and oils)
Aus (SDEM)------Aman (SDEM)--------Rabi Crops (Pulses, wheat, Maize, Oils, vegetables)
Aus (SDEM)------Aman (SDEM)--------Mustard (BARI-14), Boro (AWD)

ⓑ. Medium High (MH-1, MH-2 & ML) Land CP (60-70% farmer);

Aus (SDEM)------Aman (SDEM)---------Rabi Crops (Pulses intercropping/relay cropping, Sunflower etc.)
Jute----------Aman----------Rabi crops
Fallow----------Aman (SDEM)----------Rabi crop (Pulses)
Fallow----------Mustard----------Boro (AWD)

ⓒ. Low land CP (30-35% farmers)

Fallow----------Boro (AWD)----------Aman (LIV, Rabi Relay crops etc.)
Aus----------Boro (AWD)----------Aman

③. High quality seed production requires new skills from land management to seed harvest including regular field inspection and surveillance by the appropriate authority. After harvesting, seed processing, storing, tagging, labelling and certification are important stages in term of quality assurance and marketability. Government collaboration helps develop farmers skills and market opportunity and local SDEM seed availability at peak growing period.

④. GHGs emissions from Agro-ecosystem is a center of concerns of scientists now-a-day. Since, south-west part of Bangladesh has high CI with high inputs production system, the emission of GHGs is also high. After scientific evaluation, an appropriate adaptation measures are essential right now in the awake climate change.

⑤. Above all, soil health is a must for crop health vis-à-vis human health. Soil test, including soil nutrients and pollutants, for the selection of crops and recommendation of fertilizers are integral part of safe food production suggested by the farmers. This will help health and environment safe as well as climate change risk reduction with more adaptation options.

SECTION SEVEN

Flashback: Recurring vivid images of the project

7. Flashback: Recurring vivid images of the project

Hon'ble National Parliament Member visited WEAP farmers' congregation and WEAP activity display

A WEAP farmer was selling own-grown vegetables at dooryard

Deputy Commissioner, UNO visited farmers' congregation

Govt. Fisheries Officer inspected & advised on reservoir's fishes

Field visit by Tsutsui San

Field visit by Tsutsui San & Konuma San

A WEAP farmer was found irrigating rice field from reservoir

Farmers received seed preservation drums

Mr. Konuma San visited vermicompost sale center

Soil test workshop with farmers

Deputy Director, DAE was addressing at farmers' gathering, DAE officials, Hon'ble National Parliament member also addressed.

Deputy Commissioner was addressing at farmers' gathering, UNO & UAEO Jhenaidah were seen and also addressed in the occasion

Meeting with vermicompost producers

Digging for making water reservoir at crop field

WEAP farmer was nursing rabi crop field

Cultural function held at farmers' gathering

Farmers'' rally to mark 'World Water Day'

Wheat growing by WEAP farmers

Farmers' exposure visit to Govt. Rural Development Academy

Fencing to grow vegetables on reservoir & to protect children

Vermicompost is being sold at Fertilizer's dealer shop

Director, NGO Bureau visited water reservoir

Farmers' meeting

A WEAP farmer prepared and used organic pesticides in potato field

ANNEXURE

ANNEXURE-1: CASE STUDY

Case Study of WEAP Farmer: One


Mr. Komolesh Sharma

A bout the Farmer:

Name	Komolesh Sharma
Village	Kuruliya
Union	Niyamotpur
Thana	Kaliganj
District	Jhenaidah
Farmers ID	165

Income and expenditure Rice production in 50 decimals Land byTraditional Practice

Expenditure			Income
Seed	4,00		Total Rice Production: 33 Maunds
Irrigation	6,800		
Fertilizer	2,290		Price of 33Mds rice = (BDT @ 33 x 1,000 BDT)
Pesticide	2,200		BDT 33000
Labor	5,500		Net profit = (33000-17190) = 15,810 BDT
Total	17,190		

Mr komolesh Sharma is a small farmer with 50 dcml lands. He lives with his wife and son in a village named Kurulia which is 6 kilometers away from Kaligonj. Agriculture is his only income source. He couldn't bear the educational cost of his two children, so gave marriage his daughter without higher study. He was worried about the cost of rice production.

