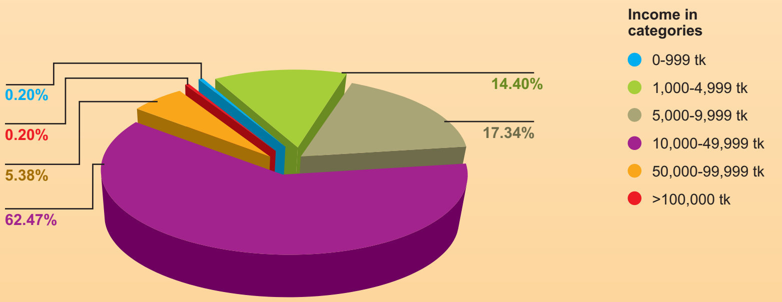
SAP

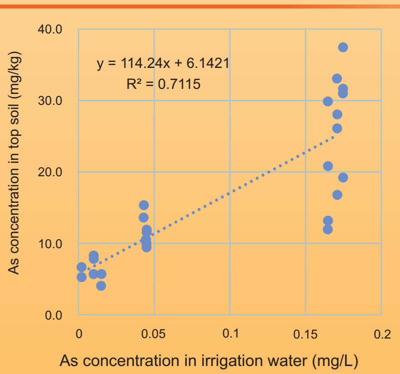
PROJECT REPORT

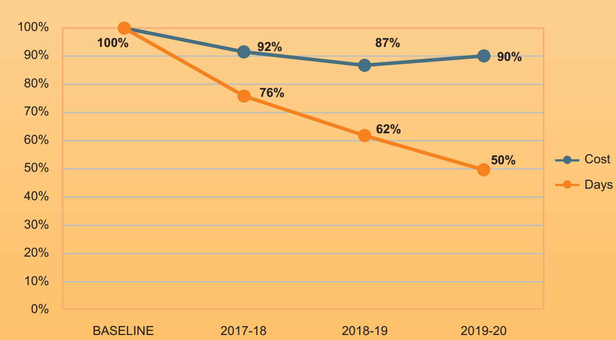
Promotion of Sustainable Agriculture Practice (SAP) with Less Irrigation Water

- Aim for the fundamental solution of arsenic pollution.

Percent farmers benefitted from SAP Approach







Asia Arsenic Network (AAN), Japan
Share the Planet Association, Japan
AID Foundation, Bangladesh

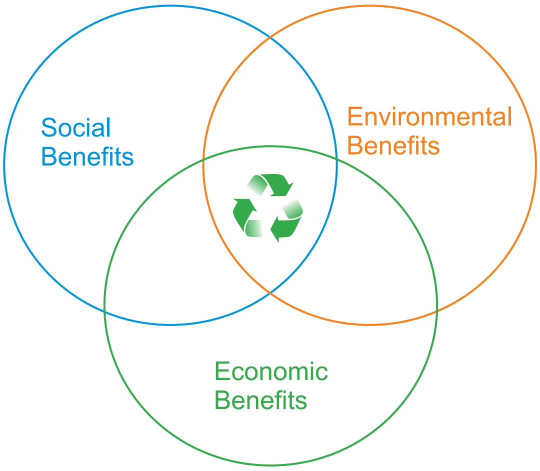
September 2020

Financed by
Ministry of Foreign Affairs, Japan

PROJECT
ON

PROMOTION OF SUSTAINABLE AGRICULTURE PRACTICE (SAP)

- Aim for the fundamental solution of arsenic pollution



SAP

Prepared by

Parimal Kumar Ray, MS in Agriculture, MDS
Md. Shamim Uddin, PhD

Asia Arsenic Network, Japan
Share the Planet Association, Japan
and
AID Foundation, Bangladesh

Financed by

Ministry of Foreign Affairs, Japan

Promotion of Sustainable Agriculture Practice (SAP) with Less Irrigation Water

- Aim for the fundamental solution of arsenic pollution.

September 2020

REVIEW & EDIT

A Team of Professors:
Bangladesh Agricultural University (BAU), Mymensingh and
Adjunct Faculty, Interdisciplinary Institute for Food Security (IIFS), BAU

Professor Dr. Mujaffar Hossain, Department of Animal Science

Professor Dr. Amirul Islam, Department of Agricultural and Applied Statistics

Professor Dr. Abdul Kader, Department of Agronomy

Professor Dr. Harunur Rashid, Department of Fisheries, and

Mr. Kripangshu Shekhor Biswas
Deputy Director, Department of Agricultural Extension, Jhenaidah

ADVICE AND COOPERATION

Prof. Hiroshi Yokota

Tamiko Ishiyama

Tetsuo Tsutsui

http://www.aan-bangladesh.org/

CONTACT

Asia Arsenic Network (AAN)
YDF General Hospital (7th Floor)
Plot-23, Avenue-8, Block-H
Banasree, Dhaka-1219

PRINTED BY

Arka

PREFACE

The agriculture sector in Bangladesh has particular importance for the sustained food and nutritional security of its larger, dense and ever-growing population. Amid COVID-19, cyclone-Amphan and flood situation, the sector continues to serve round the clock setting targets, keeping eye on timely harvest of last Boro rice to present T. Aman production so as to expedite ongoing development in agriculture and achieving food security. It is virtually important to joint hands of both government and non-government actors to keep pace of present development in Bangladesh.

I appreciate the approach on Sustainable Agriculture Practice (SAP) carried out by AID Foundation as an implementing organization in cooperation with Asia Arsenic Network and Share the Planet Association, Japan. The approach, including less water irrigation practice, promotion of Rabi crops, vermicomposting, soil test etc., is not only impacting farmers' economies, but it also helps meeting environmental challenges. By visiting project farmers, I feel that the farmers shall continue to improve SAP approach and its expansion through farmer to farmer exchange, hands-on-training to gather more knowledge to get benefitted both economically and environmentally. I feel deeply that it would help bringing quality of life improvement, boosting up the food security and meeting climate challenges.

I am also happy to see the report highlights some field observations that will serve as a reference for policy inputs for both government, development partners and other users in their endeavors towards the agricultural development of the country.

I would like to extend my sincere thanks to officials of aforementioned organizations involved in striving for excellence.

Kripangshu Shekhor Biswas
Deputy Director,
Office of the Deputy Director,
Department of Agricultural Extension, Jhenaidah
17 September, 2020

PREFACE

It is a great pleasure for us to share that, AID Foundation is celebrating the glorious 28 years of its inception this year. Each of the years bears special significance as it heralds another year. Having begun its journey on December 17, 1992 AID Foundation has crossed a bumpy terrain to become what it is today. But it still has a long way to go.

I'm very happy to express that, we were able to upgrade the socio-economic conditions of more disadvantaged people (Farmers) in the community (Jhenaidah Sadar, Kaligonj Upazila, Kotchandpur Upazila in Jhenaidah District) and at the same time helped them to live a dignified life through 'Promotion of Sustainable Agriculture Practice (SAP)-with less irrigation water' project activities. We would like to convey our heartiest gratitude to Ministry of Foreign Affairs (MoFA) Japan, Asia Arsenic Network (AAN) & Share the Planet Association (SPA) Japan for supporting us financially and technically during the entire project period. At the end of the day, we feel gratified learning that our farmers are able to reduce the use of underground water through adopting Alternative Wet & Dry (AWD) irrigation method in paddy cultivation. Less irrigation crop like Rabi and Vegetable cultivation gradually increased among the target community. Farmers are benefitted by soil test based fertilizer management and able to reduce fertilizer cost. Interested SAP farmers are producing and using vermin-compost with the support of the project and do understand the benefit of it. Eco-friendly Sustainable Agriculture Practice (SAP) also led to Less Irrigation, Less Underground Water, and Less Arsenic Contamination in the targeted SAP implementation area considered as arsenic prone area. Apparently, the project is contributing to achieving Sustainable Development Goals (SDGs), specifically, Ensure sustainable food production systems directly, and other goals such as reduce the number of death and illness from water and soil pollution, universal drinking water access, increase water use efficiency, protect water related ecosystems, improve global use efficiency in consumption.

In the long run, to the Sustainability, the government should initiate multiple pragmatic schemes on the life and livelihood of the poor, environmental protection, safe food assurance programme, value chain maintenance and climate change. At the crossroads, more outreach and education programmes are needed for the uplift of people's lifestyle and the country's rapid march forward. AID Foundation remains ready to be a proud partner of this visionary government in its development initiatives.

On behalf of AID Foundation, I would like to thank all of our partners, sponsors, donors, colleagues and the community members who are allowing us to serve them and the Government of Bangladesh. I also want to thank to all associates inside and outside of our country for their direct or indirect support to make our development approaches sharpened and more suitable to the sustainability.

Tarikul Islam Palash
Founder & Chief Executive
AID Foundation
http://aid-bd.org/

PREFACE

Japan and Bangladesh are located in the east and west of the Asian monsoon region, and both share a common culture such as, rice as the staple food with a variety of vegetables and fishes. Another common issue is that recent drastic climate change and excessive devotion to modern agriculture threaten the sustainability of agriculture.

Especially in Bangladesh, depletion of ground water and a secondary pollution by arsenic due to waste of a large amount of water resources for irrigation are serious problems. In this project, these two countries that eat rice as their staple food will work together, with their farmers, who have a common sense of crisis about the sustainability of agriculture, and will not take any economic risk by changing the planting system rather improving the farming method sustainably.

It has been proven to save irrigation water. In particular, I think it is very valuable that it was made possible by the efforts of actual farmers, not by experiments at test sites.

With this result as a starting point, I hope that new agriculture will spread throughout Bangladesh and that agriculture is good for the environment and human health.

Finally, I would like to thank all the people involved in this project.

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

PREFACE

The arsenic-contaminated groundwater has been often used for irrigation of Boro rice farming in Bangladesh. There are same cases in the vegetable cultivation, too. It has been, therefore, deeply concerned that the arsenic contamination is to be concerned in the groundwater-soil-food chain system.

AAN has engaged in the above chain problems through the SAP project and examined the arsenic contamination of irrigation water, farm land water, and rice & vegetable. As a result, we show here the findings for the "Sustainable agriculture practice", such as the promotion of multi cropping with Aman rice, Rabi crops and vegetable, the variety of vegetable without arsenic-contamination, the need to develop selective breeding of vegetables tolerant of As-contamination, and the less consume of groundwater for irrigation by using pipe line.

The field works in the above examination have been carried with SAP farmers. We would like to express our gratitude for their efforts.

Prof. Hiroshi Yokota
Representative of AAN

Table of Contents

Acronym

AAN	-	Asia Arsenic Network
ADD	-	Additional Deputy Director
AEZ	-	Agro Ecological Zone
AID	-	Actions In Development
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
Bigha	-	Approx. 1335 square meter (36.54 meter x 36.45 meter)
CI	-	Cropping Intensity
DAE	-	Department of Agricultural Extension
DCML	-	Decimal (1/100 acre = 40.4686 meter square)
DD	-	Deputy Director
DFID	-	Department of International Development – GOV.UK
DTW	-	Deep Tube Well
ET	-	Evapotranspiration
FGD	-	Focus Group Discussion
GDP	-	Gross Domestic Product
IRRI	-	International Rice Research Institute
Kg	-	Kilogram
LGIs	-	Local Government Institutes
MT	-	Metric Ton
Maund	-	40kg = 0.4MT
NGOs	-	Non-governmental Organizations
OM	-	Organic Matter
PDM	-	Project Development Matrix
SAAO	-	Sub-Assistant Agriculture Officer
SAP	-	Sustainable Agriculture Practice
SAGs	-	Sustainable Agriculture Goals
SPA	-	Share the Planet Association
SRDI	-	Soil Resource Development Institute
STW	-	Shallow Tube Well
UNO	-	Upazilla Nirbahi Officer (Sub-district Chief Executive)
WHO	-	World Health Organization

List of Annexure

① Case studies of SAP farmers
② List of participants of SAP workshops
(Government officials, academicians, researcher and Scientist)
③ Interpretation of critical limit of soil nutrients
④ Annex-4: 328 Irrigation well arsenic contaminated data

Appendix

1) Standard of Irrigation water for As-contamination
2) Standard of farm land soil for As-contamination
3) Standard of vegetable for As-contamination
4) Standard of seed for As-contamination
5) Arsenic concentration in fertilizers

Web Documents

Presentation
SAP Farmers' Voice

Executive Summary

Agriculture is the main driver of livelihood as well as Bangladesh economy. Though its share to GDP is now on the verge of secular decline (over the past four more decades), its immense contribution to food and nutrition supply, raw material for industry, rural people's employment is still vivid and key to more than 15% in GDP (2015-16) where farmers are pivotal.

Marginal and poor farmers constitute a major part of the population who unfortunately remain below the poverty line in Bangladesh. Yet, with the advancement of technological interventions and research in Bangladesh agriculture sector together with the untiring efforts of poor farmers pave the ways to triple the food production (about 35 million tons of rice in 2019) with a pace of >5% annual growth to feed nearly 170 million populaces. Since independence (1971) until last decade, we have been witnessing a shift from subsistence level of agriculture to semi-commercialization with decades of interventions. Now, we witness a massive shift; a takeoff from semi-commercialization to commercialization in agriculture.

Sustainability in agriculture in 21st century is a nexus of three dimensions: ensuring food security, meeting socio-economic challenges of and decisive mitigation measures from climate variabilities. So, the sustainable agriculture system must be built on an approach that will be integrated, resource conserving, connecting farms with socially supportive and commercially competitive, and ecologically/environmentally sound. Hereafter, resource management makes a big difference between present state of agriculture and sustainable agriculture.

Despite all of the above, with the pace of population growth, the need for sustainably increased food production is essentially required; it demands optimum land use vis-à-vis conservational practices, appropriate technology with the informed choice of farmers, backstopping farmers with capacity building and of providing technical assistance, post-harvest management of farmers' produce including enabling environment conducive to market condition/facilities, supply chain/value chain management etc. Historically, land use planning has largely been an economic concern. So, focus has to be put in place on comprehensive land use planning with integration of economic, ecological, social and cultural values/acceptance in production system without disturbing the potential demands of resources for future generation what we often call sustainability.

Land, quality seeds, irrigation, fertilizers and capital are critical inputs/resources required for increasing crop production, but they are increasingly scarce nowadays. The linear expansion of modern agricultural practices has been reversing the process of returning renewable resources back to soil since long and at the same time intensification of cultivation practices make arable lands gradually losing the carrying capacity with huge crop loads. Indiscriminate use of non-recommended doses of the chemical fertilizers, pesticides, herbicides etc., have added antidote to soils making it gradually more unproductive too. While overused irrigation water for upland Boro rice cultivation not only depletes ground water level but it restricts both aerobic and anaerobic microbial activities in soils thereby untapped crop growth potential (Boro rice) under continuously flooded/submersed condition; and also render soils relatively unproductive.

The project titled "Promotion of Sustainable Agriculture Practice (SAP) - aim for the fundamental solution of arsenic pollution" was implemented at three upazilas under Jhenaidah district of Bangladesh. The research questions of the project are understandable, yet comprehensive. Farmers in the project target area used to follow rice-based cropping pattern though the area is potential for growing Rabi crops. With

the unsustainable irrigation practices for Boro rice cultivation (under flood irrigation system), the uplands get flooded during Rabi season; the lowlands, at the same time, have to bear the burden of excess flood-water run-off and remain stagnant; crop growth/yield potential is untapped and ground water continue to diminish. These impose almost a bulling effect that rock the farming communities. Due to reckless installation of STW and DTW, tube wells (for drinking water) in the dry season remain almost inoperative in many places and an apprehension of arsenic contamination in soils, crops and thereby in food chain is not unlikely. Before the project inception, we experienced that the farmers had lack of early maturing quality seeds for the promotion of Rabi crops cultivation and that was a major setback. So, keeping those views in mind, the project thought about developing 40% advanced farmers into resource farmers by backstopping them with various capacity building activities and getting them engaged for facilitation of other members by group approach.

However, while on implementing SAP project, we experience that farmers don't listen to the result of national reconnaissance soil survey and thereby fertilizer recommendation, until and unless they find results at their own field's soils being tested. So, we emphasized/supported farmers to have their soil tested; the production of vermicompost and various other forms of organic fertilizers, etc. to have their soils fertilized with organic sources along with other means such as diversification of crops so that the process of renewable sources get momentum and back to soils as well. A balanced, robust soil health is a must for intensifying production, sustained food and nutritional security.

During the stipulated project period, approx.17 % (251) farmers tested their soils in SRDI lab in Jhenaidah that resulted the presence of low average soil nutrients such as % Nitrogen (0.14), Boron (0.24) and % OM (1.65) while very high and high phosphorous (31.47) and Potassium 0.43 respectively. So, farmers followed recommended crops with recommended doses of chemical fertilizers; 30-40% reduction of potassium and phosphorus fertilizers; and used various organic fertilizers including vermicompost together helped them getting benefitted financially by lowering the cost of production of inputs[1]. Of about 11% (166) SAP farmers produced 20.32 MT vermicompost (an organic fertilizer, rich in essential nutrients as many as 11 out of 17 requiring for crop growth) and reproduced red worms (one variety of earthworms that produce vermicompost). Some SAP farmers noticed that they became able to bring back their lands productive[2]. Farmers who produced vermicompost also earned money by selling vermicompost as well as red worms to other interested farmers. Results are evident in case studies, focus group discussion and video documentation during field visit with project staff and district DAE officials.

Motivation to SAP farmers took time for increasing cropping intensity despite present soil fertility status, mindset and knowledge for selection of crops, capitals and other resources, but the project consistently motivated and backstopped SAP farmers to have their cropping intensity increased. We observed some changes among 12% (177) SAP farmers who were able to increase their cropping intensity up to 269% in 2019-20 (Project year-3) from 220% in 2018–2019 Rabi season. During the period, we also observed that SAP farmers included short-duration Rabi crops (e.g., cabbage, cauliflower, leafy vegetables, etc.) in their cropping pattern where they used to grow Boro rice or other perennial crops. Though the sample size is too small to compare its plausibly with national cropping intensity i.e., 216% (2020) and that of Jhenaidah District 263% (2020) but we believe that farmers are finding solution and they will continue to use it.

Ground water is a very essential input and a scarce resource for increasing crop productivity as well as sustainable agriculture which is being gradually depleted and contaminated by arsenic concentration unscrupulously over the years. Though, irrigation water requirement for Boro rice production varies with the varieties concerned (between short & long duration) but the BRRI observation/research[3] seems that the present irrigation practice would definitely render this crucial resource redundant day by day. We have also been experiencing that climate variability and overuse of groundwater together pave the way of making a significant portion of the country unavailable for irrigation water during dry season. Therefore, a sustainable practice in irrigation management at farmers' field is essentially required to keep the present

1 SAP Farmers' reference value reveals that avg. 30-40% cost reduction of chemical fertilizers thereby reduction in cost of production had been possible.

2 Vermicompost increases water holding capacity of soil: irrigation water savings by 30-40%; 26% of yield increase in commercial agriculture as well as make readily available of most essential nutrients in soil (Ref. Ecological and Practical Applications of Sustainable Agriculture, Springer Publication, 2020).

3 According to BRRI study 4,000 liters of water is used as irrigation for producing per kg of Boro rice in farmers' field compared to 2,000 liters in an experimental plot (Some lessons by Nasima Tanvir Chowdhury)

pace of growth in Bangladesh agriculture to continue as well as to intensify the production sustainably to make dividend in food security and commercialization.

So, enhancing irrigation water-use efficiency and water productivity need to be promoted through optimal use so as to protect the ecological balance and save irrigation cost as well as cost of production. In the upland agriculture where water is a must demand, adaptive land use plan by rain-fed agriculture, cultivation of less water requiring crops such as Rabi crops including vegetables can be best suited to ensure food and nutritional security, enhancement of sustainable intensification and diversification of climate resilient agricultural production with increased commercialization in agriculture.

SAP farmers' data analysis reveals that 1,500 SAP farmers (poor and marginal) have their capacity built on different SAP interventions including less water irrigation practice gradually i.e., 22% in 1st. year; 43% in 2nd. Year; and 47% in 3rd. year at the upland Boro rice field by using AWD (Alternate Wetting and Drying) technology. We observed that of about 47% of the SAP farmers maintained almost 50% less water scheduling in 2019-20 Boro season compared to the baseline. It helped them maintaining water use efficiency in upland rice cultivation as well as optimal crop growth i.e., an increase of crop yields. Thirteen percent (197) SAP farmers' data reveal that crop yields, on an average additional 4.12 maunds rice/bigha, were possible under simultaneously wetting and drying of lands according to farmers' judgment invariably.

Despite the above, we also consistently monitored and analyzed irrigation water scheduling of 323 SAP farmers, who, among the rest of SAP farmers, responded first to SAP interventions without fear of losing yields. These include efficiency in water scheduling as well as reduction of 10% irrigation cost/bigha by negotiating with commercial water suppliers, reducing fuel cost by lessening the number of pumping out irrigation water by own/groups' operative machines during the project period. Here, as above, we also experience 50% less water scheduling; 10% less irrigation cost; and higher irrigation cost saving (some results are given inside) by own/group's machines than that of contractual basis with commercial water suppliers.

We also experienced that as many as 174 non-target farmers (neighbors of SAP farmers) in the second year followed less irrigation practice as their fellow farmers were getting benefitted. During FGD (Video document) with SAP farmers in third year, we noticed of about 5-8 non-SAP farmers invariably visited SAP farmers to be acquainted with SAP practices, especially of less irrigation technology.

So, 50% reduction in irrigation scheduling at 10% cost savings (least cost savings) is a big challenge for them who adopted AWD technology. We have discussed and raised this issue with Department of Agricultural Extension, Upazilla administration, Deputy Commissioner, Member of the parliament in the project area time to time and held meetings. This discussion is on among them but yet to find a solution. This is actually an agony of SAP farmers with an apprehension of potential reverse of the mindset if nothing could be done in near future.