Then he joined the WEAP farmers' committee and became the President of the group. He received training from this project on AWD techniques, know-how to minimize crop production cost and efficient use of irrigation water reservoir. He is always active in group discussion, Apex meeting and sincere in communicating fellow farmers. By receiving training, his mindset changed to certain extent, followed AWD technique and reduced water scheduling from 85days to 60days for Boro rice production and irrigation cost saving by an avg. BDT 2,000. At the same time, crop yield increased by 2 maunds. Yet the cost of production can be reduced further If fertilizers and insecticide cost are minimized. He will do it gradually.

Income and expenditure Rice production in 40 decimals Land byAWD technique

Rice Expenditure			Rice Income
Seed	400		Total Rice Production: 35 Maunds
Irrigation	4700		
Fertilizer	2290		Price of 35Maunds rice = (BDT @ 35 x 1000BDT)
Insecticides	2200		BDT 35,000
Labor	5500		Profit = (35,000-15090) = 19,910
Total	15090		

Mr. Sharma is happy as he got 126% higher profit now than before. At the same time he believes that he saves environment

Case Study of WEAP Farmer: Two

About the Farmer:

Name	Md Nurul Islam
Village	Mostobapur
Union	Niamatpur
Thana	Kaliganj
District	Jhenaidah
Farmers ID	171

Md. Nurul Islam

Md Nurul Islam is a farmer who owns 80 dcml lands. He lives in a small village which is 7 km away from the Upazila with 4 family members. He is very popular to other villages for his philanthropic activity. But he had no enough source of income except agriculture. However. he couldn't produce sufficient amount of foods from his lands and it feels unconfutable and gets indebted with loan from micro credit.

He joined Water-use Efficient Agriculture project committee in 2018 and gathered knowledge about AWD technique, vermicomposting and cropping pattern as well as profitable agriculture. He started using vermicompost instead of chemical fertilizer and decided to cultivate Rabi crops by changing rice-rice cropping pattern.

Last year, in Rabi season, he cultivated one Rabi crop (Lentil) in his 80-decimal lands and had the following particulars of income-expenditure.

Rice production including income and expenditure in 80 dcml lands

Expenditure			Income
Seed	2424		Total Rice Produced = 55 Maunds
Irrigation	11103		
Fertilizer	11995		Sale price of 55 Maunds rice = (BDT @ 55 x 1,000 BDT) BDT 55,000
Insecticide	2424		
Labor	5018		Profit = (55,000-32,964) =BDT. 22,036
Total	32964		

Rabi Crop in 80 decimal lands

Expenditure			Income
Seed	950		Total Lentil production = 680 kg (17 Maunds)
Irrigation	2400		
Fertilizer	1500		Sale price of 360kg Lentil = (@680*115) = BDT 78,200
Insecticide	1450		
Labor	2000		Profit = (78,200-8,300) =69,900 BDT
Total	8,300		

Md. Nurul got 317% higher profit in Rabi cultivation than that of rice and he is happy too. Now, he wants to cultivate betel leaf with vermicompost which is more profitable than rice. He contributes to his society in many ways including social mediation, marriage ceremony and donation to poor people in needs.

Case Study of WEAP Farmer: Three

About Farmer:

Name	Md Afzal Hossen
Village	Alaipur
Union	Sundorpur Durgapur
Thana	Kaliganj
District	Jhenaidah
Farmers ID	87

Md. Afjal Hossein

Md Afzal Hossein is a WEAP farmer who owns 300 decimal lands. He lived in Alaipur, which is 5 km away from the Kaliganj Upazila. Most of the lands of his village is low, so Rice is the main crop of that area. Many people depend on agriculture here, Mr Afzal has no income source except agriculture, but he couldn't get enough profit from it because of high input production cost. In 2018, he joined WEAP project. When SBF formed groups in Alaipur, everybody selected him as the President of farmers' apex committee for his honesty, sincerity and devotion. Then he took part in some training such as- seed training, WEAP training, and GAP training. He acquired knowledge about the efficient use of water in Agriculture. Digging small pond (Reservoir) is one of the ways of efficient use of water and by this pond he was able to save cost of irrigation. As he received seed management training from SBF, he became interested to produce and preserve the seeds, multiply seeds for his own lands and to get more sale proceeds than paddy. In the following season, (last year), he cultivated one Rabi crop (Lentil) in his 30-decimal land and had the following particulars of income-expenditure.

Paddy sold as food

Paddy Production	Production Cost per Maund	Sale Price per Maund
1 Maund paddy	BDT@750	BDT@1,000
Total Paddy produced= 30 Maunds	30*750=22,500	30*1000=30,000
Total profit = BDT (30,000-22,500) = BDT 7,500		

Paddy sold as seed

Paddy Production	Production Cost per Maund	Sale Price per Maund
1 Maund paddy	BDT@750	BDT@1,000
Total seed produced= 20 Maunds Paddy as food produced=10 Maund	750*20=15,000	20mds (800 kg*@55/kg =BDT. 44,000
Remaining paddy (as food) 10 mds	750*10= 7,500	10* 1000=10,000 BDT
Seed cost saving for Irrigation	0	600 BDT
Total Cost of production = (15000+7500)= BDT. 22,500		
Total Price = (44,000+10,000)		54,600
Total Profit = (54,000-22,500)		BDT. 31,500

Mr Afjal Hossein got 420% higher profit in rice-as-seed than rice-as-food. Aditionally, he saves irrigation cost amounting to BDT.600 and has started producing seeds commertially. He saved his seed cost for boro and aman season, he gets healthy benefits from the seed sale to the farmers and market. Afjal Hossein has became seed para-trainer, he disseminates the seed production knowledge and WEAP knowledge as well in the locality

Case Study of WEAP Farmer: Four

A bout the Farmer

Name	Md. Nasir Mondol
Village	Mohadebpur
Union	Sundorpur Durgapur
Thana	Kaliganj
District	Jhenaidah
Farmers ID	18

Md. Nasir Mondol

Md Nasir Mondol is a farmer who owns 184 decimal lands at different parcels. He lives in Mohadebpur village, 3 km away from Kaliganj Upazila. He has 5 family members; two sons and one girl are studying. He is the only earning member of his family. He joined WEAP in 2018. He is the president of his village WEAP committee; He is involved in many social activities. He received WEAP and GAP training from Sonar Bangla Foundation.

He used to cultivate Boro paddy, but didn't get proper amount of crop from his lands and the soil condition was going bad day by day as well as crop productivity. When he learned the benefits soil test, his one parcel having 25 decimal lands was tested. He then followed through recommended doses of fertilizer for his lands. Last year, in Rabi season, he cultivated one Rabi crop (Lentil) in his 25 decimal lands and had the following particulars of income and expenditure.

Paddy (Boro) production in 25 dcml land before Soil test

Total Fertilizer Cost			Total Production	
Fertilizer Name	Amount	Price	Total Paddy Production	Price
Urea	35 kg	780	16 Maunds @1000*16= BDT. 16,000	16,000/=
TSP/DAP	20 kg	440		
MOP	11 kg	165		
Zip sum	5.5 kg	165		
Zinc Sulfate	1kg	200		
Organic Fertilizer/ Compost	30 kg	300		
Total	81.5 kg	2050/=	Total	16,000/=

Paddy (Boro) production in 25 dcml lands after Soil test

Total Fertilizer Cost			Total Production	
Fertilizer Name	Amount	Price	Total Paddy Production	Price
Urea	20 kg	320	18.5 Maunds @1000*18.5= BDT.	18,500/=
TSP/DOP	5 kg	110		
MOP	6 kg	90		
Zip sum	6.5 kg	195		
Zinc Sulfate	1.5 kg	300		
Organic/ Compost	50 kg	500		
Total	89 kg	1515/=	Total	18,500/=
Total Profit (18,500-16000) = BDT 2,500				

Md. Nasir Mondol was benefitted from soil test and in term of monetary value BDT 2,500 due to follow recommended doses of fertilizers. Now, his is interested to have their remaing lands tested to improve soil health and sustain crop productivity. He also shared his experiences with non-target farmers.

Case Study of WEAP Farmer: Five

About Farmer:

Name	Md Mominur Rahman
Village	Komlapur
Union	Sundorpur Durgapur
Thana	Kaliganj
District	Jhenaidah
Farmers ID	98

Md. Mominur Rahman

Md. Mominur Rahman is a WEAP farmer who owns 110 decimal lands. He has 2 children. Agriculture is the only income source for his family. While asked, he said he had been losing interest in agriculture due to high production cost as well as irrigation cost.