Availability of quality seeds of different crop varieties at farmers' reach matters in terms of production, multiplication, early marketing and farmers' economies. Availability of diverse quality seeds enhances crop diversity both in Rabi and Kharif seasons. Among the SAP farmers, 200 farmers of three Upazilas were trained in seed production and preservation. Of them 69% (137) produced seeds of Rabi crops and 31% (63) produced seeds of paddy, summer vegetables etc. During the project period in 2018-19 and 2019-20 Rabi seasons, the stated SAP farmers produced a total of 42.32 MT of 11 varieties Rabi seeds for sale and multiplication; of them 33.48 MT were sold in the local market and to other SAP farmers. SAP farmers were financially benefitted by selling these Rabi seeds worth BDT 2.32 million. When most of the farmers in the target area had been facing scarcity of Rabi seeds during 2018-19 Rabi crop season, some of our SAP farmers had comparative advantage with the seeds available for cultivating in Rabi season. We feel that the challenge of seed spread to enhance crop diversity in the locality is still evident as most of the SAP farmers sold these 'seeds as food' with cheaper price in the local market as well as the quality of seeds that the farmers produced is in question to other farmers.

Data analysis of Rabi crop cultivation by 1,500 SAP farmers reveals that percentage of SAP farmers and their area of lands under Rabi crops both were gradually increased for practicing agriculture sustainably. The result shows that 94% (1,410) of SAP farmers cultivated Rabi crops in 2019-20 compared to 77% (1,158) in 2016-17 baseline and the land areas under Rabi crops increased gradually from 38% in the baseline to 58% in 2019-20 Rabi season. Case study shows income balance of the poor and marginal SAP farmers, but we also experienced some challenges in 2018-19 Rabi season where <5% (74) SAP farmers incurred losses/damage of Rabi crops, Boro rice, flower plantation etc., due to foggy weather at early winter followed by erratic rainfall pattern at late winter. District DAE (Govt) officials visited SAP farmers' field, held workshop with farmers in three project areas. It had improved some farmers' cultivation practices but not all. However, we had to face an onslaught in 2019-20 Rabi season where the damage was mostly caused by the cyclone Amphan followed by the COVID-19 pandemic situation severely meaning that almost all farmers hardly sold their produce (Rabi crops, rice, other cash crops) to retails and whole sale market. We deeply considered the stated challenges and put in place among the DAE officials and LGIs representatives in the district workshop held on 10 August 2020.

Though, the effectiveness of SAP approach is a time taking question, but the initiatives and results, until now, make dividend in terms of number of farmers being involved (47% in succession) with increased water-use efficiency, profitability (66% farmers befitted; 62.47% farmers' additional annual income average range was BDT. 10,000 - 49,999) as well as safe environment by the approach.

However, the challenge remains as it had been in the past and would remain in future too, but the people around the farmers' institutions must have a stake to be proactive so as to help them meeting those challenges; togetherness brings diversity, diversity brings sustainability.

SECTION ONE

An Overview of the Project Background

An Overview of the Project Background

With the introduction of Green revolution in the early sixties, Bangladesh was not far from its reality, even its succession from the then East-Pakistan to now Bangladesh, bears the same myth and legacy too. Newer technologies with high input agriculture, though has tripled the food production to feed more than double the populace in the last four more decades of Bangladesh since its independence, left many residual effects; it pollutes environment and soil health render the sustainable production system redundant.

The project area comprises 3 upazilas (sub-districts) viz., Jhenaidaha Sadar, Kotchandpur and Kaligonj under Jhenaidaha district. The area belongs to AEZ-11, a part of High Ganges River flood plain of southwestern Bangladesh. Much of its topography is characterized predominantly by highland and medium highland. A few low laying areas comprising 'Baor and beels' (low to medium water catchment area) are also located in the project area of Kotchandpur and Jhenaidah Sadar Upazilla. The texture of the soil is very fine (loamy/clay) including mainly calcareous dark grey floodplain soils and calcareous brown floodplain soils. 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 unscrupulous use of ground water by DTW, STW etc. that may pave the way of increasing arsenic (As) contamination in groundwater could have impacted agriculture. As such, an apprehension of correlation among water, soil and crop is not unlikely that might have also risk of arsenic metabolism due to nutritional deficiency; it is an issue of concern and risk for having exposure to both human and animal health. DFID and WHO survey samples in the late nineties had also sufficiently proved arsenic (As) contamination at high concentration in drinking water in Bangladesh, a serious threat to public health; it is as high as in the Ganges Delta of Asian region.

Although, the area is mostly suitable for Rabi crops such as pulses, oilseed, vegetables (winter) and spices like turmeric, onion, garlic etc., but it also favors 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 other reality is that the vast of uplands are mostly cultivated by Boro rice under flood irrigation that take away critical resources such as land, water, capital etc. Moreover, the medium and long duration Aman rice varieties, used to grow during monsoon, come under drought injury in the later of its growth cycle needs recurrent supplementary irrigation and it impacts profitability; delays wheat seeding and affects the effort to expand wheat production, although decreased amount of cool weather in winter season (Rabi season) also affects wheat yields.

The land quality of this region is gradually deteriorating by various means including over fertilization by chemical fertilizers along with the acceleration of monocropping that impacts the balance of nutrients in soils over years. The capital intense production deprives farmers, often found them complaining not getting fair price (especially rice) of their produce. When excess irrigation water, overdose of fertilizer and pesticides comprehend the production cost mostly (70-80%) then the claim might continue to be echoed is the reality of target area.

However, among the challenges, promotion of monoculture, depletion of ground water, increased cost of production, exposure to arsenic toxicity deserve to be mentioned.

Under the purview of the above, the project sets long term Sustainable Agriculture Goals (SAGs) to sustain: 1. economic viability of farm operations; 2. environmentally sound production system; 3. quality life improvement for farmers and societal people as a whole thereby accepting it socially; 4. secure food (farmers' adaptive food security system) to meet local and national demands and not the least, the gradually increased productivity that meets food supply with the on-going pace of population growth.

Keeping those views in mind, this project was initially developed to promote **Sustainable Agriculture Practice (SAP)** with less irrigation water. Its long-term aim was to reduce arsenic in soil and environment while ensuring water-use-efficient cropping system.

The project followed sustainable approaches to agriculture farming based on modern ecological science combined with indigenous knowledge. The target farmers were those who followed traditional Rabi crop cultivation including winter vegetables, pulses, oils and spices crops, sugarcane, wheat and so on by employing techniques – such as crop diversification, less water requiring cropping pattern under eco-friendly soil management while overcoming rice monoculture farming.

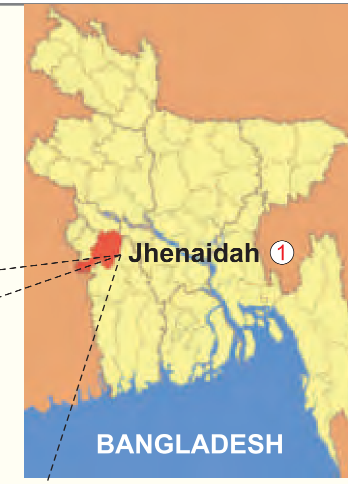
The major part of the project was to develop skills of at least 1,500 poor and marginal target farmers on the diverse farming practices and approaches that were expected to benefit them economically, environmentally and socially acceptable manner so as to sustain their incomes, resources and communities. The project activities were divided into six major parts: 1) forming target-farmers' groups ; 2) encouraging farmers in the uplands for Rabi crops cultivation practice with less water irrigation ; 3) developing skills for the farmers for quality seed production; 4) engaging farmers in participatory planning & self-evaluation; 5) conducting feasibility study of the sustainable and environmentally conscious food production practices and 6) disseminating outputs to wider audiences for thought provoking improvement of the SAP. Add to this, the project was to develop a network of farmers (group approach) linked with local agencies and NGOs for making the project's outcomes sustainable.

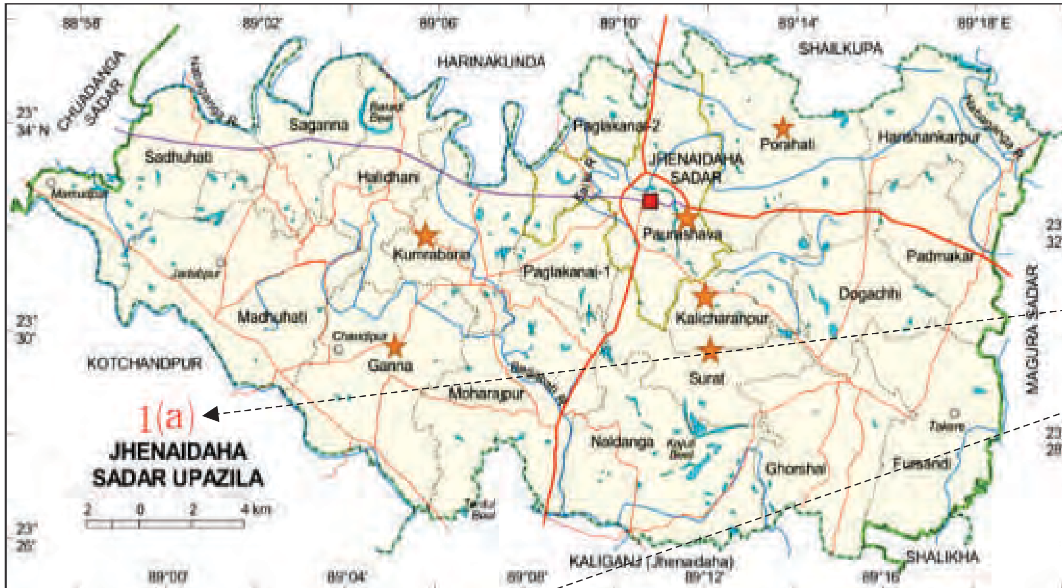
With the promotion of sustainable agriculture practice (SAP), the project would ultimately lead to many positive impacts such as, recovery of underground water, reducing arsenic concentration in soil and crop, recovery of biodiversity and reducing hunger vis-à-vis poverty in the target farmers gradually.

The project was implemented by the tripartite partnership of NGOs viz., AID Foundation, Share the Planet Association and Asia Arsenic Network (AAN) in three sub- districts under Jhenaidah district, the South-western part of Bangladesh (Map of Bangladesh).

Map (Jhenaidah-1) shows the location of SAP project under Jhenaidah district of Bangladesh and its sub-districts: 1. (a) Jhenaidah Sadar; 1. (b) Kotchandpur; and 1. (c) Kaliganj with their 13 lower administrative units (Unions). Target 50 SAP groups are located at those administrative units (star marked). Village-wise distribution of the groups has shown in Table-9 of section-4.

SAP PROJECT LOCATION





Union (Lower Admin. Unit)	No. of Group
Ganna	8
Kumrabari	2
Shurat	3
Municipality	1
Kalicharanpur	2
Purahati	9
Boluhor	5
Municipality	2
Elangi	1
Kushna	2
Tailochandpur	9
Sundarpur-Durgapur	4
Raigram	2
13	**50**

SECTION TWO

An Overview of the Project

An Overview of the Project

The Title and Characteristics of the Project

SUSTAINABLE AGRICULTURE PRACTICE (SAP)

(Promotion of Sustainable Agriculture Practice with less irrigation water - aim for the fundamental solution of arsenic pollution)

Project period

- 18 July 2017-17 July 2020(Extended up to 30 Sept. 2020 following COVID -19)

Project focal point/Purpose

① In the target area, a foundation for Sustainable Agriculture Practice is developed by farmers' skills development and arrangement of seed foundation system;

② Evaluation and Dissemination of Sustainable Agriculture Practice of this project.

Project goal

- The number of farmers who practise sustainable agriculture with less irrigation water is increased:
  - ① Indicator: 1200 farmers/1500)
  - ② Measurement: Follow-up survey on less irrigation for Paddy and Rabi crop practice, and others

Long term Challenge

- Promotion of Sustainable Agriculture Practice (SAP) focusing Water-use Efficient Crop Cultivation for Reduction of Arsenic Contamination in Soil and Environment.

SAP Project Approach

The project followed sustainable approaches to agriculture farming -

A. Optimal use of irrigation water in Sustainable Agriculture Practice by –

① AWD method in upland Boro rice field;

B. Crop diversification and intensification by-

① supply of early maturing quality seeds, mostly seeds of Rabi crops, to seed producing farmers;

② introducing/promoting Rabi crops including vegetable thereby changing rice-based cropping pattern;

③ producing quality seeds of Rabi crops, its preservation, making it readily available in the target area by seasonal multiplication so as to make it available to other fellow farmers or local market etc.;

④ increasing cropping intensity by introducing short duration Rabi crops sustainably.

C. Backstopping farmers through group approach, capacity building in appropriate technology and support services for Sustainable Agriculture Practice under the following-

① Group approach by forming groups; composed of members who follow through SAP criteria, be identified through baseline and have informed choice of appropriate technologies under SAP;

② Capacity building of group members by formal trainings, workshop, seminar, meeting on appropriate technologies, developing advanced farmers as resource persons in groups for facilitation and shared learning, have them exposure on demo plots & field days, yearly self-evaluation and planning;

③ Supporting farmers for vermicomposting (production of organic fertilizer) e.g., supply of red worms, hands-on-techniques for producing vermicompost, encouraging farmers for preparation and use of other organic fertilizers, pesticides etc.;

④ Helping farmers to have their soils tested for assessing fertility status of their lands (e.g., OM percentage, essential soil nutrients etc.) and need for organic fertilizers and/or recommended doses of chemical fertilizers, recommended crops etc.;

D. Small research activity

Feasibility study of sustainable and environmentally conscious food production system by-

① sample testing of arsenic concentration in irrigation water, soils, field crops (Boro and Aman), vegetables from farmers' field and nearby local markets, organic fertilizers and pesticides etc.;

② feasibility testing of pipe irrigation system for water-use efficiency;

E. Networking/Coordination between farmer and Government

① Participation of DAE officials, local government representative, public representative in formal and informal trainings, meetings, seminars, workshops with SAP farmers and staff members;

② Visit of DAE officials/personnel time to time in the SAP field, provide support services, have dialogue with SAP farmers, provide feedback etc.,

③ Responding to SAP farmers in special needs.

SECTION THREE

Data Analysis, References and Result Demonstration Over SAP Approaches

Data Analysis, References and Result Demonstration Over SAP Approaches

3.1. Irrigation Water Scheduling by Alternate Wetting and Drying (AWD) Technology

Farmers can maintain optimal water scheduling in Boro rice with the help of Irrigation water saving AWD technology. It helps maintain irrigation-water use efficiency by 30-40% thereby reduce ground water use and irrigation-cost saving BDT. 7,000-10,000 per hectare as well as optimal crop growth thereby increase additional crop yields by 500 kg of Boro rice per hectare (Decoded from video clip: DAE/ Ministry of Agriculture)

However, the rate of water requirement of crops varies with atmospheric condition (temperature, rainfall), rice varieties, soil type, crop age, duration of the crop growth, land elevation and water management status in the field etc. Safe AWD technology can be applied under following conditions:

① 10-15 days after transplanting of 22-30 days old seedlings, or when the direct seeded rice crop is already 10 cm tall until first heading, 2-3 cm standing water should be kept in the field;

② a week before to a week after the peak of flowering, water should be kept at a 5 cm depth to avoid water stress;

③ after flowering and during grain filling, AWD is safe; in safe AWD, water savings maybe relatively small about 15-25% and there is no yield penalty;

④ irrigation should be stopped 15 days before the crop harvest.
(Ref: Decoded from video produced by "The IRRC- Water Saving Working Group", IRRI, Philippines)

So, Boro rice requires safe AWD technology during 80-100 [165-75 = 90 days (±10)] days in its life cycle. Water balance studies of BRRI show that much more water is supplied by irrigation than is actually required for evapotranspiration (ET), seepage and percolation. According to BRRI study, 4,000 liters of water is used as irrigation for per kg of Boro rice production in farmers' field compared to 2,000 liters in an experimental plot. Irrigation water requirement for Boro rice production also varies with the varieties of longer duration.

In SAP project, we collected SAP farmers water scheduling data three times during the Boro rice cultivation since when irrigation scheduling begun. The data were analyzed in spread sheets year wise and found the following results -

Observation: 1

The baseline data (BSL) of 1,500 SAP farmers in 2016-17 Boro season shows that none of them used AWD before the project intervention. Farmers' mindset on Boro rice cultivation under flood irrigation system, almost always under standing water, is a traditional practice; it takes time to bring changes in their mindset for fear of yield penalty/compensation. Note that the farmers used to irrigate on an average 74 days (BSL). With the introduction of AWD technology, only 22% (323) SAP farmers found responding to AWD at the first year of the project in 2017-18, then 43% (646) and 47% (698) in 2018-19 and 2019-20 respectively. So, 47% (698) of SAP farmers were finally able to maintain less water scheduling in Boro rice field. The result shows (Fig-1 & Table-1) that the SAP farmers gradually maintained water use efficiency (by adjusting irrigation scheduling) by 50% as compared to baseline data (Avg. 37 irrigation scheduling in 2019-20 as compared to avg. 74 scheduling in the Baseline data of 2016-17).

Fig.-1 SAP Farmers in Less-water Irrigation Practice

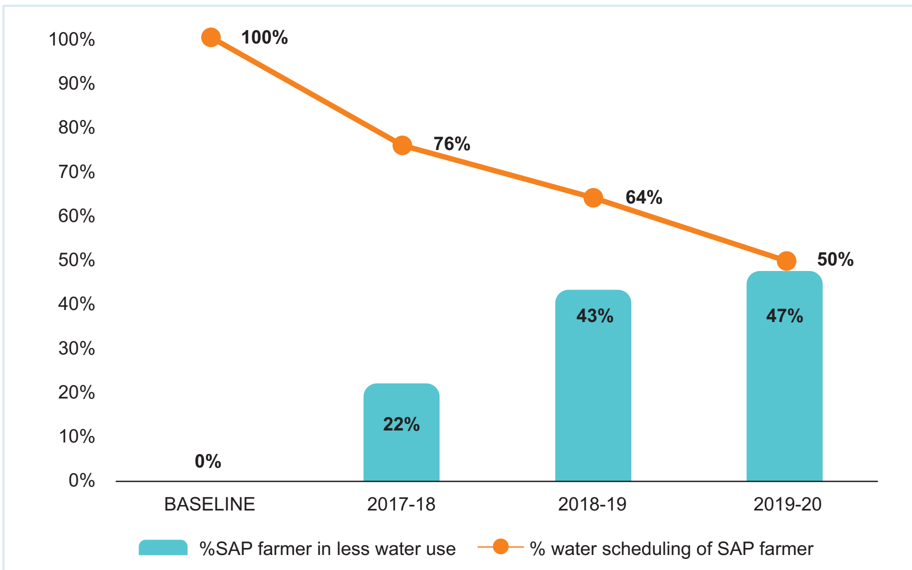


Table-1: SAP farmers in less water irrigation practice and percent reduction of irrigation scheduling.

Baseline	2017-18	2018-19	2019-20
0	323	646	698
0%	22%	43%	47%
74	56	47	37
100%	76%	64%	50%

Observation: 2

We consistently monitored the water scheduling of 323 SAP farmers (who responded first year through project end) and their cost of irrigation since 2017-18 to 2019-20 Boro season where the result shows (Fig-2 & Table-2) a reduction of water usage of about 50 % and irrigation water cost savings of about 10% (BDT. 294) per bigha of Boro rice cultivation (Avg. BDT. 2,986 in 2016-17 to avg. BDT. 2,692 in 2019-20). The figure also shows year wise percentage of water usage and cost savings as compared to the BSL. There was fluctuation of cost savings observed between 2017-18 and 2019-20 because of soaring up water prices due to erratic rainfall pattern as reported.

Photo: Less water irrigation practice by Farmers

Fig.-2 Less Water Irrigation by 323 SAP Farmers

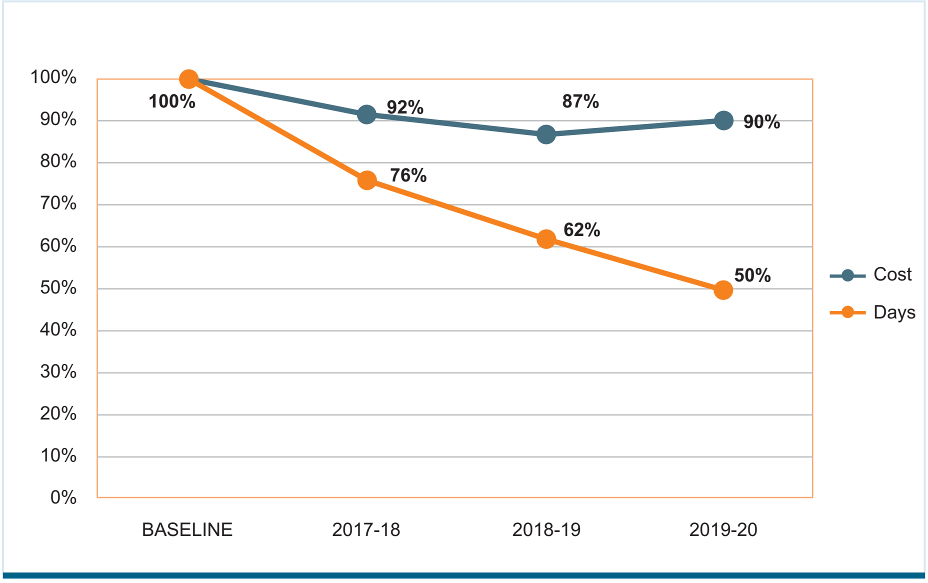


Table-2: Reduction of water usage and irrigation cost savings per bigha.