In April 2018, he engaged himself with WEAP project. He was nominated as the vice president of village WEAP committee. He received training on WEAP, GAP and seed production. He was always active in WEAP activities. He acquired knowledge on how to irrigate lands efficiently and as such, wanted to dig water reservoir, a small pond at field corner thereby saved irrigation cost in 46 decimal lands for Boro and Aman.

With the reservoir, he used to irrigate Boro paddy and reduced 20 times schedule of using underground water and saved cost of irrigation by the contract. He also used water from reservoir to irrigate 8 times in Aman paddy for seedbed preparation and supplementary irrigation. This saved groundwater.

Rice production in 46 decimals without before digging of reservoir

Expenditure					Income
	Boro	Aman	Total		
Seed	550	380	930		Total Rice Produced 33 Maunds
Irrigation	2000	1200	3200		
Fertilizer	2830	2770	5600		Sale price of 33 Maunds Rice = (BDT @1,000x33) = BDT 33,000
Insecticide	2700	1700	4400		
Labor	6100	6100	12200		Profit = (33,000 -26330) = BDT 6,670
Total	14,180	12,150	26,330		

Rice production in 46 decimals with water reservoir

Rice Expenditure					Rice Income
	Boro	Amon	Total		
Seed	550	380	930		Total Rice Produced 35 Maunds
Irrigation	1104	0	3200		
Fertilizer	2830	2770	5600		Sale price of 35 Maunds rice = BDT @ 1000 x35 = BDT 35,000
Insecticide	2700	1700	4400		
Labor	5600	5000	12200		Profit = (35,000 -22634) = BDT 12,366
Total	12784	9850	22634		

Mr. Rahman got almost double the amount of profit from by digging water reservoir. He is now interested to dig a new pond by his own cost. He is very happy to have income balance as well as less use of underground water. In second year, he also received profit margin of BDT 5,696 from one land parcel. He wants to increase Rabi crop cultivate and communicated Upazila Agriculture office for seed support through WEAP.

Case Study of WEAP Farmer: Six

About the Farmer:

Name	Ms. Rojina Akter
Village	Mostabapur
Union	Niamatpur
Thana	Kaliganj
District	Jhenaidah
Farmers ID	108


Ms. Rojina Akter

Rice (Boro) expenditure and income in 33 decimal lands:

Rice Expenditure			Rice Income
Seed	500		Total Rice Produced 25 Maunds
Irrigation	6000		
Fertilizer	4000		Sale Price of 25Maunds rice = (BDT @ 720x 25
Insecticide	800		BDT 18,000
Labor	5000		Profit = (18000-16300) = BDT 1,700
Total	16300 BDT		

Ms. Rojina Akter is a very small farmer, she has 33 decimal lands. She lives with his husband and only daughter (Class- 4). Her husband is a daily labor and he was the only earning member of her family but he couldn't maintain the family with his earnings. Day by day, they were getting indebted. She was interested to join WEAP farmers' committee. She was interested for vermicomposting and as such SBF supported Redworm. She then started producing vermicompost in 2018 as well as multiplying Redworms. Initially, she started producing vermicompost with two containers, now she produces vermicompost with 40 containers. By producing vermicompost, she is using it for her own land and selling it to non-target farmers and increasing income day by day.

Initial Cost of Vermicompost, Red worm and instruments:

Instruments	Cost
2 pots	50*2= BDT 100
Shade	24*2=480
Total = 100+ 480 = BDT 580	

Income from Vermicompost and Redworm

Vermin Compost	Amount (Kg)	BDT		Red worm	Amount	Price
Self-use in land	100	1,000		Started with	1kg	1,000
Sell to others	500	5,000		Multiplied	9kg	9000
Total Produced	600	6,000		Total	10kg	10,000
Total Income 6,000 BDT + 10,000 BDT = 16,000						
Profit = 16,000 – 580 = BDT 15,420						

Now, Rojina Akter is a leader of vermicompost producers of Mostabapur village farmers' Committee. He shares her knowledge with others in various meeting and discussion. She also minimizes the cost of rice production by using vermicompost in this year. With income balance from vermicompost as fertilizer and Irrigation cost saving, Rojina is happy with her family.