Particulars	Baseline	2017-18	2018-19	2019-20
Cost (BDT)	2,986	2,750	2610	2,692
Irrigation Schedule	74	56	46	37
Cost (%)	100%	92%	87%	90%
Irrigation Schedule (%)	100%	76%	62%	50%

Observation: 3

Among the 698 (47%) SAP farmers, 197 (28%) SAP farmers owned STW. Data analysis of 197 SAP farmers shows that irrigation cost saving @ BDT459 per bigha had been possible i.e. 36% [(459-294)/459*100] more cost savings than that of observation-2. We also experienced from interview with farmers that who owns STW, DTW operated by fuel/electricity are getting much benefitted. The reasons for the stated difference between Observation-2 and 3 is that Boro paddy is cultivated under flood irrigation system like all over Bangladesh. The commercial irrigation water suppliers/contract water suppliers don't reduce the unit price of water whatsoever individual farmer's water scheduling is. As such, farmers often have to negotiate with the commercial water suppliers, but the negotiation is level-biased! However, the SAP farmers amicably settle this issue with irrigation water suppliers but least reduction of unit price was possible sometimes and somewhere that didn't make any big difference. The

Fig.-3 SAP farmers under additional crop yield in categories

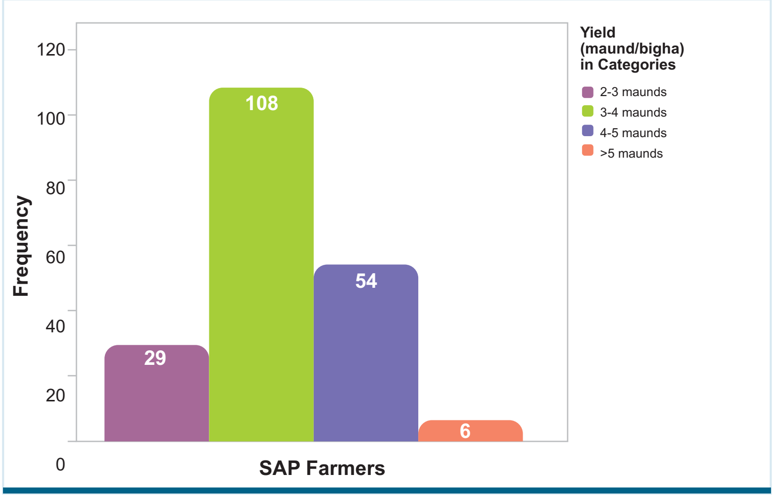
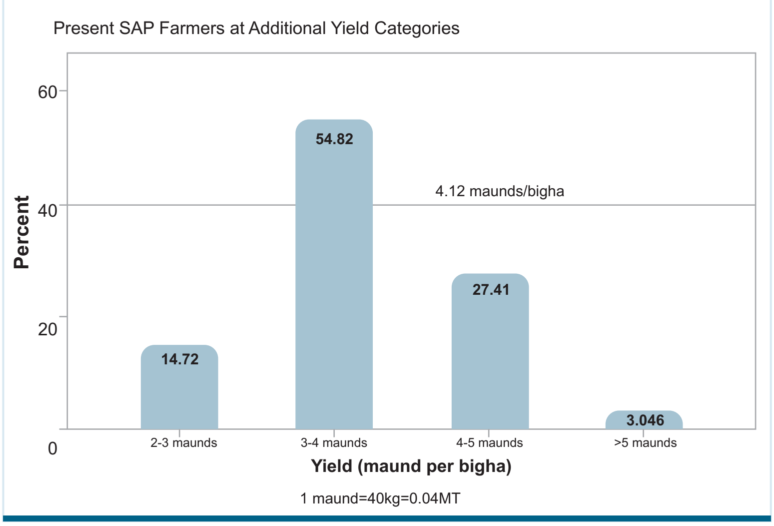


Fig.-4.1 **Percent SAP farmers under additional crop yields in categories**

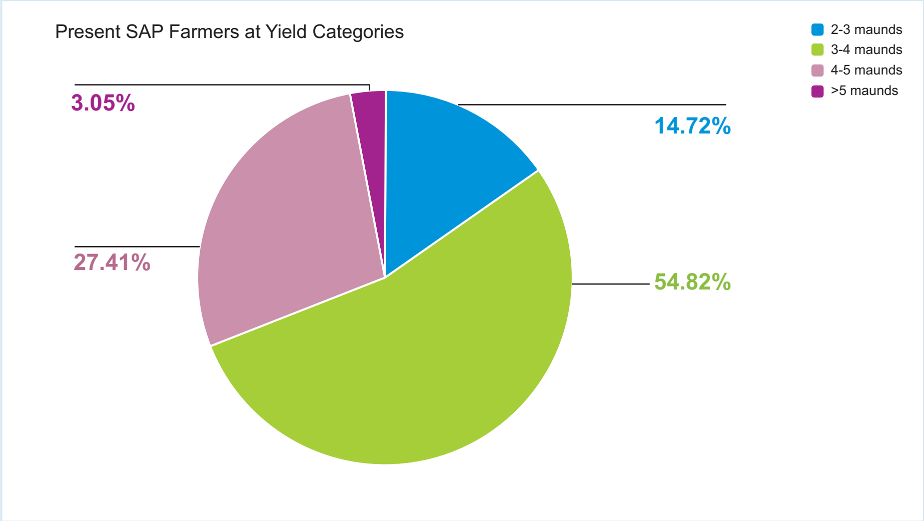


challenges have impacted among the farmers invariably as such that would determine the future fate of AWD practice in the area.

We conducted six Focus Group Discussions (FGDs) with 72 project farmers on 15-16 July 2020 of which 50% were randomly selected from three project areas. We understood from the FGD that SAP farmers had optimal crop growth by using AWD technology according to their judgment invariably. Following the FGD, project staff took interview of 197 SAP farmers who found additional crop yields (Fig-3). It helped them getting additional crop yields on an average of 4.12 maunds Boro rice/bigha (Fig-4.1 & 4.2) as well as incomes under simultaneously wetting and drying of lands. When DAE officials visited in July 2020 and had dialogue with SAP farmers, some of these farmers also informed DAE officials about the results. So, by using AWD, the irrigation cost savings and additional Boro rice harvest together added additional income to 197 SAP farmers of about BDT 4,369 per bigha/ farmer.

Besides the above, we also experienced that not all farmers used Field Water (measuring) Tool under AWD despite repeated motivation. The SAP farmers used their local wisdom instead and interestingly, there were no evidences of yield compensation/penalty reported either from the farmers or from our project staff members. Though, there is no way of showing complacence since the technology and its safe-use are concerned, we feel its necessity as long as the less water irrigation practice with AWD goes on. This is because AWD is used only during safe period of Boro rice cultivation followed by monitoring of moisture level at root zone by field water measuring tools.

Fig.-4.2 **Percent SAP farmers under additional crop yields in categories**



3.2. Crop Diversification: Change in the pattern and cropping intensity.

Crop diversification was initiated by-

3.2.1. Supply (by the project) of early maturing quality seeds, mostly of Rabi crops, from BADC, BARI and Research Institute to seed producing farmers;

Observation:1

Availability of quality seeds of different crop varieties at farmers' reach matters in terms of production, multiplication, early marketing and farmers' economies. Availability of diverse quality seeds enhances crop diversity both in Rabi and Kharif seasons. Although Bangladesh farmers used to meet more than 70% of country's seed demands but availability of quality seed of early variety and its timely supply enhance Rabi crop cultivation. According to the agriculture experts (ibid), it is possible to increase 15-25 percent of agriculture production by only using quality seeds. So, availability and quality seeds are essentially required for the promotion of Rabi crops cultivation so does diversification.

In the year, 2017 and 2018, a total of 172 kg Rabi crop seeds of different BARI varieties were supplied to 47 seed producing farmers in the target area (Table-3). Although small quantity seeds were distributed but the farmers multiplied those seeds for seed spread and were benefitted by selling to other farmers and local market (Table-6)

Table-3: Supply of Rabi Crop seeds in 2017 & 2018

Seed Variety	Lentil BARI 3 & 8	Mustard BARI 14	Wheat BARI 29	Grass pea BARI 5	Chick pea BARI 6	Pea BARI 3	Black gram BARI 4
Amount (Kg)	59	2.05	84	5	8	11	3
	Total		**172.05**				

3.2.2. Introducing/promoting Rabi crops including vegetable thereby changing cropping pattern.

Observation-2

Healthy soil is necessary to sustain biodiversity, ecosystems and agriculture. SAP farmers have been gradually maintaining healthy soil by diversifying crops in the area's rice-based cropping pattern; it has been sustainably enhancing cropping intensity too, thereby saved cost of production and improved farmers' economies.

Our field staff collected data of 1,500 farmers at a fixed time (1-10 February) from two project years. The data were checked and verified by the project coordinator, Project Manager and entered in to spreadsheets for analysis.

The result shows that the percentage of SAP farmers under Rabi crop cultivation and the area of lands under Rabi crops both were gradually increased for practicing agriculture sustainably. The result by the analysis of 1,500 SAP farmers' Rabi crop cultivation practice shows that 94% (1,410) of the SAP farmers have been cultivating Rabi crops compared to 77% (1,158) in the baseline (Figure -5, Table-4). However, the data analysis of the land areas under Rabi crops reveals that land area under Rabi crops during the stipulated period have also been gradually increased from 38% in the baseline of 2016-17 Rabi season to 49% in 2018-19 Rabi season and finally 58% in the last 2019-20 Rabi season((Figure -6, Table-5) by replacing some fallow and Boro lands by Rabi crops.

Fig.-5 Cultivation of Rabi Crops by SAP farmers

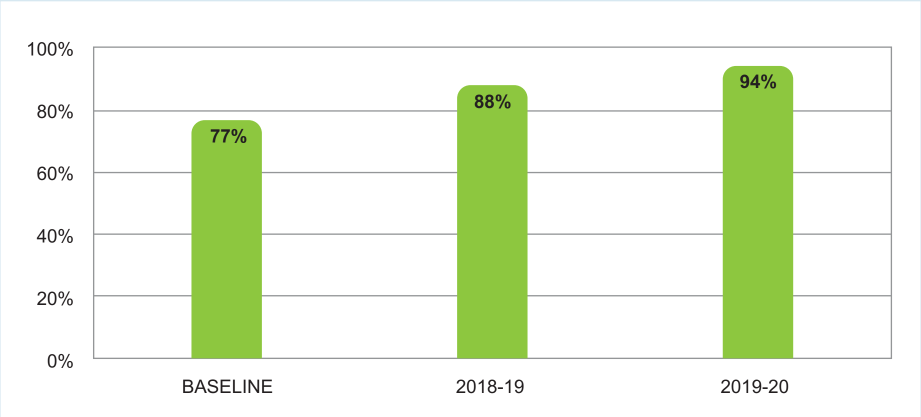


Table-4: Percentage of increased SAP farmers in Rabi crops.

Baseline (Farmer)	2018-19 (Farmer)	2019-20 (Farmer)
1158	1327	1410
77%	88%	94%

SAP farmers also increased their income earnings by selling more Rabi crops. Case studies show the evidence (Annexure -1)

Fig.-6 Percentage of Increased Rabi Cropped Area by 1,500 SAP Farmers

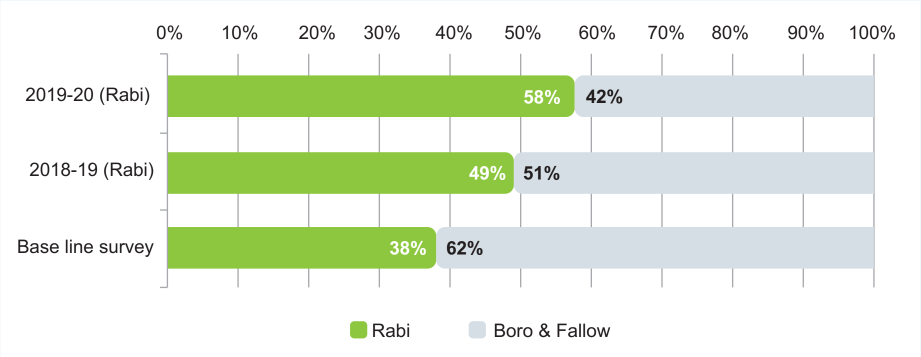


Table-5: Percentage of increased Rabi cropped area by SAP farmers

Particulars	Baseline		2018-19		2019-20	
Rabi season	Land (decimal)	% land area	Land (decimal)	% land area	Land (decimal)	% land area
Rabi	96,069	38%	122,344	49%	145,769	58%
Boro & Fallow	155,506l	62%	125,918	51%	105,806	42%

The SAP project consistently monitored Rabi crop promotion at a farm lands of 22 farmers (some of them were SAP farmers) at Purahati union under Jhenaidah Sadar Upazilla. These farm lands were medium high lands, mostly used for Boro rice cultivation. After SAP interventions, the cropping pattern was almost changed with the inclusion of more Rabi crop recorded in successive project years.

Before 05 February 2018

After 07 February 2019

After 07 February 2020

Photo: Increased Rabi crop cultivation by replacing Boro rice

Photo: Damage of Rabi crops in 2018

Apart from the above, we also experienced some challenges in 2018 where <5% farmers (74 farmers) incurred losses /damage of Rabi crops, Boro rice, flower plantation due to foggy weather in early winter and erratic rainfall pattern at late winter season. We assumed that those who suffered by crop damage mostly had lack of know-how/mitigation practices. We raised this issue in the meetings with district DAE (Govt) officials. DAE officials visited the field, held workshops with farmers in three project areas; it improved some farmers' cultivation practices. However, we had different scenario in 2019-20 Rabi season where the damage was mostly caused by the cyclone Amphan. The target farmers were also affected seriously by the pandemic situation meaning that they couldn't sell their produce (Rabi crops, rice, other cash crops) to retails and whole sale markets. DAE officials of Kotchandpur visited and helped some project farmers. We deeply considered the stated challenges and put in place among the DAE officials and LGIs representatives in the district workshop.

3.2.3 Producing quality seeds of Rabi crops, its preservation and multiplication, making seeds readily available for sowing in next seasons and available to other fellow farmers or local market etc.;

Observation-3

Table-6: Rabi Seed production and multiplication by SAP Farmers

Seeds	Year	SAP farmers	Production (MT)	Multiplication (MT)	Sale (MT)	Income (in million BDT)
Lentil, mustard, Chili, Red amaranth, Gourds, Brinjal, Wheat, bean, spinach, tomato, Pigeon pea, Black Gram	2018-19	66	15.8891	3.35525	12.21405	0.885515
	2019-20	137	26.4291	5.1588	21.2703	1.434561
	Total:		**42.3182**	**8.51405**	**33.48435**	**2.320076**

Among 1,500 SAP farmers, 200 (13%) advanced farmers were selected in consultation with groups from three Upazilas and trained them in seed production and preservation technology. Data analysis shows that all trained farmers were found producing seeds; among them, 137 (69%) produced seeds of Rabi crops and the rest produced seeds of paddy, summer vegetable etc. During the project period, 15.66 MT Rabi seeds were produced by 66 farmers in 2018-19 while 26.43 MT rabi seeds were produced by 137 farmers in 2019-20 (Table-6). They were financially benefitted by selling 33.48 MT of 11 varieties Rabi seeds in two Rabi seasons worth BDT 2.3 million.

However, we experienced different scenarios about seed spread in the project area: (1) though seed demands still remain particularly for new crops, such as hybrid maize, summer tomato etc. but while most of the farmers in the locality found facing scarcity of seeds during 2018-19 Rabi season, some of the SAP farmers had comparative advantage with the seeds produced by them made available for cultivating in Rabi season; (2) though 21% of seeds were preserved for multiplication, but 79% of seeds that SAP farmers produced were sold in the local market as food at low price for want of money; and (3) challenge still remains as regards to the quality of seeds they produced i.e., other farmers' trust on seed quality as these seeds are similar to what they see at open market sale. As availability of diverse quality seeds propel wheels of crop diversification, so these experiences require future attention.

3.2.4 Cropping intensity (CI)

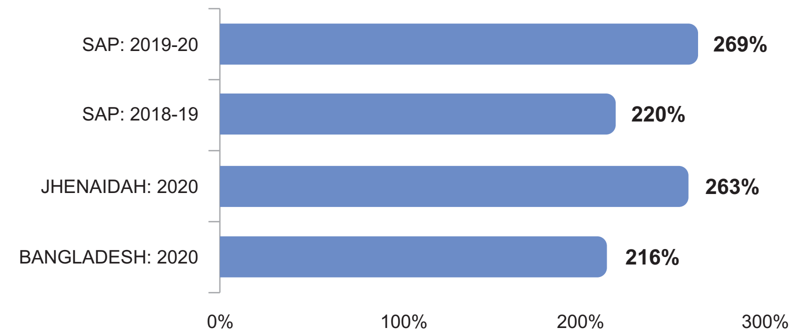
Observation-4

Farmers used to grow crops during Rabi and Kharif seasons (Kharif-1 & 2) of Bangladesh is considered an agriculture year. They grow different crops in different pieces of lands (land parcels) in a year. Cropping intensity refers to raising of a number of crops from the same field during one agriculture year. Cropping intensity is calculated by dividing total cropped AREA with net cropped AREA. Net cropped area is the sum of area of all the crop fields taken for consideration. Total cropped area is calculated by (area of single cropped area x 1) plus (area of double cropped area x 2) plus (area of triple cropped area x 3) plus (area of quadruple cropped area x4). Thus, higher cropping intensity means that a higher portion of the net area is being cropped more than once during one agricultural year.

CI calculation is simplified here following the above stated formula considering huge fragmentation (up to 21 fragments were observed for a farmer in the project area) of land holding by Bangladeshi farmers; first, the number of crops grown per parcel of lands over the year was calculated and multiplied them by net area and summed up to bring out total cropped area. Then, by using the above stated formula, the CI was calculated. Data was collected year-wise by the project staff members and the data was computed by spread sheets.

Cropping intensity is exhaustive to soil nutrients; it requires more fertilizers and irrigation for crop productivity. We experience that farmers who had their soils tested and used with vermicompost mostly came under intensification. It was tested where Boro rice had been cultivated. Our objective was to see whether or not the SAP farmers become able to intensify production of Rabi crops by replacing the Boro rice where possible or applicable.

Fig.-7 Cropping Intensity



	Bangladesh: 2020	Jhenaidah: 2020	SAP: 2018-19	SAP: 2019-20
Cropping Indensity	216%	263%	220%	269%

However, motivation to SAP farmers took time for increasing cropping intensity having present soil fertility status, mindset and knowledge for selection of crops, capitals and other resources, but the project consistently motivated and backstopped SAP farmers to have their cropping intensity increased. We observed the change among 12% (177) SAP farmers who were able to increase their cropping intensity by 269% in 2019-20 than 220% in 2018-2019 Rabi crop season (Figure-7). During the period, we observed that SAP farmers included more short duration Rabi crops (e.g., Cabbage, Cauliflower, leafy vegetables etc.) in the same field where they used to grow Boro rice or other perennial crops. Though the sample size being so small to compare it plausibly with the national data of cropping intensity i.e., 216% and that of Jhenaidah district 263% but we believe that farmers are finding solution and they will continue to use it.

Photo: Cabbage production by SAP farmers

3.3 Backstopping farmers with group approach, capacity building in appropriate technology and support services for Sustainable Agriculture Practice

3.3.1 Group Approach

The project adopted group approach by forming 50 groups identified through baseline and criteria as laid down in SAP i.e., member should possess at least 50 decimal arable lands and informed consent of SAP practices.

There were 1,500 target farmers under 50 groups (50x30=1500 members) formed in three Upazilla, such as: Jhenaidah sadar (25 gr.), Kaligonj (15 gr.) and Kotchandpur (10 gr.) The advanced 400 farmers (on an average 8 person in a group) were selected and trained in SAP approaches. They performed as resource persons (Farmer) in groups to facilitate SAP practices.

Photo: A resource farmer found facilitating group meeting

Over 90% groups were found functional with >80% group meetings. Members took part in group planning exercises for crop diversification, Rabi seed production, less water irrigation practice in Boro rice facilitated by resources persons. Our field staff used to attend these meetings and kept continuing support to them; among other, vermicompost production, soil test and linking SAP farmers with government officials etc. for technical assistance and networking.

3.3.2 Capacity building training both formal and informal were also imparted for SAP members time to time;

Photo: Formal SAP training

Out of 1,500 farmers, the project provided formal training to 40% (600) of the SAP farmers on SAP approaches. We experience that 1,500 SAP farmers have their capacity built on formal and informal training, workshop, seminar exposure etc. However, many of the SAP farmers have keen interest on recurring capacity building on new technology in agriculture, know-how of maximizing profit on their small lands and integrated farm management. They want training sessions as close as possible to their living places so as to save time, cost and for convenience of field works.

A brief of different types of capacity building follows –

a) group meeting for all members once in a month where the resource farmers facilitated shared learnings to other fellow farmers in their respective groups;

b) field meetings where, in some meetings, DAE officials including SAAO also attended and provided field training to farmers;

c) field days on farmers' challenges in crop production, protection etc.., where DAE officials paid on-farm visits, discussed mitigation measures on challenges that farmers experienced;

d) self- evaluation of farmers' SAP practices, planning and reinforcement exercises by themselves in groups and assembling in yearly Upazilla workshops where DAE officials, public representatives, LGIs' representatives, other officials like Bank etc., participated, observed and exchanged views;

e) Field exposure of farmers held time to time on advanced farmers' fields who raised demo plots; in all field exposure, DAE officials also participated;

f) Frequent field visit by the project staff members, local & foreign experts and provided their feedback to the staff members and farmers;

g) Vermicompost production, soil test, Arsenic test etc., support services and hands on training were also provided by the project staff and SRDI resource personnel.

Photo: Various capacity building activities for SAP farmers

Training

Field Days

A SAP demo plot

Self-evaluation workshop workshop

Japanese visitors at SAP project (Vermicompost on the right)

Exposure to SAP demo

Farmers' rally for SAP promotion

Soil collection for test

3.3.3 Using organic fertilizers (supported farmers for vermicomposting e.g., supply of red worms, hands-on- techniques for producing vermicompost, encourage farmers for preparation of other organic fertilizers and their usage etc.,);

A good soil should have at least 2.5% organic matter. Vermicompost is a good source of soil organic matter. Vermicompost contains humus that improves soil texture and structure; increases porosity, water holding capacity thereby improves soil health, ultimately helps reduce the extent of soil wat er requirements (30-40% water use efficiency is possible by international research report) for crop growth. Use of organic fertilizer saves the environment & reduces cost of production by reducing the use of chemical fertilizer by 30-40 % vis-à-vis improve farmers' economics. Of about 12% (166) SAP farmers produced 20.32 MT vermicompost (an organic fertilizer, rich in essential nutrients as many as 11 out of 17 requiring for crop growth). The SAP farmers also reproduced red worms (one variety of earthworms that produce vermicompost) and were financially benefitted by cost saving of chemical fertilizers.

Photo: Vermicompost production at farmers' house

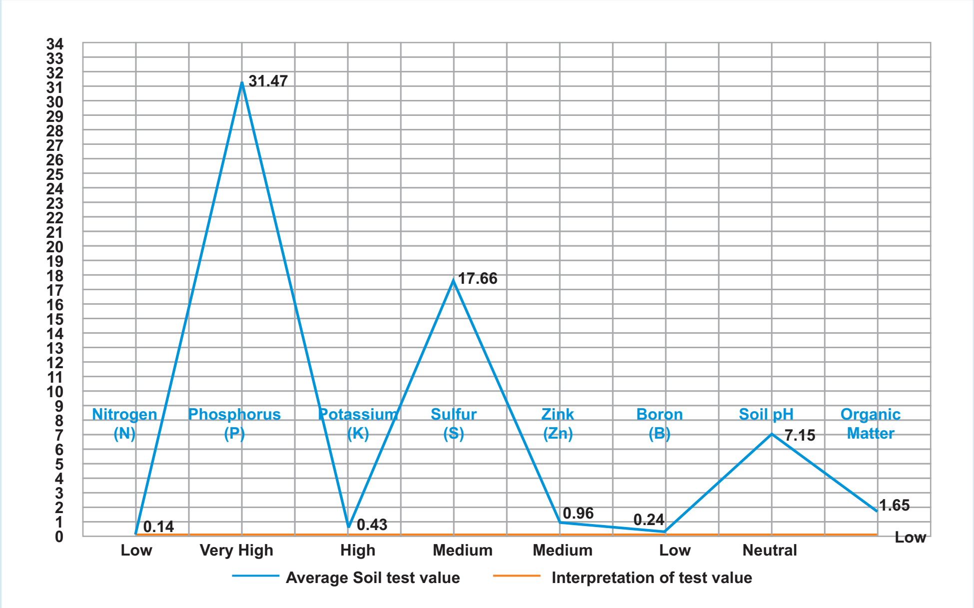
Some SAP farmers noticed that they became able to bring back their lands productive by using vermicompost. They added saying that they hardly produce any crops in their lands but with the use of vermicompost, they smiled by producing and selling vegetables, pulses etc. in their lands. However, the farmers who produced vermicompost also earned money by selling both vermicompost and red worms to other interested farmers. Results are also evident in case studies, focus group discussion and video documentation during field visit with project staff and district DAE officials.

3.3.4 Helping farmers conduct soil test for assessing fertility status of lands, need for organic fertilizers, recommended doses of chemical fertilizers etc.

The project supported approx.17 % (251) farmers to have their soils tested from SRDI lab in Jhenaidah. The test result shows the presence of avg. 1.65% OM which is low. The critical limit (CL) of other nutrients below which crop will suffer from its deficiency were interpretated[4](Fig-8). There were important observations such as- low, medium, high and very high level of soil nutrients. Following soil test, SAP farmers were benefitted and added saying that they were going to cut potassium and phosphorus fertilizers by about 30-40% that might have saved cost of production. Moreover, farmers have started following recommended crops with recommended doses of chemical fertilizers along with vermicompost (a nitrogen supplement that helps protect soil from washing away magnesium and sulfur during rainy season etc.) to have their soils fertilized with organic sources and to follow crop diversification so that the process of renewable sources get momentum and back to soils. A balanced, robust soil health is a must for intensifying production, sustained food and nutritional security. (Reference values for interpretation of critical limit of soil nutrients are annexed at annexure- 2)

4 Fertilizer Recommendation Guide- 2018, BARC; ISBN:984-500-029-1

Fig.-8 Soil test value of SAP farmers

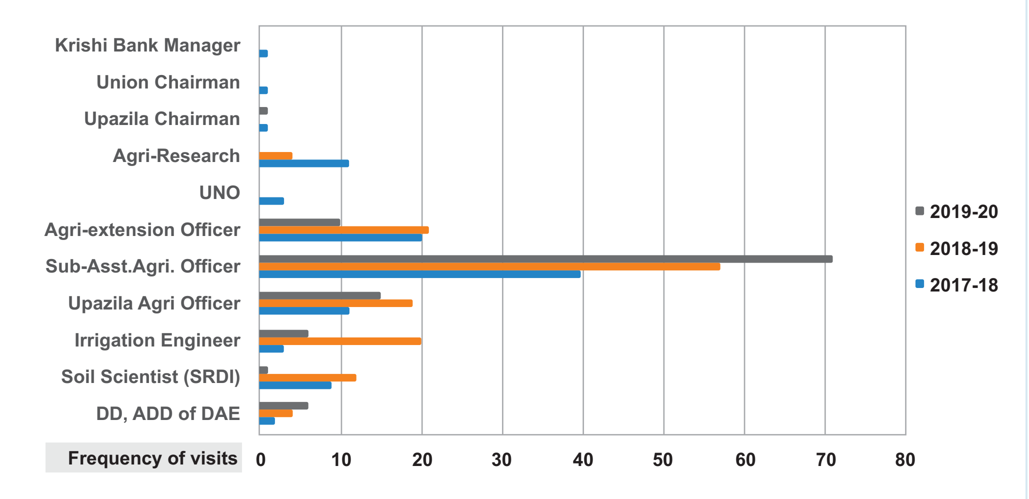


3.4 Networking/Coordination between farmer and Government, Research

Photo: Networking meeting with district DAE officials

During the project period, DAE officials, Scientist from SRDI and Spices Research Institutes, Bank officials, LGIs representatives, Public representatives participated in training, seminar, field days, field exposure, farmers' self-evaluation workshop, annual workshops (Fig-9). With these attachments of different officials and actors in various SAP interventions, farmers and staff members were introduced and had dialogues, received valuable feedback etc. The SAP farmers received time to time support services from DAE officials. Some examples are vivid and mentionable that DAE officials visited SAP farmers' fields, held workshop during 2019's Rabi crop damage; following Amphan and COVID-19 situation when SAP farmers couldn't sell their produce, DAE officials of Kotchandpur area linked SAP farmers with retail and whole sale market. Sub-Assistant Agriculture officers visited SAP farmers' fields and group meetings almost regularly and guided them as well. During FGDs with SAP farmers in 15-16 July 202 0, SAP farmers informed that they were getting better supports and cooperation from DAE officials than before. The following figure shows the extent of linkage and networking with government officials.

Fig.-9 Networking & Linkage



SECTION FOUR

Achievement status for output (based on PDM)

Achievement status for output (based on PDM)

1. Eligible farmers are identified as target farmers and organized under farmers' groups for SAP.

(1) 1,500 farmers identified as target farmers through baseline survey

(2) 50 farmers' groups will be formed by the first year of the project.

Confirmation method: Record of the project

The project record shows that the baseline survey identified 1,500 farmers (89% Male, 11% Female) as per SAP farmers' criteria (Table-7) in the first year successfully.

Table-7: SAP Criteria

(1) 1,500 marginal and small farmers;

(2) Each SAP farmer should have ⩾ 50 decimal land;

(3) Informed consent to SAP practices;

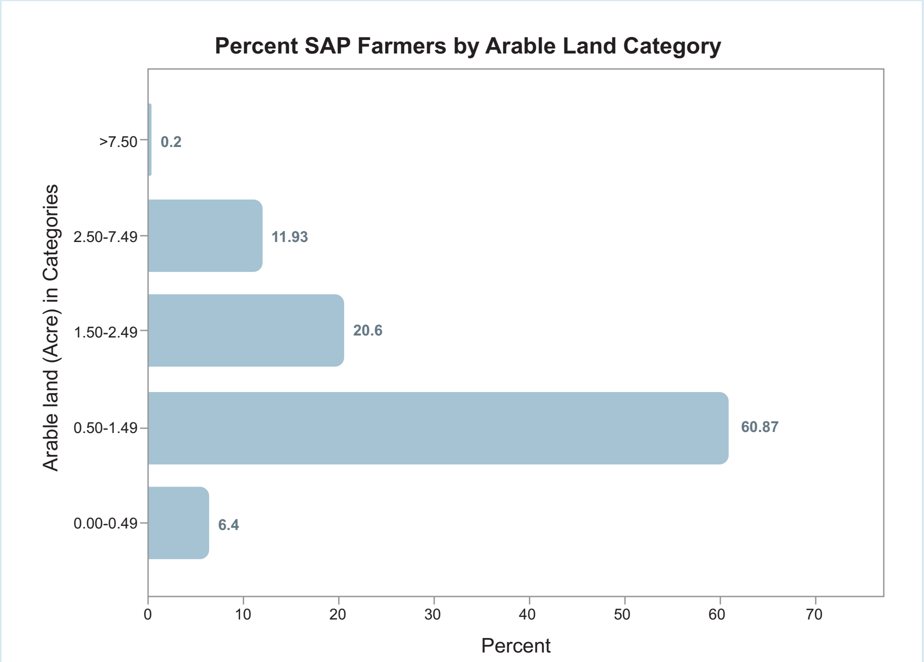
(4) 50 farmers' groups will be formed by the first year of the project.

Classification/categorization of SAP farmers (Table-8 & Fig.-10) by arable land size according to Agriculture Survey, 2005 of Bangladesh Government –

Table-8: Farm Size Structure of SAP farmers

Farm Size (Acres) of category SAP farmers	Number of SAP farmers	Proportion to the operated category SAP farmers (%)
Landless (0.00 to 0.49)	96	6.4
Marginal (0.50 to 1.49)	913	60.9
Small (1.50 to 2.49)	309	20.6
Medium (2.50 to 7.49)	179	11.9
Large (Over 7.50)	3	0.2
Total	**1500**	**100.00**

Fig.-10 Percent SAP farmers by arable land size



Target 1,500 farmers were then assembled in 50 groups each with 30 members in 38 village under 13 unions/ Municipalities in three Upazilla of Jhenaidah districts. The table (9) and Maps- (1) shows the locations.

Table-9: SAP project area with number of groups formed

Upazilla	Union	Village with group number in bracket	Farmers
Jhenaidah Sadar	Ganna	Ganna (1), Bashipara (1), Paikpara (2), Madhabpur (2), Khalkula (1) and Narayanpur (1)	8gr.x30members = 240
	Kumra Baria	Nagar Bathan (2)	2x30 = 60
	Shurat	Laudia (1), Chutlia (2)	3x30 = 90
	Municipality	Choto kamar kundu (1)	1x30 = 30
	Kalicharanpur	Kalicharanpur (1), Badanpur (1)	2x30 = 60
	Porahati	Porahati (2), Rupdah (1), Modhupur (1), Chuadanga (1), Aruakandi (1), Chapri (1), Bijoypur (1) and Uttar Kastoshagra (1)	9x30 = 270
Kaligonj	Sundarpur-Durgapur	Dumurtola (1), Kadirkol (2), Durgapur (1)	4x30 = 120
	Tailochandpur	Pukuria (5), Tillah (2), Monoharpur (2)	9x30 = 270
	Raigram	Bhatghara (1), Aktarpur (1)	2x30 = 60
Kotchandpur	Boluhor	Bidda dharpur (1), Boluhar (1), Uttar fulbari (1), Dokkhin fulbari (1), Murutia (1)	5x30 = 150
	Municipality	Rudrapur (1), Baro bamundia (1)	2x30 =60
	Elangi	Balarampur (1),	1x30 = 30
	Kushna	Sharkhali (1), Mohonpur (1)	2x30 = 60
	Total: 50 groups x 30 farmers = 1,500 target farmers		

2. Capacity of the Target farmers is developed for SAP.

(1) 400 resource persons will be selected;

(2) 360 resource persons will get SAP training. And they will be able to advise other members

1st year 180 out of 200

2nd year 180 out of 200

(3) 180 resource persons will get follow up training. And they will be able to advise farmers' institutions to other members. And also, they will prepare demonstration plots.

(4) Each group hold 80%< monthly meeting over year.

Confirmation method: Record of the project

(1) The project record shows that 400 resource farmers were selected for three-day long SAP training through discussion in 50 groups from three Upazilas of Jhenaidah District.

(2) Among them, 200 farmers trained under 08 batches in 8 November- 23 December of 2017 (first year of the project). In the 2nd year (11-29 December, 2018) another 200 resource farmers were trained under 08 batches, details are as under-

First year (2017): 200 Farmers

- Jhenaidah Sadar: 100 (90 male & 10 female)
- Kaligonj Upazilla: 50 (47 male & 03 female)
- Kotchandpur Upazilla: 50 (48 male & 02 female)

Second year (2018): 200 Farmers

- Jhenaidah Sadar: 100 (90 male & 10 female)
- Kaligonj Upazilla: 50 (47 male & 03 female)
- Kotchandpur Upazilla: 50 (48 male & 02 female)

Training particularly helped increase farmers' knowledge on safe use of AWD, line sowing and furrow irrigation system to maintain water scheduling; cultivation of Rabi crops including vegetable; diversification of crop (cropping pattern and rotation); efficient soil management; use of appropriate seed rate; preparation and use of organic fertilizers (vermicomposting e.g., hands-on-techniques for producing vermicompost); encouraging farmers for preparation of other organic fertilizers and their usage; soil collection techniques for soil test, importance of soil OM and the need for organic fertilizers and application of recommended doses of chemical fertilizers to increase crop yields, cropping intensity etc.;

The project farmers overwhelmingly responded to SAP approach. Farming skills, capacity and the use of SAP techniques gradually increased among the resource farmers.

Group leaders, resource persons together discussed the importance of SAP in monthly group meetings. They were key to spread the SAP and took challenge especially less water irrigation practice as it was new to them. During field visit, it was observed that groups' owed irrigation pumps were employed first under the leadership of group leader and resource persons for practicing less irrigation techniques and thereby they motivated other members of their groups to take the challenge.

(3) Follow up training among 100 resource persons (4 batches) have been conducted successfully in the second year from 24 November to 10 December 10, 2018 and another 100 resource persons (4 batches) have been conducted successfully in the third year from 15-29 December, 2019 (2 batches) and 13 January and 10 February 2020 (2 batches)

A total of 250 SAP and seed demonstration plots had been developed. In the year 2017-18, 50 SAP demo on Rabi crop and vegetables and in the 2018-19, another 200 SAP demo on Rabi crop and vegetables had been demonstrated. All the relevant documents, data and photos are available at the SAP-AID project office, Jhenaidah.

(4) Regular monthly meeting in the SAP group level had been conducted accordingly in presence of SAP project staff which is verified by the meeting resolution books and by the POs and PC randomly. At least 90% groups were active and found promoting SAP by participation in group meeting actively.

3. SAP farming increased in the target area. (both the number of farmers and area)

(1) 180 farmers will be able to produce SAP seeds in their own farms.

1st year 90 out of 100
2nd year90 out of 100
And of them, 50 farmers will go for demonstration farms.
1st year: 25 farmers
2nd year: 25 farmers

(2) Various qualified SAP seeds (more than 5 varieties) will be easily available in the community (each 3 Upazilla) by the end of project.

(3) Resource persons (360) and seed producers (180) will be able to transfer their own techniques and experiences to other farmers.

(1) The project record shows that a total of 200 farmers were selected for two-day long SAP seed training through discussion in 50 groups from three Upazilas of Jhenaidah District.

Among them, 100 farmers were trained (2- day) for seed production under 4 batches from 1st to 8th November 2017; another 100 farmers from 31 October-6 November , 2018; and a follow up training (1-day) conducted for 50 seed producers under two batches, each with 25 seed producers in 2018 & 2019 who, among the 200 farmers, went for raising demonstration farms.

Seed training: 1 -8 November, 2017

- Jhenaidah Sadar: 50
- Kaligonj Upazilla: 25
- Kotchandpur Upazilla: 25

Seed training: 31 October -6 November, 2018

- Jhenaidah Sadar: 50
- Kaligonj Upazilla: 25
- Kotchandpur Upazilla: 25

1 batch seed follow-up training: 12 November, 2018

- Jhenaidah Sadar: 25

1 batch seed follow-up training: 27 November 2019

- Kaligonj Upazilla: 15
- Kotchandpur Upazilla: 10

4. The experience of farmers is reinforced through self-evaluation

(1) Each group will be able to make annual plan and schedule of SAP farming based on workshop and self-evaluation every year.

1st year: 30groups
2nd year: 40groups

Confirmation method: Record of the project

1st year: 2017-18

A total of 30 groups prepared annual plan as per the record of individual group. The compiled group-wise plan was presented and shared at Upazilla level workshop with the participation of 100 representative on an average 3-4 members from each group. DAE officials, LGIs representatives and public representative also participated in such workshops as observers.

2nd year: 2018-19

A total of 39 groups (one short of the target) prepared their annual plan as per the record of individual group. The compiled group-wise plan was presented and shared at Upazilla level workshop with the participation of 100 representative on an average 3-4 members from each of the 39 groups. Due to unavoidable circumstances one farmers' group couldn't participate in the Upazilla workshop at final stage.

5. The result/ outcome / learning / impact disseminated among the wider stakeholders.

(1) Asses the effectiveness of SAP for farmers by the end of project.

(2) Conclude from assessment between arsenic pollution and SAP.

(3) Final report will be published

5.1 Effectiveness refers to goal. Though the effectiveness of SAP approach is a time taking question, but the initiatives by the SAP farmers so far taken during the stipulated period, and the results that we have from the project until now, make dividend in terms of percent farmers being involved (47% in succession) meticulously in less irrigation practice that they derived the results of 50% cut in irrigation scheduling (i.e., extent of water use efficiency); percent farmers under Rabi crop cultivation (94%) and the gradual increasing volume of lands (from 38% to 58%) under Rabi crops by SAP farmers during Rabi seasons; seeds of Rabi crops production, multiplication and spread by SAP farmers (69%); creating opportunity by SAP approach for farmers' economic balance (Economic benefits of 66% farmers; of them 62.47% farmers' additional annual average income ranges from BDT. 10,000 - 49,999) and environmental safeties by the approach as well.

5.2 Relationship between arsenic pollution and SAP: Bangladesh is a country of nearly 170 million people with a limited land of 147,000 Km2. In the last two decades, arsenic contamination of groundwater has become a serious public health problem and at present 19 million people is still drinking arsenic-contaminated water above Bangladeshi drinking water standard (0.05mg/L). On the other hand, over the last 3 decades there has been a rapid growth in utilization of groundwater for irrigation in Bangladesh, where about 86% of total groundwater is utilized for crop and vegetable cultivation to meet the food demands for increasing population in Bangladesh. It is estimated that several hundred thousand of irrigation wells are installed for agricultural purposes and many of them are contaminated with arsenic, posing a potential risk to the arsenic contamination of crops and vegetable which threatening the health of millions of people. To reduce the health risk from groundwater arsenic contamination, this 3-year project titled “Practical Investigation on Arsenic Decrease in Soil and Crops by Using Less Irrigation Groundwater Contaminated with Arsenic” is being conducted in Jhenaidah district to examine the effect of arsenic on farmland soil and food chain. The Jhenaidah district is located in the southwestern part of Bangladesh and belongs to the high Ganges river floodplain. The soil type of this region is calcareous dark grey/brown floodplain soil with low fertility. According to the meteorological data recorded at Jhenaidah city during 2001-2011, the mean annual rainfall was 1467mm, the mean annual maximum and minimum temperatures were 37.1 and 11.2°C respectively, and the mean annual humidity was 80%. Groundwater is used for domestic and irrigation purposes in this area. Here farmers are growing paddy, jute, wheat, sugarcane, mustard seed, onion, garlic, and a variety of pulse and vegetables. A great deal of chemical fertilizers and pesticides are used for the crop cultivation in this area.

It is expected that findings from the investigation will reduce the use of arsenic-contaminated irrigation water and strengthen farmers’ capacity to promote sustainable agriculture practices.

SECTION FIVE

Economic Situation following SAP Approach

Economic Situation following SAP Approach

The project interventions begun on 18 July 2017. We observed that farmers in the project areas had been bewildered with the cost of production as compared to their economic return.

We conducted the BSL survey of 2016-17 (at the onset of Rabi season in 2017). So, first half of Rabi season was almost passed since the inception year of the project. Though we got to impart some capacity building trainings in November & December in 2017 that impacted some farmers. For instance, 323 farmers, whose references were cited above (Table -2 & Figure-2), came forward on less irrigation practice showing the path to other farmers. We experience that despite various capacity building and motivational activities, farmers' internal factors including land size, capital investment, knowledge, participation in SAP activities etc., vary farmer to farmer. In the rice- based cropping pattern of the project target area, fear on yield compensation/penalty in less irrigation practice, damage to Rabi crop due to seasonal fluctuation of weather or climate variability etc., among other were major concerns to the farmers at the outset of project interventions for which mitigation measures were taken time to time as stated before. However, we observed positive change of farmers' mindset at last; they took part in SAP approach gradually looking at benefits there-from.