Annexure- 2:
Critical Limit of Soil Nutrients and Interpretation

Critical limit of soil nutrients for interpretation of Soil test (Ref. Fertilizer Recommendation Guide-2018, Bangladesh Agricultural Research Council)

1. Classification of Soils on the basis of Soil pH value

Level	pH value
Strongly Acidic	>3
Acidic	2.9-5.5
Slightly acidic	5.6-6.5
Neutral	6.6-7.3
Slightly alkaline	7.4-8.4
Strongly alkaline	8.5-8.9
Very strong alkaline	>9

2. Classification of Soils by Soil Organic matter (%)

Level	%Organic Matter
Very high	>5.5
High	3.5-5.5
Medium	1.8-3.4
Low	1.0-1.7
Very low	<1.0

3. Interpretation of soil test values based on critical limit (A &B)

Interpretation of soil test values based on critical limits

A: Loamy to Clayey Soils of Upland Crops

Nutrient element*	Very Low	Low	Medium	Optimum	High	Very high
N (%)	≤0.09	0.091-0.18	0.181-0.27	0.271-0.36	0.361-0.45	>0.45
P (µg/g soil) (Olsen)	≤7.5	7.51-15.0	15.1-22.5	22.51-30	30.1-37.5	>37.5
P (µg/g) (Bray & Kurtz)	≤5.25	5.25-10.5	10.51-15.75	15.76-21.0	21.1-26.25	>26.25
S (µg/g) soil	≤7.5	7.51-15.0	15.1-22.5	22.51-30	30.1-37.5	>37.5
K (meq/100g)	≤0.09	0.091-0.18	0.181-0.27	0.271-0.36	0.361-0.45	>0.45
Ca (meq/100g)	≤1.5	1.51-3.0	3.1-4.5	4.51-6.0	6.1-7.5	>7.5
Mg (meq/100g)	≤0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Cu (µg/g)	≤0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Zn (µg/g)	≤0.45	0.451-0.9	0.91-1.35	1.351-1.8	1.81-2.25	>2.25
Fe (µg/g)	≤3.0	3.1-6.0	6.1-9.0	9.1-12.0	12.1-15.0	>15.0
Mn (µg/g)	≤0.75	0.756-1.5	1.51-2.25	2.256-3.0	3.1-3.75	>3.75
B (µg/g)	≤0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Mo (µg/g)	≤0.075	0.076-0.15	0.151-0.225	0.226-0.30	0.31-0.375	>0.375

B : Loamy to Clayey Soils of Wetland Rice Crops

Nutrient element*	Very Low	Low	Medium	Optimum	High	Very high
N (%)	≤ 0.09	0.0910.18	1.181-0.27	0.271-0.36	0.361-0.45	>0.45
P (µg/g) (Olsen)	≤ 6.0	6.1-12.0	12.1-18.0	18.1-24.0	24.1-30.0	>30.0
P (µg/g) (Bray & Kurtz)	≤ 3.75	3.76-7.5	7.6-11.25	11.26-15.0	15.1-18.75	>18.75
S (µg/g)	≤ 9.0	9.1-18.0	18.1-27.0	27.1-36.0	36.1-45.0	>45.0
K (meq/100g)	≤ 0.075	0.076-0.15	0.151-0.225	0.226-0.30	0.31-0.375	>0.375
Ca (meq/100g)	≤ 1.5	1.51-3.0	3.1-4.5	4.51-6.0	6.1-7.5	>7.5
Mg (meq/100g)	≤ 0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Cu (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61.0.75	>0.75
Zn (µg/g)	≤ 0.45	0.451-0.9	0.91-1.35	1.351-1.8	1.81-2.225	>2.25
Fe (µg/g)	≤ 3.0	3.1-6.0	6.1-9.0	9.1-12.0	12.1-15.0	>15.0
Mn (µg/g)	≤ 0.75	0.756-1.5	1.51-2.25	2.256-3.0	3.1-3.75	>3.75
B (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Mo (µg/g)	≤ 0.075	0.076-0.15	0.151-0.225	0.226-0.30	0.31-0.375	>0.375

Annexure-3: Web Documents

- 1 . https://www.youtube.com/channel/UCTQVYbCy70rpJAM85WlsKow
- 2 . www.sbfbd.org
- 3. https://www.facebook.com/profile.php?id=100007793358445

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