Against the backdrop, we conducted an income survey with interview in July 2020 with each of the 1,500 SAP farmers on SAP components and farmers' yearly additional economic balance was entered in to spread sheet.

The data analysis shows that 66% farmers (Table-10, Fig.-11) were benefitted by SAP approach with varying ranges of additional yearly income follows-

Fig.-11 **Percent Benefitted and Non-benefitted SAP Farmers**

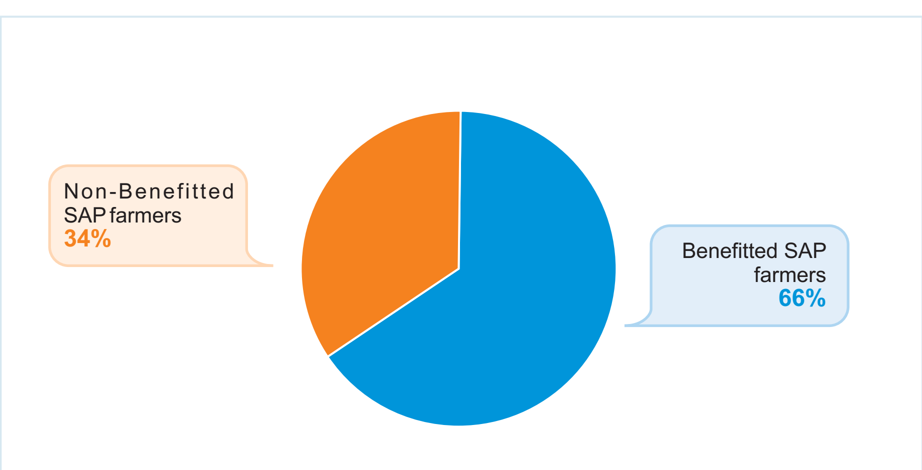


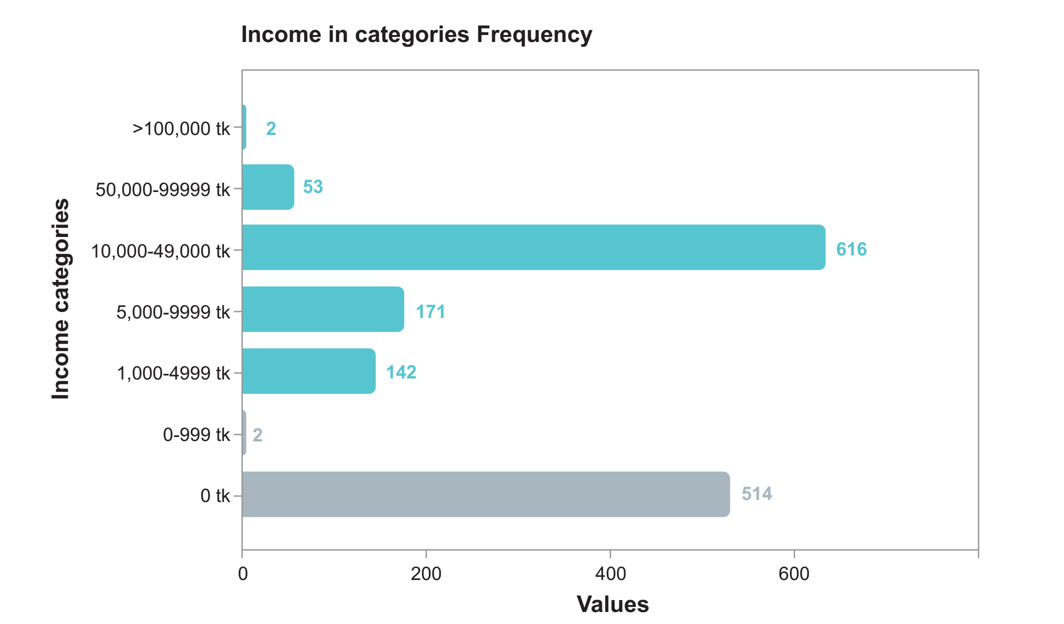
Table-10: Percent benefited and non-benefitted SAP farmers

Benefitted SAP Farmers	Non-Benefitted SAP farmers	Total
986	514	1,500
66%	34%	100%

According to output obtained[5], the variable 'income' has 1,500 data and the range of income varies from '0' to 112,000 BDT' with a mean= 12050.69, median= 8000.00 and the standard deviation =15737.58. However, the mean income value of benefitted SAP farmers was 18332.69. The income distribution was positively skewed (2.232) as the additional income distribution of 1,500 SAP farmers was very asymmetrical about mean and that of Mean>Median. The modal value falls under income class/ category 6 i.e., repeated highest number of SAP farmers' addition yearly income ranges from BDT. 10,000 to BDT. 49,999.

The results are graphically presented in two ways: (1) The income distribution as against 1,500 (benefitted and non-benefitted) SAP farmers (Fig.12.1 & 12.2); and (2) Income distribution as against benefitted 986 (66%) SAP farmers only (Fig. 13.1 & 13.2)

Fig.-12.1 Income distribution of both benefitted and non-benefitted SAP farmers



5 The additional income data were classified/categorized by creating dummies, "recoded in to different variables" and analyzed by SPSS [Recoded Income in to unequal class intervals: (Lowest thru 0=1); (0 thru 999=2); (1000 thru 4999=3); (5000 thru 9999=4); (10000 thru 49999=5); (50000 thru 99999=6); (100000 thru Highest=7) in to Income Cat. Variable labels Income Cat 'Income in Categories'.]

Fig.-12.2 Income distribution (%) of benefitted and non-benefitted SAP farmers

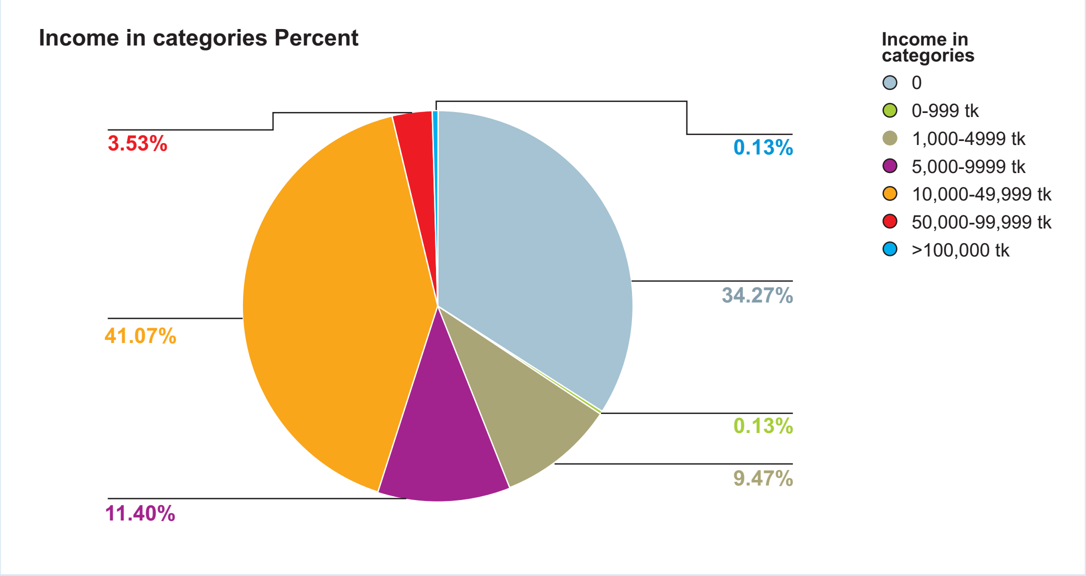


Fig.-13.1 Yearly income distribution of benefitted SAP farmers

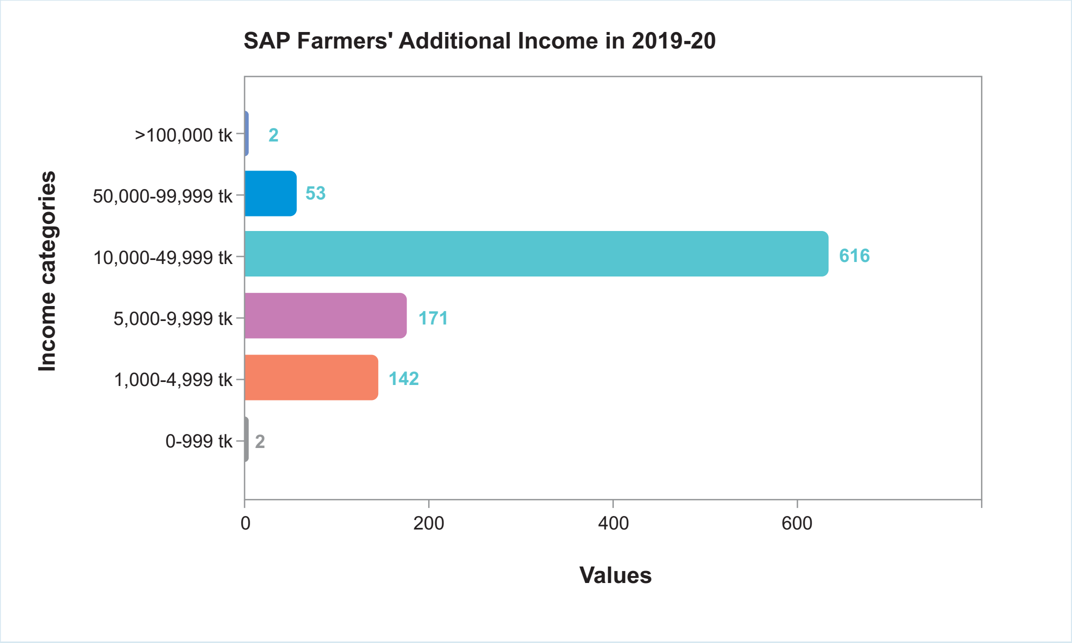
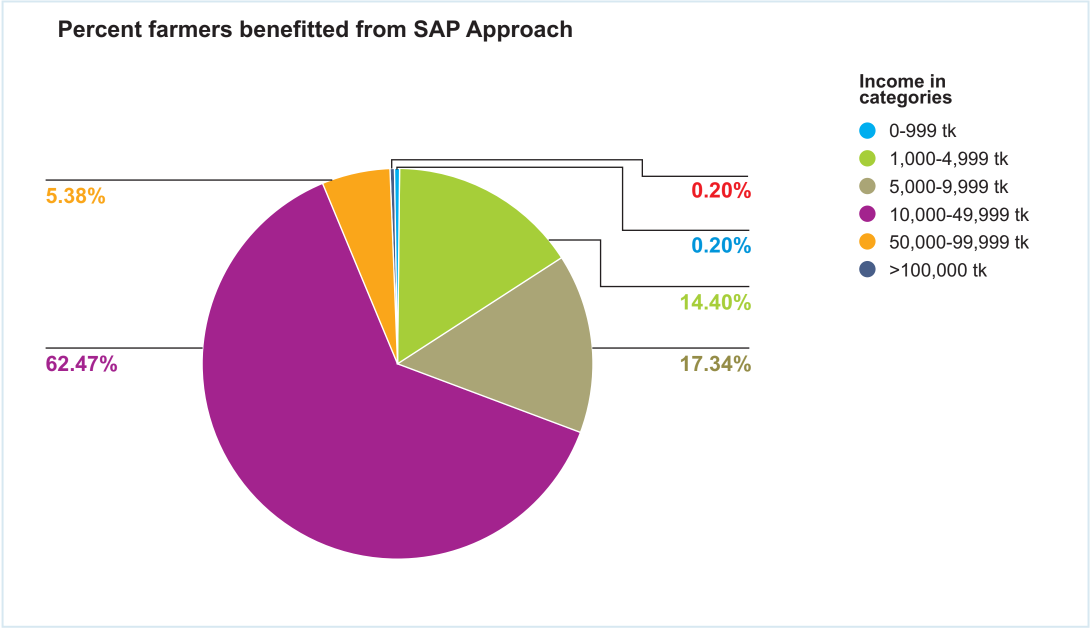


Fig.-13.2 **Income distribution (%) of benefitted SAP farmers**



SECTION SIX

Chapter 1

Arsenic survey of the irrigation wells

1.1 Materials and method

To know the arsenic concentration of the existing irrigation wells, a survey was conducted on randomly selected 328 irrigation wells from 50 farmer's groups in 56 villages of 13 Unions (see Table 1). Based on the project planning, 128 water sampling was conducted in 1st year (December 2017 to 6 January 2018) and 200 water sampling in 2nd year (December 2018 to February 2019). Arsenic test was conducted by HACH field test kit at site, which was performed by three students of Jashore University of Science and Technology after proper training. The survey included interviews with farmers on their socio-economic status, cropping patterns, problems, their interest in SAP project and so on.

Photo: Sampling water from an irrigation well

To know the level of accuracy of the field tested data of arsenic concentration, 25 water samples (8%) were collected in polyethylene bottles with necessary preservative added for laboratory test. They were duly delivered to AAN Laboratory in Jashore and analyzed by Atomic Absorption Spectrophotometer (AAS; ShimadzuAA-7000). The results of the field tested 328 irrigation wells are summarized in Table-1 with other relevant information and 25 laboratory data are given in Annex-4.

Photo: Conducting field arsenic test using HACH kit

Photo: Conducting an interview on a farmer

1.2 Results and discussion

Among the tested 328 irrigation water samples, 306 (93%) water samples were found arsenic safe and 22 (7%) arsenic contaminated above the Bangladesh drinking water standard of 0.05 mg/L, (Appendix 1). From Kaligonj Upazila, 118 irrigation well water samples were tested for arsenic, where all of the water samples were safe below the Bangladesh drinking water standard. After the field test, arsenic concentration results were shared to the farmers. The Union and Upazila wise arsenic contaminated result is shown in table-11 below:

Table-11: Summary of the arsenic test results

Upazila	Union	No. of villages surveyed	No. of irrigation wells surveyed	No. of arsenic safe wells	No. of arsenic contaminated wells	Contamination (%)
Jhenaidha Sadar	Ganna	6	25	22	3	12.0
	Kalicharanpur	5	22	20	2	9.1
	Kumrabaria	2	6	4	2	33.3
	Paurashava	6	24	24	0	0.0
	Porahati	9	50	40	10	20.0
	Surat	2	13	13	0	0.0
Sub total	**6 Unions**	**30**	**140**	**123**	**17**	**12.1**
Kaligonj	Roygram	2	15	15	0	0.0
	Simla Rokonpur	5	92	92	0	0.0
	Sundarpur Durgapur	4	11	11	0	0.0
Sub total	**3 Unions**	**11**	**118**	**118**	**0**	**0.0**
Kotchandpur	Baluhar	7	34	33	1	2.9
	Elangi	1	10	10	0	0.0
	Kushna	2	12	8	4	33.3
	Paurashava	5	14	14	0	0.0
Sub total	**4 Unions**	**15**	**70**	**65**	**5**	**7.1**
Total	**13 Unions**	**56**	**328**	**306**	**22**	**6.7**

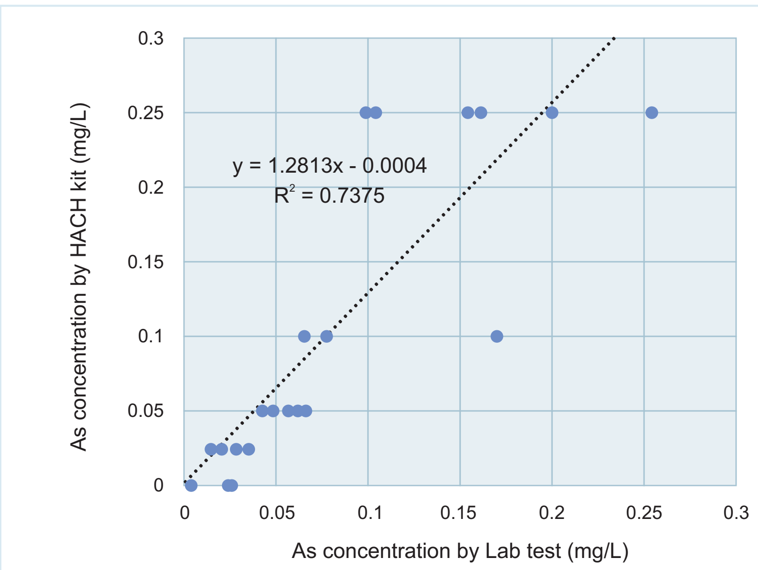
1.3 AAN Laboratory Cross-Checked Results

The comparison of arsenic concentration between HACH kit and AAN Laboratory test results of 25 water samples is shown in Fig. 14. It is observed that HACH kit result was relatively high compared to the AAN Laboratory result (m=1.28 and R2 = 0.74). On the other hand, AAN Laboratory found four water samples arsenic contaminated at 0.056, 0.060, 0.063 and 0.066 mg/L but they were arsenic safe (0.05 mg/L) by HACH kit during the field test.

Photo: Measuring arsenic by AAS

It happens occasionally because the field test is performed by field kit with color estimated by eyes, and it is a little difficult to judge the produced color using the color chart which has only six colors indicating 0.01, 0.025, 0.05, 0.10, 0.25 and 0.50 mg/L (or 10, 25, 50, 100, 250 and 500 ppb). With regard to the remaining 21 samples, both HACH kit and AAN Laboratory test found 11 arsenic safe and 10 arsenic contaminated. The result of cross-checked arsenic concentration of the 25 water samples is provided in detail in Annex-1 with arsenic screening data.

Fig.-14 Comparison of arsenic concentrations between HACH kit and AAN Laboratory analysis



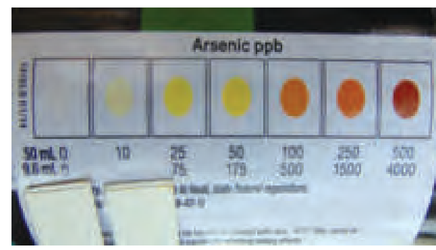
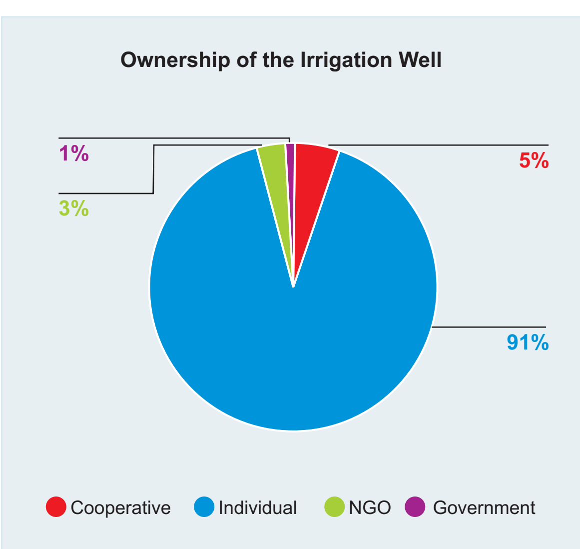
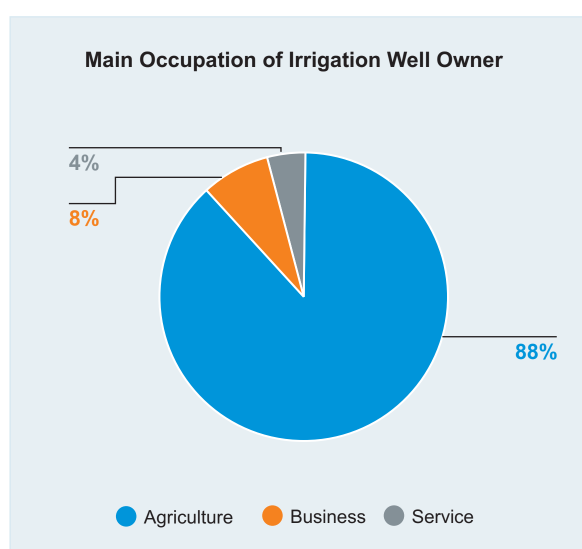


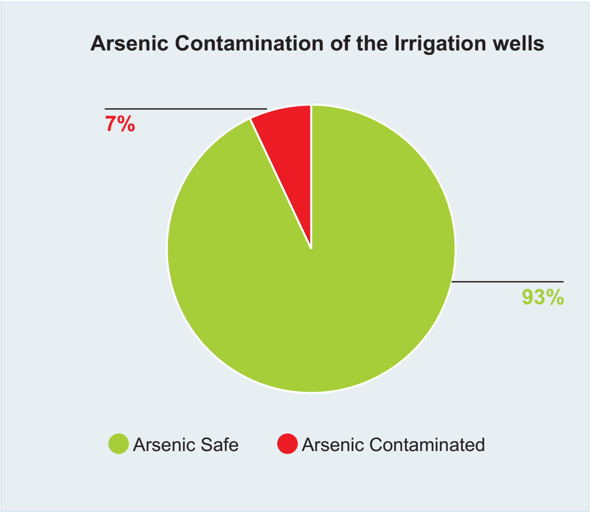
Photo: Color Chart of HACH arsenic test kit

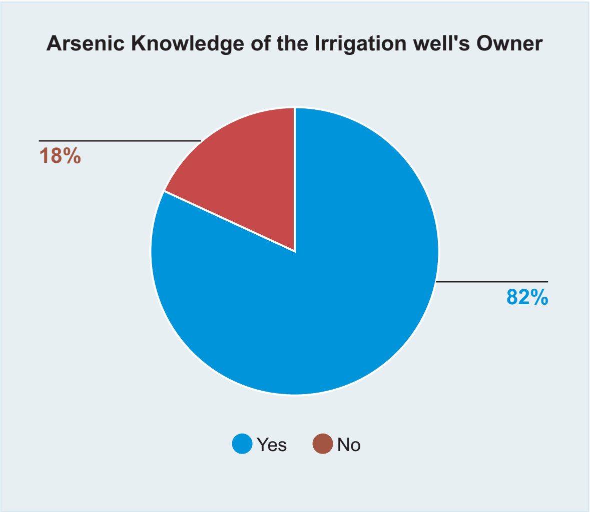
1.4 Result of Questionnaire Survey

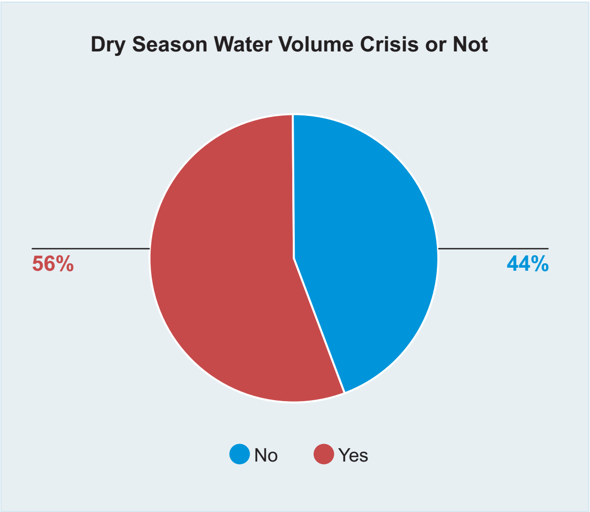
Some of the important findings from the interview with farmers as part of the arsenic survey is shown in graphs below:

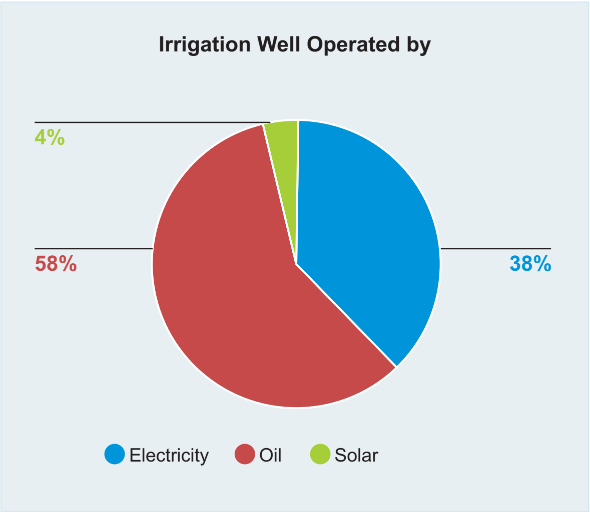


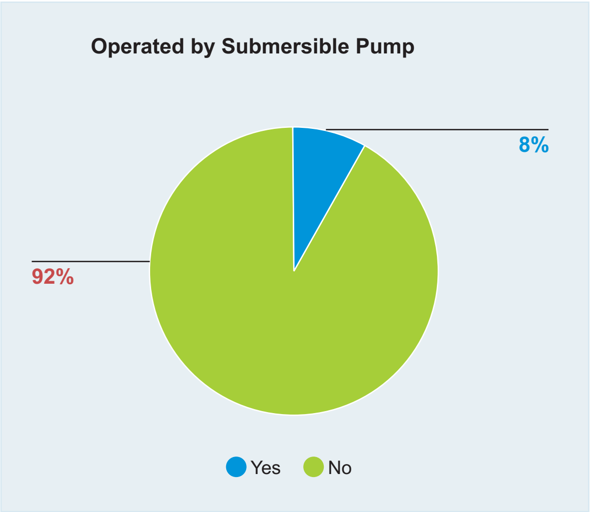


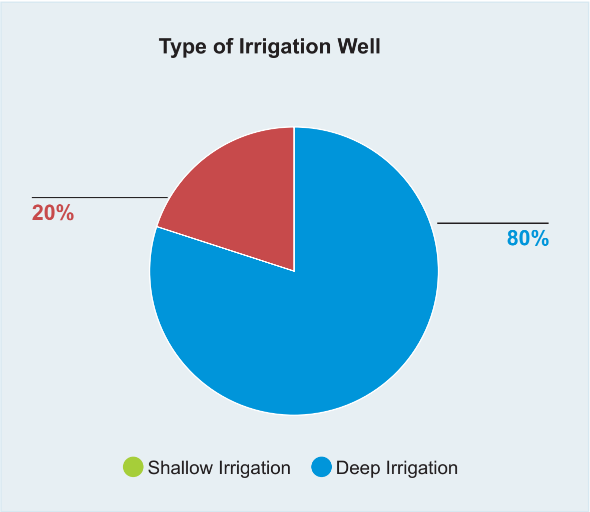

Arsenic Contamination of the Irrigation wells
7%
93%
Arsenic Safe
Arsenic Contaminated


Arsenic Knowledge of the Irrigation well's Owner
18%
82%
Yes
No


Dry Season Water Volume Crisis or Not
56%
44%
No
Yes


Irrigation Well Operated by
4%
58%
38%
Electricity
Oil
Solar


Operated by Submersible Pump
8%
92%
Yes
No


Type of Irrigation Well
20%
80%
Shallow Irrigation
Deep Irrigation

Chapter 2
Installation of Ganna Irrigation Well

2.1 Suitability Evaluation of Irrigation Wells

The project had a plan to install one irrigation well to promote SAP activities among the farmers. So, it is very important to conduct suitability evaluation of irrigation well to reduce the risk of arsenic contamination in environment as well as food chain. Based on the necessity and farmers demands, the evaluation was conducted in Ganna village of Jhenaidah Sadar Upazila, where it is recommended to install an irrigation wells at 280 feet in depth at proposed site at Basipara (GPS location: N= 23.46937 and E = 89.08877) of Ganna village. As it was observed that farmers are not getting sufficient water in the peak dry season, it is probably needed to attach a submersible pump to withdraw water from groundwater aquifer even in the peak dry season. Electricity line was available near the proposed sites and it is recommended to run the pump by electricity. The pipe diameter of irrigation well was considered 4 inches diameter based on the coverage area and project budget allocation. Some information was collected on existing wells with a view to finding suitable and arsenic-safe aquifers, as summarized in the table 12 below:

Table-12: Results of the suitability evaluation of Ganna irrigation well

SI	Well Owner	Location	Well Type	Installation year	Depth (ft)	Filter Screen (ft)	GPS Location (N)	GPS Location (E)	Arsenic (µg/L)
1	Jamal Uddin	Ganna	D-STW	2005	120	100-120	23.46931	89.08898	<10
2	Amzad Hossain	Ganna	I-STW	2017	130	100-130	23.46964	89.08759	<10
3	Dayud Hasan	Ganna	I-DTW	2013	280	190-280	23.46700	89.08589	<10

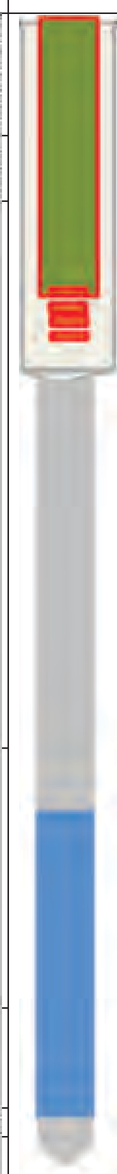
***Note:** 1) D-STW= Drinking shallow tubewell, 2) I-STW= Irrigating shallow tube well, 3) I-DTW = Irrigation deep tube well. Water was collected from nearby tube well of the place where irrigation well is planned. Data of the blue-highlighted site was taken into consideration in selecting the site for new irrigation well by farmers.*

2.2 Installation of irrigation well

Based on the AAN recommendation, AID installed one irrigation well on 18-February-2018 in Basipara of Ganna village. The arsenic concentration of the irrigation water sample was found 0.038 mg/L, and the geological information of the newly installed irrigation well is shown in Fig. 15 below.

Photo: Installing Irrigation DTW in Ganna village

Fig.-15 Geological log-sheet of the installed Ganna irrigation well

Depth (ft)		Type of Soil	Color	Soil Type		
To	From	I. Clay 2. Hard Soil 3. Silty Clay 4. Plastic Soil 5. Fine Sand 6. Medium Sand 7. Coarse Sand 8. Gravel	1. White 2. Black 3. Petat 4. Red 5. Yellow 6. Gray 7. Browri 8. Greenish brown 9. Yellowish pay	Symbol	Well Design	Comments
0	6	Silt	Little Brown			A. 6" Housing Pipe (78 ft.) B. 4" GI Column pipe (6 ft.) C. Submereible pump (attached with bottom of GI pipe at 65 fi.)
6	24	Silty Clay				
24	39	Very Fine Sand	White			
39	168	Medium Sand	Gray			4" Pipe (102 ft.)
168	225	Coarse Sand	Gray			Stainer (67')
225	249	Medium Sand				
249	255	Medium Sand with Clay Mix	Gray-Black			Sand Trap (10')
255	300	Medium Sand	Gray			

2.3 Improvement work of the irrigation well

Based on project planning, AID constructed rainwater-harvesting facilities near the irrigation DTW site to use rainwater for agricultural purposes. The improvement work of Ganna irrigation well was conducted in February 2020. Now both tanks (PVC and rectangular) were connected with irrigation well, and reservoir tanks can be filled with irrigation DTW water alone and with rainwater. Now, farmers can put water in their neighboring lands from the preserved tanks at critical times using flexible PVC pipe when electricity is cutoff or pump damage/ or became non-functional.

Photo: water supply from rainwater reservoir tanks to neighboring lands in Ganna village

Chapter 3

Arsenic contamination research in water-soil-food chain system

3.1 Sampling of water, soil and crops

Based on the difference of arsenic concentrations (high, medium and low) in irrigation well water samples, three sites were selected for the practical investigation from three Upazilas under this project. Water samples were collected from three irrigation wells and 10 irrigation canals in polyethylene bottles and acidified for the arsenic analysis. The depths of the wells were determined based on interviews with the irrigation well owners. Soil samples (144 in total) were collected in a zip-lock polyethylene bags using a hand boring with hammering method from ground level to 1 meter in depth (at 0.2m intervals) at 24 spots. Ten rice samples were collected after its harvest. The water, soil and rice (after harvesting) samples were collected at five times (3 dry seasons: 2018, 2019 and 2020; and 2 rainy seasons: 2018 and 2019) and brought to AAN Laboratory in Jashore for arsenic analysis. A detail of the collected soil samples is shown in Table-13 below.

Photo: Collecting soil samples from rice field using a hammering method

Table-13: Description of the soil samples collected

Sl	Upazila	Type of contamination area	No. of targeted lands	No. of vertical samples	No. of soil samples collected
1	Jhenaidah Sader	High arsenic in irrigation well water: Area-1 (As=0.165-0.175mg/L)	4 lands (12 spots)	6	72
2	Kotchandpur	Medium arsenic in irrigation well water: Area-2 (As=0.043-0.045mg/L)	3 lands (9 spots)	6	54
3	Kaligonj	Low arsenic in irrigation well water site: Area-3 (As=0.002-0.015mg/L)	3 lands (3 spots)	6	18
		Total number of collected soil samples			**144**

- *During the total 3 years project period, collected soil samples (144) total 5 times (dry season 2018, rainy season 2018, dry season 2019, rainy season 2019 and dry season 2020) and monitored arsenic concentration.*

3.2 Pretreatment of soil, crops, vegetable and fertilizer samples for arsenic analysis

Dried samples were made powder and mixed homogeneously. Then 0.5 - 2.0g of the powder sample was put into a digestion vessel and digested with nitric acid and hydrogen peroxide solution using USEPA 3050B method (USEPA, 1996). After cooling it, the mixture was diluted to 100 ml by adding distilled water and filtered through Whatman No. 41 filter paper. The filtered mixture was then placed for the determination of arsenic by AAS (AA-7000) at AAN Laboratory in Jashore.

Photo: Digesting soil samples

Photo: Processing soil samples for arsenic test

3.3 Results and Discussion

3.3.1 Comparison of arsenic concentration among the vertical soil samples

The vertical soil samples were collected from 10 lands, and measured arsenic concentration. The seasonal monitoring data (3 dry and 2 rainy seasons) is shown in Table 14 and Fig. 16. The summary results is shown as below:

1) The top soil of Area-1 (high arsenic in irrigation well water area) is relatively highly contaminated (10.2 to 54.7 mg/Kg);
2) The top soil of Area-2 (medium arsenic in irrigation well water area) is contaminated with arsenic at medium level (9.2 to 15.1 mg/Kg);
3) The top soil of Area-3 (low arsenic in irrigation well water area) is comparatively less contaminated compared to other areas.

High arsenic in the top soil of Area-1 may have been caused by rice cultivation with arsenic contaminated water that was waterlogged as mentioned later (See 3.3.3). It is observed that the arsenic concentration in soil samples shows most high value on the top soil and gradually decreases toward sub-soil samples as shown in Fig.16, where the seasonal (3 dry and 2 rainy seasons) arsenic concentration is monitored.

Fig.-16 **Vertical distribution of average arsenic contamination in sub-soil samples in high arsenic contaminated area, tested in five times (three dry and two rainy seasons)**

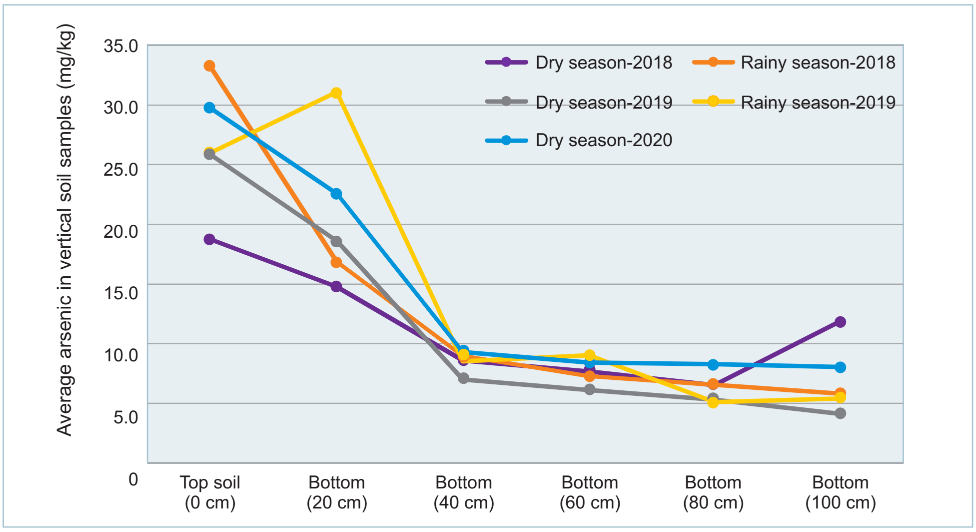


Table-14: Arsenic concentration in soil samples collected in 2018, 2019 and 2020

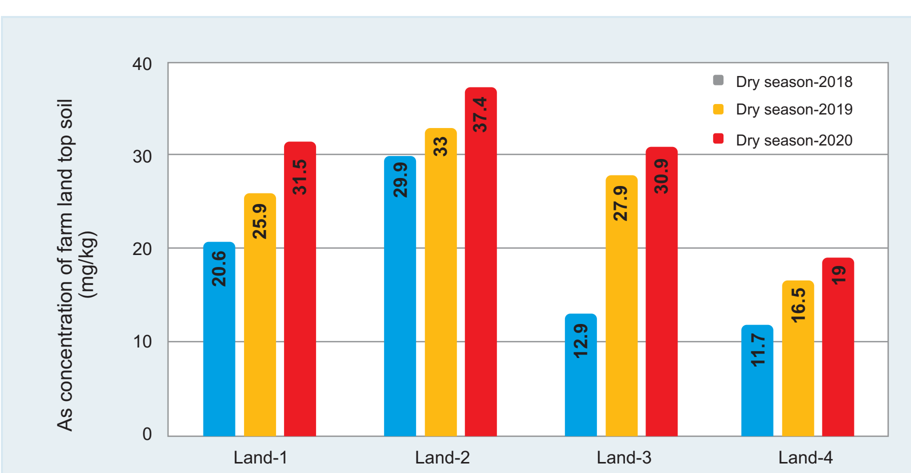
Sl. No	Sampling Area	Sampling Land	Sampling Point	Average Arsenic Concentration of sampling points A, B, and C (mg/kg)				
				Dry Season 2018	Rainy Season 2018	Dry Season 2019	Rainy Season 2019	Dry Season 2020
1	Area with high arsenic in irrigation well water (Area-1)	Land-1	Top soil (0 cm)	20.6	32	25.9	31.5	31.5
			Bottom (20 cm)	6.6	9.8	24.9	27.1	22.3
			Bottom (40 cm)	7.4	9.1	8.4	8.1	8.2
			Bottom (60 cm)	7.4	8.7	7.3	7.5	8.8
			Bottom (80 cm)	8.8	3.9	3.6	4.1	7.3
			Bottom (100 cm)	6.5	7	4.2	5.9	8.6
		Land-2	Top soil (0 cm)	29.7	54.7	33.0	31.2	37.4
			Bottom (20 cm)	34.5	24.1	17.4	41.4	26.5
			Bottom (40 cm)	10.3	10	5.3	12.4	9.5
			Bottom (60 cm)	7.3	7.7	5.3	7.2	8.6
			Bottom (80 cm)	3.3	4.9	5.4	4.7	7.6
			Bottom (100 cm)	3.4	4.8	1.8	4.8	9.7
		Land-3	Top soil (0 cm)	12.9	33.1	27.9	31.1	30.9
			Bottom (20 cm)	10.4	21.1	17.1	33.6	26.5
			Bottom (40 cm)	7.4	6.8	5.2	8.4	10.5
			Bottom (60 cm)	5.6	5.8	5.7	14.7	8.7
			Bottom (80 cm)	6.4	7.2	4.5	5.3	8.4
			Bottom (100 cm)	20	5.8	4.6	4.6	7.2
		Land-4	Top soil (0 cm)	11.7	12.7	16.5	10.2	19.0
			Bottom (20 cm)	7.5	12.4	15.1	22.2	15.0
			Bottom (40 cm)	9.2	10	9.1	5.2	9.0
			Bottom (60 cm)	10.4	6.9	6.3	6.7	7.6
			Bottom (80 cm)	7.6	10.2	7.7	6.3	9.9
			Bottom (100 cm)	17.6	5.7	5.9	6.4	6.7
2	Area with medium arsenic in irrigation well water (Area-2)	Land-5	Top soil (0 cm)	11.4	11.9	9.8	11.8	15.0
			Bottom (20 cm)	10.2	6.5	4.4	9	10.4
			Bottom (40 cm)	7.5	5.7	4.3	7.2	5.1
			Bottom (60 cm)	7.2	5.5	4.5	6.4	5.6
			Bottom (80 cm)	7.2	6.1	4.7	6	5.4
			Bottom (100 cm)	7	5.5	4.1	5.5	4.7
		Land-6	Top soil (0 cm)	11.6	11.5	10.3	9.7	13.4
			Bottom (20 cm)	7.9	8.5	7.6	7.1	10.8
			Bottom (40 cm)	6.1	7	5.6	5.8	7.6
			Bottom (60 cm)	6.1	7	4.9	6.4	5.4
			Bottom (80 cm)	8.7	6.7	5.2	5.8	5.2
			Bottom (100 cm)	7.6	6.9	5.6	7.3	6.7

Sl. No	Sampling Area	Sampling Land	Sampling Point	Average Arsenic Concentration of sampling points A, B, and C (mg/kg)				
				Dry Season 2018	Rainy Season 2018	Dry Season 2019	Rainy Season 2019	Dry Season 2020
		Land-7	Top soil (0 cm)	9.2	15	11.4	10.9	15.1
			Bottom (20 cm)	7.7	10	5.8	6.9	14.5
			Bottom (40 cm)	8.4	7.6	4.9	5.1	5.3
			Bottom (60 cm)	6.2	5.9	5.8	6	5.3
			Bottom (80 cm)	6.8	8.5	6.3	6.4	4.7
			Bottom (100 cm)	5.9	6.9	4.6	5	4.4
3	Area with low arsenic in irrigation well water (Area-3)	Land-8	Top soil (0 cm)	6.3	3.3	5.4	5.6	5.4
			Bottom (20 cm)	9.4	7.7	6.4	7.2	7.5
			Bottom (40 cm)	8.7	8.1	6.2	7.5	6.7
			Bottom (60 cm)	10.5	7.4	6.7	5.5	5.5
			Bottom (80 cm)	4.2	4.4	4.4	1.4	5.0
			Bottom (100 cm)	4.5	5	5.1	1.2	8.3
		Land-9	Top soil (0 cm)	6.4	2.6	3.5	2.9	7.6
			Bottom (20 cm)	8.7	6.1	7.0	2.5	8.6
			Bottom (40 cm)	2.6	8.7	5.6	4.7	9.7
			Bottom (60 cm)	5.2	7.5	5.9	5.3	8.9
			Bottom (80 cm)	1.9	6.3	3.6	5.6	8.5
			Bottom (100 cm)	3.2	6.6	3.8	3.3	7.9
		Land-10	Top soil (0 cm)	5	4.8	3.8	2.8	8.0
			Bottom (20 cm)	4.1	6.8	4.4	2.3	7.4
			Bottom (40 cm)	9.1	11.1	7.0	5.3	8.5
			Bottom (60 cm)	6.1	7	5.2	3.5	8.5
			Bottom (80 cm)	4.4	8	3.2	3.3	8.0
			Bottom (100 cm)	2.9	4.5	2.2	4.2	6.6

3.3.2 Arsenic increasing tendency of farmland top soils

It was observed that farmland top soil arsenic concentration is increasing (every year) due to use of arsenic contaminated groundwater for agricultural purposes. Three years (dry season) arsenic concentration data of top soils is shown in Fig.17. The average arsenic concentration (4 top soil samples) of Area-1 for 3 dry seasons is 18.8 mg/kg in year 2018, 25.8 mg/kg in year 2019, and 29.7 mg/Kg in year 2020, where it is observed that the arsenic concentration of farmland top soil is gradually increasing every year due to use groundwater for irrigation purposes.

Fig.-17 Arsenic increasing tendency in farmland top soils due to use arsenic contaminated irrigation water in high arsenic contaminated area (land-1 to land-4)



3.3.3 Relationship of arsenic concentration between irrigation water and farmland soil

The relationship of arsenic concentrations among irrigation water, farmland water and top soil is shown in Table 15, Fig. 18 and Fig. 19. The average arsenic concentration of irrigation well water samples in high, medium and low arsenic concentration areas (in 2018~2020) was 0.170, 0.044 and 0.009 mg/L respectively, whereas the average arsenic concentration in farmland water was found at slightly decreasing level (0.165, 0.037 and 0.008 mg/L) compared to that of irrigation water.

With regard to the relationship among irrigation water, farmland water and top soil, it is observed that there is a tendency that the arsenic concentration of farmland soil is high where the arsenic concentrations of irrigation well water and farmland water are high, showing that the arsenic concentration of farmland soil is positively affected by the arsenic concentration of irrigation well water. An assumption is induced here that the excessive withdrawal of arsenic contaminated groundwater for irrigation purposes results in elevated arsenic concentration in top soils of rice field. In soils arsenic is generally in the range of 5-10 mg/Kg and concentration above 20 mg/Kg is considered high (Appendix 2). In this practical investigation, the arsenic concentration in farmland soil exceeded 20mg/Kg in two samples in year 2018 for Area-1, and three samples in both year 2019 and year 2020 for same Area-1, which may indicate the increase in other soil in future. Details of As-concentration in irrigation well water, farmland water and farmland top soil are shown in Table 15, and their relationship in Fig 18 and Fig 19.

Table-15: Arsenic concentrations in irrigation well water, farmland water and farmland soil

Sampling Location	Sampling Land	Sampling: Dry season 2018			Sampling: Dry season 2019			Sampling: Dry season 2020		
		As in irrigation water (mg/L)	As in farm land water (mg/L)	As in top soil (mg/kg)	As in irrigation water (mg/L)	As in farm land water (mg/L)	As in top soil (mg/kg)	As in irrigation water (mg/L)	As in farm land water (mg/L)	As in top soil (mg/kg)
Area with high arsenic in irrigation well water	Land-1	0.165	0.171	20.6	0.171	0.163	25.9	0.175	0.17	31.5
	Land-2	0.165	0.166	29.7	0.171	0.154	33.0	0.175	0.178	37.4
	Land-3	0.165	0.17	12.9	0.171	0.163	27.9	0.175	0.165	30.9
	Land-4	0.165	0.163	11.7	0.171	0.151	16.6	0.175	0.16	19.0
Area with medium arsenic in irrigation well water	Land-5	0.045	0.04	11.4	0.045	0.04	9.8	0.043	0.03	15.0
	Land-6	0.045	0.042	11.6	0.045	0.042	10.3	0.043	0.027	13.4
	Land-7	0.045	0.043	9.2	0.045	0.041	11.4	0.043	0.028	15.1
Area with low arsenic in irrigation well water	Land-8	0.002	0.001	6.3	0.015	0.013	5.4	0.01	0.009	5.4
	Land-9	0.002	0.001	6.4	0.015	0.012	3.5	0.01	0.009	7.6
	Land-10	0.002	0.001	5.0	0.015	0.015	3.8	0.01	0.008	8.0

Fig.-18 Relationship of arsenic concentration between irrigation water and farmland top soil

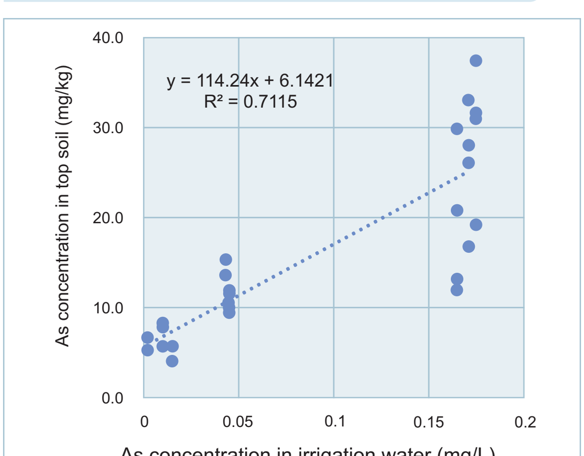
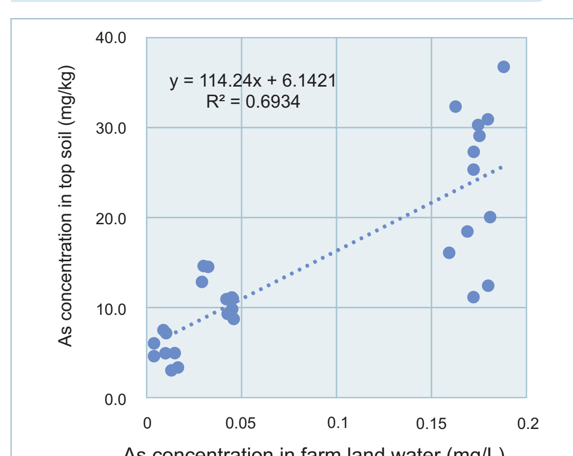


Fig.-19 Relationship of arsenic concentration between farmland water and farmland top soil



3.3.4 Relationship of arsenic concentration among farmland water, soil and rice

The relationship of arsenic concentration among farmland water, farmland soil and rice is shown in Table 16, Fig. 20 and Fig. 21. The average arsenic concentrations in rice grain in the areas with high, medium and low arsenic concentration ranged from 0.368, 0.267 and 0.138 mg/Kg, respectively. The arsenic concentration of rice grain appeared to correlate with the arsenic concentration of both farmland water and farmland soil, showing that the arsenic concentration of crops is positively affected by the arsenic concentration of irrigation water and farmland soil. Here, the maximum arsenic concentration of crop (rice grain) was 0.583mg/Kg (land-1), 2nd height 0.532mg/kg (land-2) in dry season 2020, which was above the limit of 0.5mg/Kg, and correlation graph poses a risk for the rice production in this area.

Table-16: Arsenic concentrations in farmland water, soil and rice grain

Sampling Location	Sampling Land	Sampling: Dry season 2018			Sampling: Dry season 2019			Sampling: Dry season 2020		
		As in farm land water (mg/L)	As in top soil (mg/kg)	As in rice (mg/kg)	As in farm land water (mg/L)	As in top soil (mg/kg)	As in rice (mg/kg)	As in farm land water (mg/L)	As in top soil (mg/kg)	As in rice (mg/kg)
Area with high arsenic in irrigation well water	Land-1	0.171	20.6	0.395	0.163	25.9	0.12	0.17	31.5	0.583
	Land-2	0.166	29.7	0.335	0.154	33.0	0.17	0.178	37.4	0.532
	Land-3	0.17	12.9	0.269	0.163	27.9	0.12	0.165	30.9	0.498
	Land-4	0.163	11.7	0.333	0.151	16.6	0.13	0.16	19.0	0.444
Area with medium arsenic in irrigation well water	Land-5	0.04	11.4	0.311	0.04	9.8	NC	0.03	15.0	NC
	Land-6	0.042	11.6	0.305	0.042	10.3	NC	0.027	13.4	NC
	Land-7	0.043	9.2	0.251	0.041	11.4	0.11	0.028	15.1	NC
Area with low arsenic in irrigation well water	Land-8	0.001	6.3	0.191	0.013	5.4	0.21	0.009	5.4	0.101
	Land-9	0.001	6.4	0.124	0.012	3.5	0.11	0.009	7.6	0.097
	Land-10	0.001	5.0	0.205	0.015	3.8	0.11	0.008	8.0	0.092

Note: NC= Not Cultivated

Fig.-20 Relationship of arsenic concentration between farmland water and rice samples

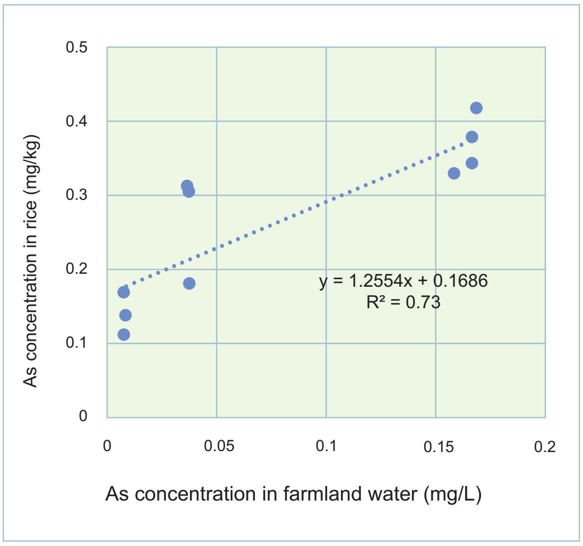
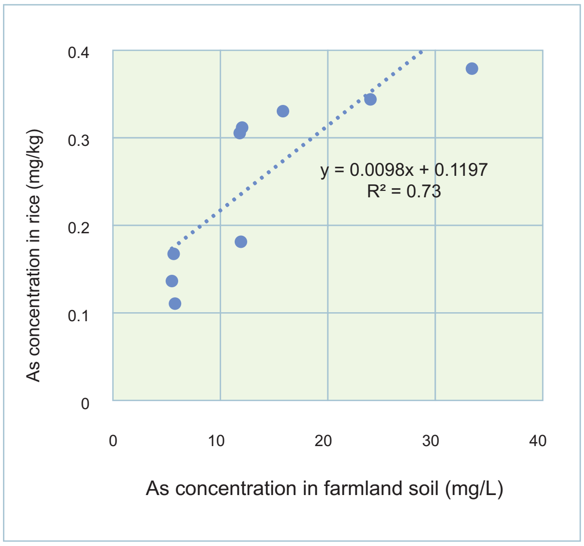


Fig.-21 Relationship of arsenic concentration between farmland top soils and rice samples



3.3.5 Comparison of arsenic concentration in BORO and AMAN rice samples

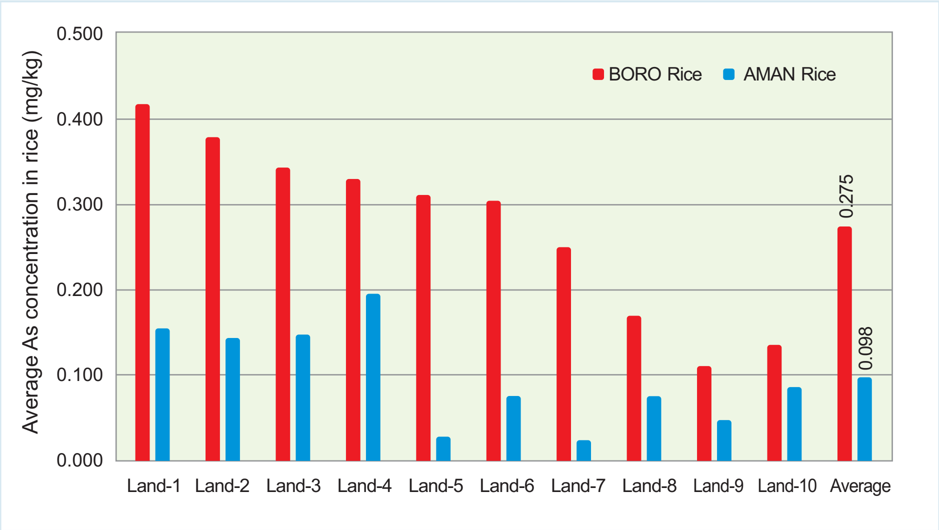
The comparison of arsenic concentrations between BORO rice (cultivated using groundwater) and AMAN rice (cultivated by mostly rainwater) samples is shown in Table 17 and Fig.22. The standard of WHO/CODEX for As-intake through rice is 0.35mg/kg. The As-concentration of BORO rice is 0.27~0.40 mg/kg in 2018 and 0.44~0.58mg/kg in 2020 in high arsenic contaminated area. The latter shows all beyond of the standard though the former shows a little within/beyond of the standard. AMAN rice is below the standard. The average arsenic concentration of the BORO rice samples (n=10) was found relatively high (2.8 times) compared to the AMAN rice. The reason may be because AMAN rice is cultivated mostly by rainwater and BORO rice is cultivated by groundwater, that is contaminated with arsenic under waterlog condition.

Table-17: Comparison of arsenic concentrations of BORO and AMAN rice cultivated in land-1 to land-10

Sampling Location	Sampling Land	Sampling: 2018		Sampling: 2019		Sampling: 2020		Average	
		BORO Rice	AMAN Rice	BORO Rice	AMAN Rice	BORO Rice	AMAN Rice	BORO Rice	AMAN Rice
Area with high arsenic in irrigation well water	Land-1	0.395	0.190	0.120	0.274	0.583	NC	0.417	0.155
	Land-2	0.335	0.118	0.170	0.271	0.532	NC	0.379	0.144
	Land-3	0.269	0.176	0.120	0.263	0.498	NC	0.343	0.148
	Land-4	0.333	0.259	0.130	0.213	0.444	NC	0.330	0.195
Area with medium arsenic in irrigation	Land-5	0.311	0.027	NC	NC	NC	NC	0.311	0.027
	Land-6	0.305	0.075	NC	NC	NC	NC	0.305	0.075
	Land-7	0.251	0.024	0.110	NC	NC	NC	0.251	0.024
Area with low arsenic in irrigation	Land-8	0.191	0.075	0.210	NC	0.101	NC	0.167	0.075
	Land-9	0.124	0.047	0.110	NC	0.097	NC	0.110	0.047
	Land-10	0.205	0.086	0.110	NC	0.092	NC	0.136	0.086

Note: NC = Not cultivated

Fig.-22 Comparison of arsenic concentration between BORO and AMAN rice samples



3.3.6 Attachment of water flow meter with the research based three irrigation wells

A water flow meter is attached with the research based three irrigation wells to know the volume of groundwater used for agricultural purposes. From that water flow meter, it was observed that a total 38,987,000 liters groundwater is withdrawn from Sep/2018 to Apr/20 (32 months) in high arsenic in irrigation water area where extracted 2.5 (kg/year) arsenic from ground aquifer through irrigation water, whereas 0.8 and 0.1 (kg/year) in medium and low arsenic in irrigation well areas, respectively. It is expected that the load of additional arsenic, which extracted from ground aquifer through irrigation water is posing threat to the surrounding environment that may contaminated food-chain grown nearby the irrigation well site.

Photo: Attached water flow meter with research based irrigation wells

Table-18: Amount of arsenic withdrawn through irrigation water

Research Area	Status of Water Flow Meter				Operational Period (months)	Volume of ground water withdrawn (M^3)	Average Arsenic (mg/L)	Arsenic withdrawn through groundwater (Kg/year)
	Setting Date	Starting Reading (M^3)	Ending Date	Ending Reading (M^3)				
Area with high arsenic in irrigation well water	7-Sep-18	0	6-May-20	38987	32 Months	38987	0.17	2.5
Area with medium arsenic in irrigation well water	8-Sep-18	0	7-May-20	50782	32 Months	50782	0.044	0.8
Area with low arsenic in irrigation well water	21-Dec-18	0	6-May-20	19296	29 Months	19296	0.009	0.1

Chapter 4

Arsenic research in food chain

4.1 Arsenic concentration in winter vegetable

44 vegetable samples (SAP farmland-24 varieties and 20 varies from market) were collected in December 2018 and their As-concentration was measured as shown in Table 19. There is no standard of vegetable for As-contamination in a world. We will set here two kinds of standard, 0.5mg/kg and 0.1mg/kg (Appendix 3).

Only bitter gourd, collected from market, is beyond the standard of 0.5mg/kg. Regarding the standard of 0.1mg/kg, Arum, turmeric and Spinach in SAP farm land and red amaranth, green amaranth in market are beyond the standard. The As-pollution ratio is 2% for the standard of 0.5mg/kg and 11% for the 0.1mg/kg standard.

Table-19: Comparison of arsenic concentrations of vegetable between SAP farmlands and market

Collected from SAP Farmers' Farmland				Collected from Market (Jhenaidah Municipal Market)				
Sl.	Type of the Vegetable	Eatable Part	As Concentration (mg/kg)	Sl.	Type of the Vegetable	Eatable Part	Date of Collection	As Concentration (mg/kg)
1	Radish (Mula)	Root	0.057	1	Radish (Mula)	Root	20-Dec-18	<0.04
2	Carrot	Root	0.040	2	Carrot	Root	20-Dec-18	0.088
3	Arum (kochu)	Root	0.279	3	Potato	Root	20-Dec-18	0.063
4	Arum (Man Kochu)	Root	0.074	4	Arum (Man Kochu)	Root	20-Dec-18	0.078
5	Arum (Ol Kochu)	Root	0.094					
6	Mete Alu	Root	0.049					
7	Spinach (Palong Shak)	Leaf	0.130					
8	Basil (Tsurumurasaki)	Leaf	0.050					
9	Cabbage (Pata Kopi)	Leaf	0.043	5	Cabbage (Pata Kopi)	Leaf	20-Dec-18	<0.04
				6	Red amaranth	Leaf	20-Dec-18	0.34
				7	Green amaranth	Leaf	20-Dec-18	0.399
				8	Stick (green amaranth)	Leaf	20-Dec-18	0.181
10	Bean (Sim)	Flower/Fruit	0.050	9	Bean (Sim)	Flower/Fruit	20-Dec-18	<0.04
11	Pointed Gourd (Patol)	Flower/Fruit	0.045					
12	Eggplant (Begun)	Flower/Fruit	0.083	10	Eggplant (Begun)	Flower/Fruit	20-Dec-18	<0.04
13	Papaya	Flower/Fruit	0.046					
14	Ladies Finger	Flower/Fruit	0.052	11	Ladies Finger	Flower/Fruit	20-Dec-18	0.053
15	Green Banana	Flower/Fruit	0.040	12	Green Banana	Flower/Fruit	20-Dec-18	<0.04
16	Bottle Gourd	Flower/Fruit	0.046	13	Bottle Gourd	Flower/Fruit	20-Dec-18	<0.04
17	Tomato	Flower/Fruit	0.037	14	Tomato	Flower/Fruit	20-Dec-18	<0.04
18	Cauliflower	Flower/Fruit	0.040	15	Cauliflower	Flower/Fruit	20-Dec-18	0.04
19	Pumpkin	Flower/Fruit	0.062					

Collected from SAP Farmers' Farmland				Collected from Market (Jhenaidah Municipal Market)				
Sl.	Type of the Vegetable	Eatable Part	As Concentration (mg/kg)	Sl.	Type of the Vegetable	Eatable Part	Date of Collection	As Concentration (mg/kg)
20	Maize (Butta)	Grain	<0.04					
				16	Snake gourd	Flower/Fruit	20-Dec-18	0.081
				17	Long bean	Flower/Fruit	20-Dec-18	0.096
				18	Turnip (sulgum)	Flower/Fruit	20-Dec-18	0.097
				19	Bitter gourd	Flower/Fruit	20-Dec-18	0.666
				20	Cucumber	Flower/Fruit	20-Dec-18	0.072
21	Onion	Root	0.093					
22	Garlic	Root	0.057					
23	Turmeric	Root	0.164					
24	Chilli (Kacha Morich)	Flower/Fruit	0.046					

4.2 Correlation of arsenic concentration among water, soil and vegetable samples

To know the correlation of arsenic concentration among water, soil and food-chain, the samples of 10 water, 18 soil and 26 varieties (including spices) of vegetable were collected from the SAP farmlands in December 2019, and their arsenic concentrations were measured as shown in Table 20. The research findings are summarized in below:

(i) Among the collected ten water samples, we found two samples (0.057 ppm and 0.165 ppm) were arsenic contaminated above the Bangladesh drinking water standard.

(ii) Regarding the vegetable standard of 0.5mg/kg, 5 vegetables (spinach, red amaranth, arum-root, arum-shoot and arum-leaf) were beyond the standard. The arum (root, shoot and leaf) samples were collected from Kalicharanpur village, where highest arsenic contamination was recorded in irrigation tube well water during screening period.

(iii) Regarding the vegetable standard of 0.1mg/kg, chilli is added to the 5 vegetables mentioned above.

(iv) Regarding the vegetable samples, where the arsenic concentration of water samples were below the Bangladesh drinking water standard of 0.05 mg/L, it is said that a) all samples are safe for the vegetable standard of 0.5mg/kg, and b) chilli is beyond the vegetable standard of 0.1mg/kg.

(v) It may be said that the arsenic concentration of winter vegetables is not so affected by groundwater arsenic contamination. But, the sample number is not so many and the measurement number is only one time in this examination. So, it is necessary to analyze more measurement data to propose an objective evaluation for As-contamination of winter vegetable

Table-20: Comparison of arsenic concentrations among water, soil and vegetable samples

Sl.	Water Sample #ID	Soil Sample #ID	Vegetable Sample #ID	Date of Sampling	Sample Name	Land Owner	Village	Union	Upazilla	Arsenic Concentration (ppm)		
										Water	Soil	Vegetable (Eatable)
1	W-1	S-1	F-1	6-Dec-19	Pointed Gourd	Chontu Mia	Monoharpur	Simla Reokonpur	Kaligonj	0.006	4.73	<0.05
2		S-2	F-2	6-Dec-19	Pepper	Chontu Mia	Monoharpur	Simla Reokonpur	Kaligonj		5.03	0.29
3		S-3	F-3	6-Dec-19	Banana	Latif Molla	Monoharpur	Simla Reokonpur	Kaligonj		5.8	<0.05
4		S-4	F-4	6-Dec-19	Malabar Spinach	Chontu Mia	Monoharpur	Simla Reokonpur	Kaligonj		3.9	<0.05
5			F-5	6-Dec-19	Brinjal	Chontu Mia	Monoharpur	Simla Reokonpur	Kaligonj			0.05
6		S-5	F-6	6-Dec-19	Bean	Chontu Mia	Monoharpur	Simla Reokonpur	Kaligonj		4.7	<0.05
7	W-2	S-6	F-7	6-Dec-19	Ladies Finger	Anisur Rahman	Monoharpur	Simla Reokonpur	Kaligonj	0.001	7.5	<0.05

Sl.	Water Sample #ID	Soil Sample #ID	Vegetable Sample #ID	Date of Sampling	Sample Name	Land Owner	Village	Union	Upazilla	Arsenic Concentration (ppm)		
										Water	Soil	Vegetable (Eatable)
8	W-3	S-7	F-8	6-Dec-19	Red Amaranth	Tuhinur Rahman	Monoharpur	Simla Reokonpur	Kaligonj	0.02	5.8	0.05
9	W-4	S-8	F-9	6-Dec-19	Bottle Gourd	Ramjan Ali	Tilla	Simla Reokonpur	Kaligonj	0.043	3.67	<0.05
10	W-5	S-9	F-10	6-Dec-19	Spinach	Akimul	Tilla	Simla Reokonpur	Kaligonj	0.018	8.23	0.09
11			F-11	6-Dec-19	Onion	Akimul	Tilla	Simla Reokonpur	Kaligonj			<0.05
12	W-6	S-10	F-12	6-Dec-19	Malabar Spinach	Lal-Mohommod	Fulbari	Bulohor	Kotchandpur	0.001	5.8	<0.05
13			F-13	6-Dec-19	Papaya	Lal-Mohommod	Fulbari	Bulohor	Kotchandpur			0.1
14			F-14	6-Dec-19	Banana	Lal-Mohommod	Fulbari	Bulohor	Kotchandpur			0
15			F-15	6-Dec-19	Water Spinach	Lal-Mohommod	Fulbari	Bulohor	Kotchandpur			0.09
16	W-7	S-11	F-16	6-Dec-19	Spinach	Daud Hossen	Mohonpur	Kushna	Kotchandpur	0.057	9.2	0.98
17			F-17	6-Dec-19	Red Amaranth	Darbesh	Mohonpur	Kushna	Kotchandpur			1.49
18	W-8	S-12	F-18	6-Dec-19	Daikon	Rabiul Islam	Ganna Purbapara	Ganna	Jhenaidah Sadar	0.025	2.83	0.05
19		S-13	F-19	6-Dec-19	Pointed Gourd	Rabiul Islam	Ganna Purbapara	Ganna	Jhenaidah Sadar		2.97	0.1
20		S-14	F-20	6-Dec-19	Cabbage	Rabiul Islam	Ganna Purbapara	Ganna	Jhenaidah Sadar		3.7	0
21		S-15	F-21	6-Dec-19	Brinjal	Rabiul Islam	Ganna Purbapara	Ganna	Jhenaidah Sadar		3.53	0.05
22		S-16	F-22	6-Dec-19	Turmeric	Rabiul Islam	Ganna Purbapara	Ganna	Jhenaidah Sadar		3.1	0.05
23	W-9	S-17	F-23	6-Dec-19	Bottle Gourd	Nazrul Islam	Porahati	Porahati	Jhenaidah Sadar	0.029	4.1	0.05
24	W-10	S-18	F-24	24-Oct-19	Arum (root)	Tohid Biswas	Kalicharonpur	Kalicharonpur	Jhenaidah Sadar	0.165	20.6	0.91
25			F-25	24-Oct-19	Arum (shoots)	Tohid Biswas	Kalicharonpur	Kalicharonpur	Jhenaidah Sadar			0.51
26			F-26	24-Oct-19	Arum (leaf)	Tohid Biswas	Kalicharonpur	Kalicharonpur	Jhenaidah Sadar			0.62

4.3 Arsenic concentration of vegetable collected from market

Nine Vegetable samples were collected from Mohonpur Bazaar, Kotchandpur Upazila to measure arsenic concentration as shown in Table 21. It is found that Bitter gourd is beyond the vegetable standard of 0.5mg/kg and Arum beyond 0.1mg/kg standard.

Photo: Collection of vegetable samples from market

Table-21: Arsenic concentration of the vegetable collected from market

Sl.	Sample Name	Date of Sampling	Arsenic (ppm)
1	Purple Yam (Mete-Alu)	7-Dec-2019	<0.05
2	Radish	7-Dec-2019	0.05
3	Arum (Man Kochu)	7-Dec-2019	0.19
4	Potato	7-Dec-2019	0.08
5	Bitter Gourd	7-Dec-2019	0.54
6	Pumpkin	7-Dec-2019	0.10
7	Cauliflower	7-Dec-2019	0.05
8	Long bean	7-Dec-2019	<0.05
9	Cabbage	7-Dec-2019	<0.05

4.4 Arsenic concentration of seed samples (41 varieties)

Forty-one varieties of seed/crop samples were collected from SAP farmer's households to measure arsenic concentration. All of the samples were recorded within the standard of arsenic concentration 0.5mg/kg (Appendix 4), and detail results are shown in table 22 in below:

Table-22: Arsenic concentration of seed/crops collected from SAP farmer's households

Jhenaidah Sadar Upazila		Kaligonj Upazila		Kotchandpur Upazila	
Seed Variety	As (mg/kg)	Seed Variety	As (mg/kg)	Seed Variety	As (mg/kg)
Mustard(Kastosagra)	0.14	Paddy (Local)	0.37	Pigeon pea (Motor)	0.40
Lentil (BARI-6)	0.47	Paddy (Shorna Var)	0.12	Lentil (Moshur)	0.21
Wheat (Kastosagra)	0.14	Paddy (Jira)	0.16	Chick pea (Kalai)	0.26
Pigeon pea (Kastosagra)	0.15	Mustard (Kastosagra)	0.15	Mustard	0.12
Wheat (BARI-8)	0.13	Paddy (local)	0.31	Paddy (local)	0.30
Mustard (BARI-14)	0.14	Paddy (Guti Shorna Var)	0.38		
Pulse (Kheshari)	0.19	Dhan (BRRI-5)	0.27		
Paddy (Subornolata Lal)	0.28	Wheat (BARI-14 Var)	0.12		
Chick pea(local)	0.13	Mustard (Rai)	0.13		
Mung Dal(Local)	0.17	Mustard (local)	0.24		
BARI-5 Chita Mug	<0.05	Seasame (Atshira)	0.23		
Bari-14 Mustard Seed	<0.05	Chick pea (BARI)	0.19		
Desi Chola (Chickpea)	<0.05	Lentil	0.26		
Bari-5 Lentil Seed	<0.05				
Wheat	<0.05				
Til (Goma)	0.08				
Rice (Basmoti)	0.17				
Pea (Motor Dal)	<0.05				
Grass pea	0.12				
Mug Desi	0.07				
Bitter gourd (Desi)	<0.05				
Bari-14 Mustard Seed	0.16				
Rice (Sarna)	0.19				

Chapter 5

Arsenic concentration in fertilizers

5.1 Arsenic concentration of the vermi-compost

Thirty-five (35) vermi-samples of vermi-compost (organic fertilizer) were collected from SAP farmer households to measure arsenic concentrations that are commonly used in agricultural fields in the project area. The arsenic concentration of the collected 35 vermi-compost samples is shown in Table-23. It was observed that As-concentration of all samples were within the 10 mg/kg (Appendix 5), which shows no effect on As-concentration on farmland soil.

Table-23: Arsenic concentration of the vermi-compost collected from SAP farmer households

Kaligonj Upazila		Jhenaidah Sadar Upazila		Kotchandpur Upazila	
Sampling Household	As Concentration (mg/kg)	Sampling Household	As Concentration (mg/kg)	Sampling Household	As Concentration (mg/kg)
Momin Mondol	1.88	AID Office-1	2.70	Md. Sofiuddin	2.44
Moshiar Rahman	2.03	Nazrul Islam	2.12	Mr. Ismail	2.47
Nilima	2.24	Motiar Rahman	3.41	Md. Shahjahan	2.63
Morjina	2.54	Mr. Bablu	3.79	Mr. Roshid	2.95
Lotifa	3.13	Mr. Roish	1.86	Motiar Rahman	3.09
Rohim	2.82	Mr. Rojina	2.21	Uttor Fulbari	2.10
Alauddin	1.52	Mr. Bisarot	1.99	Boro Bamundia	2.07
Asgor	2.49	Porahati AID office	2.17		
Din Mohammad	2.44	AID Office-2	3.80		
Forida	2.24	Najrul Islam	1.32		
Durgapur-1	1.99	Rasheda Khatun	2.29		
Monohorpur	3.53	Chutlia	3.13		
Pukuria	2.51				
Durgapur-2	2.36				
Momin Mondol	3.79				

5.2 Arsenic concentration in chemical fertilizers collected from local market

The arsenic concentration of the collected seven chemical fertilizers is shown in table 24, showing all of samples within the 10 mg/kg, and no effect on arsenic contamination of farmland soil.

Table-24: Arsenic concentration of the chemical fertilizers collected from local market

Sampling Date	Type of Fertilizer	Sampling Location	Upazila	As Concentration (mg/kg)
20-Dec-18	TSP	Porahati	Jhenaidah Sadar	9.57
20-Dec-18	MOP	Porahati	Jhenaidah Sadar	0.19
20-Dec-18	Urea	Porahati	Jhenaidah Sadar	0.04
20-Dec-18	Sulfer	Porahati	Jhenaidah Sadar	0.04
20-Dec-18	DAP	Porahati	Jhenaidah Sadar	9.21
20-Dec-18	Gypsum	Porahati	Jhenaidah Sadar	2.23
20-Dec-18	Boron	Porahati	Jhenaidah Sadar	<0.04

Chapter 6

Research on water supply through canal and PVC pipe

After withdrawing water from irrigation well, normally it is supplied through open canal from source to farmland plots, where it is assumed that a huge amount of water is loosed when it pass through the open canal. Water loses happen 1) due to water leakage and overflow happen in unnecessary plots, 2) some amount of water is absorbed in dry canal and also very small amount of water evaporation happen. To avoid this water loses through open canal system; farmers were started to supply water using flexible PVC pipe through motivational works. To do such research, a piece of land (10 decimal) is selected from Basipara village of Ganna Union, to know the difference of water quantity required for these researches. The land is divided into 2 equal plots, paddy was planted on 1 February 2020 in both lands, and field research was conducted for two times (19 February 2020 and 1 March 2020). It is observed that for research type-A (water flow through open canal) required double volume of water compare to research type-B (water flow through PVC pipe).

Table-25: Research on water supply through open canal and PVC pipe

Type of research	Land area for this research (decimal)	Date of Survey	Required water in canal/ PVC pipe (L)	Required water in farmland (L)	Total required water for this research (L)	Total water withdrawing time (minutes)
Research Type-A (Water flow through canal)	5.4	19-Feb-20	12,650	5,500	18,150	30.0
		01-Mar-20	12,650	5,500	18,150	30.0
Average			12,650	5,500	18,150	30.0
Research Type-B (Water flow through PVC pipe)	5.4	19-Feb-20	3,400	5,100	8,500	13.5
		01-Mar-20	3,400	5,600	9,000	14.5
Average			3,400	5,350	8,750	14.0

Photo: water supply through open canal

Photo: water supply through PVC pipe

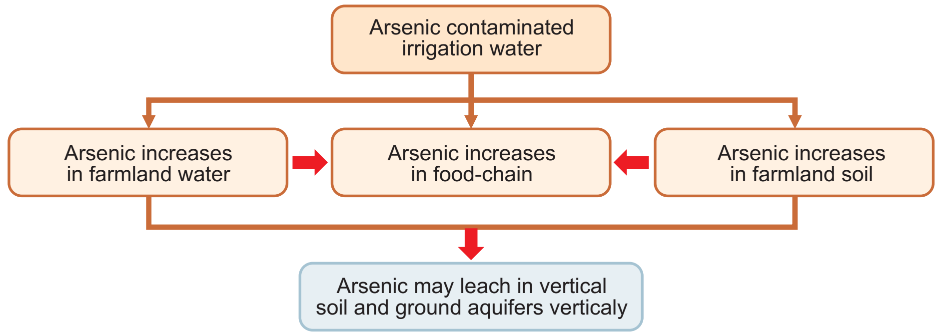
Chapter 7

Pathway of arsenic contamination in groundwater-soil-food chain system

Figures 20 and 21 above show the positive correlation between the arsenic concentrations in farmland water and rice grain and that between farmland soil and rice grain. These results indicate that the arsenic concentration in farmland soil is contaminated by irrigation well water and suggest that there is a risk associated with growing rice with arsenic contaminated irrigation water. The arsenic not only contaminates water but also pollute soil and food chain, consequently causing danger to human health by various routes of arsenic ingestion. This fact poses a threat to rice production in many areas of Bangladesh. The As-concentration of BORO rice exceeded the allowable standard of WHO/CODEX as mentioned earlier.

These factors may pose threat for the future food production in Bangladesh, where people take a large quantity of rice and vegetables in their daily diet. The effect of arsenic contaminated irrigation water on soil and food-chain is illustrated in Fig. 23.

Fig.-23 **Flow chart of effect of irrigation water arsenic contamination on soil and food-chain**



Chapter 8

Recommendation and conclusion

Through this project, farmers are promoted to do alternative crops and vegetables, which need less water than rice, and also farmers are encouraged for utilizing less water for rice cultivation through AWD method, to reduce arsenic contamination in food chain as well as protect environment. And, project has researched the arsenic contamination in groundwater-soil-food chain. The following is recommended for establishing an environment-friendly agriculture system for future food production in Bangladesh.

Photo: A SAP farmer is working in a vegetable garden

1) To use the irrigation TW water less than 0.05mg/L of As-concentration. Because it was found from the project research that BORO rice in the farm land, used high arsenic of irrigation well water, was contaminated beyond WHO/CODEX standard for As-intake through rice.

2) To install the reservoir tank of rainwater harvesting together with irrigation pump. It is the hybrid system of groundwater and rainwater for irrigation, where we can decrease groundwater usage in the rainy season by using the rainwater harvesting tank. Or, digging mini pond to reserve rain water for increasing water holding capacity of soil, supplementing irrigation to AMAN rice cultivation and pond-dyke vegetables.

3) To promote the multiple cropping, which had largely made in the previous/traditional agriculture, that is, Amam rice in the rainy season and Rabi crops/vegetable in the dry season. Because it was found that As-concentration of Aman rice was below the WHO/CODEX standard and Rabi crops were almost below the standard of As-intake.

4) To use such vegetable as Beans, Carrots, Radishes, Potatoes, Cabbages, Tomatoes and Onions for the Rabi vegetable in multiple cropping. Because it was found that the As-concentrations of these vegetables are all less than the standard of As-intake ($As \leqq 0.1$mg/kg).

5) To develop the selective breeding of vegetables tolerant of As-contamination for the multiple cropping. Because it was found that some vegetables as Spinach, Red amaranth, Arum and Bitter Gourd were beyond 0.5mg/kg and Chilli and Turmeric beyond 0.1mg/kg, which have been eaten as vegetable diet.

6) To use soft pipe connected to the out-let pipe from irrigation pump or reservoir tank of rainwater harvesting for irrigation of rice (Aman) when the irrigation through rainfall is not enough. Or, it may be used for irrigation of Robi vegetables in the dry season if necessary, and in the development of selective breeding of vegetables tolerant of As-contamination.

SECTION SEVEN

Achievement status for project goal, challenges and recommendation

Achievement status for project goal, challenges and recommendation

Achievement status for project goal

(1) The number of farmers who practice sustainable agriculture with less irrigation water is increased. Indicator 1200farmers/1500)

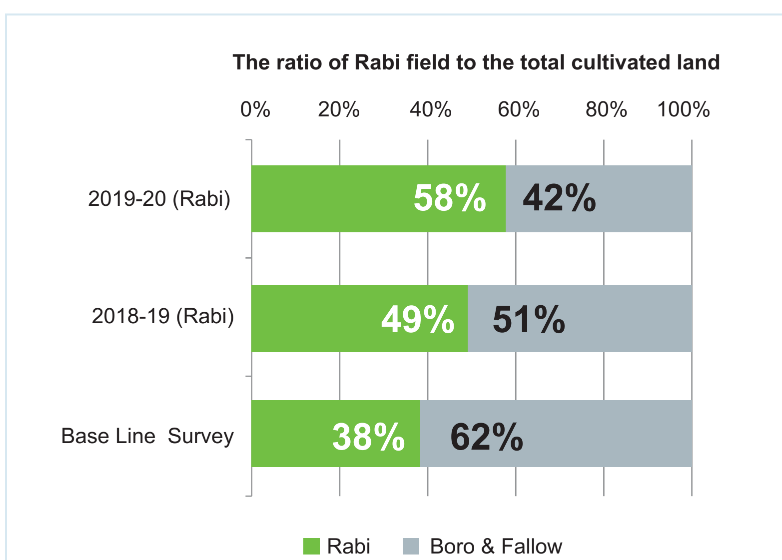
(2) Measurement Follow-up survey on less irrigation for paddy and Rabi crop practice, and others

① The follow-up survey result of Rabi farmers shows that 1,410 (94%) SAP farmers gradually came under Rabi crop cultivation with increased volume of lands from 38% to 58%, and thereby decreased volume of Boro and fallow lands from 62% to 42% i.e., less irrigation SAP approach is increased both by the number of farmers and volume of arable lands under Rabi crops sustainably.

1. Rabi cultivation

Before	1st yr.	2nd yr.	3rd yr.
1158	*	1327	1410
77%	*	88%	94%0

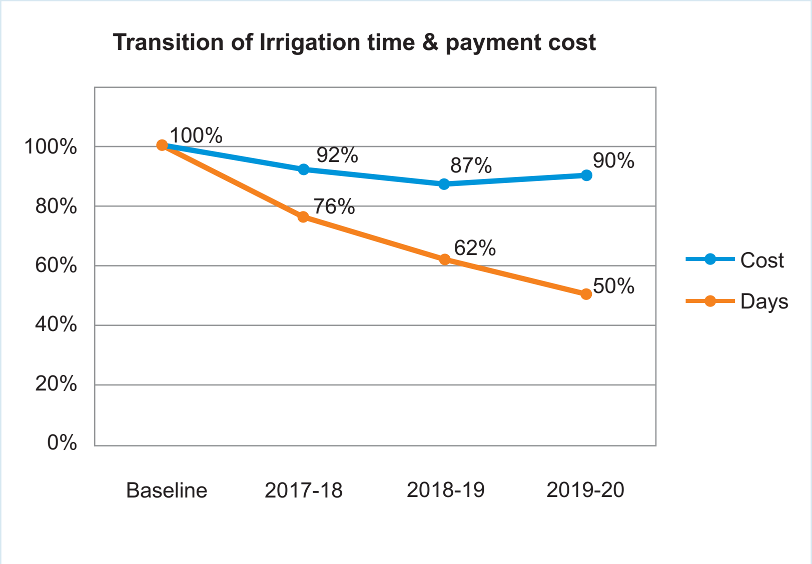
- Note that the project begun when Rabi season was about to end.



② The follow-up survey result of less irrigation practice by 698 (47%) SAP farmers reveals that who had no "less irrigate practice" in Boro Paddy cultivation (in baseline) have been able to reduce 50% water scheduling meticulously with 90% cost of payment to commercial water suppliers thereby saved cost of production under SAP approach. The result implies that less irrigation SAP approach is gradually increased among SAP farmers both by the number of farmers and percent irrigation cost savings sustainably.

2. Less Irrigation

Before	1st yr.	2nd yr.	3rd yr.
0	323	646	698
0%	22%	43%	47%



Challenges/Lesson learnt

During the project period, we experienced both challenges and lessons. We shared the challenges time to time with DAE officials, local government administration and public representatives. These are as follows-

① <5% farmers (74) who cultivated Rabi crops during 2018-19 experienced severe damage of crops due to erratic weather pattern including foggy weather, sudden with longer duration rainfall, disease & pest infestation etc. We experienced that those who suffered by crop damage mostly had lack of know-how/knowledge of mitigation practices, absence of appropriate technology of weather forecasting/early warning system etc. So, we held workshops at three areas with those farmers and DAE officers. In 2019-20 Rabi season, we had similar such experience but this time the damage was mostly caused by the cyclone Amphan. However, the target farmers were also affected seriously by the pandemic situation of COVID-19 meaning they could hardly sell their produce (Rabi crops, rice, other cash crops) to retails and whole sale market;

② The commercial irrigation water suppliers/contract water suppliers don't reduce the unit price of water whatsoever individual farmer's water scheduling is. As such, farmers often negotiated with the commercial water suppliers but least reduction of unit prices was possible sometimes and somewhere that didn't make a big difference in irrigation cost saving. Even we see increased water price in 2017-18 and 2019-20 due to erratic rainfall pattern. The challenges impacted among the SAP farmers and would likely to be counterproductive in the future fate of less irrigation practice;

③ It is a matter of concern that medium high and high lands get mostly flooded during Rabi season for Boro rice cultivation by the conventional flood irrigation system as well as vested interest by a section of commercial water suppliers. As such farmers even of being interested can't produce Rabi crops. In the 2nd year's self-evaluation workshop, SAP farmers raised this issue to local authority;

④ When most of the non-target farmers in the project area, during 2018-19 Rabi crop season, had been suffering from unavailability of Rabi seeds, some of our target farmers had been comparative advantageous as they had seeds produced by them made available for cultivating. Yet, we feel that the challenge of quality Rabi seed production and its spread are still evident to enhance crop diversity in the locality;

⑤ During FGDs with farmers, we understood that every SAP farmer wants to be trained with newer technology to produce commercially viable products seasonally and the training venue should be as close as to their living places; added saying that would save cost of training as well as save time for their field works;

⑥ We experienced that farmers don't listen to the result of national reconnaissance soil survey and thereby recommendation of fertilizers until and unless they find the results for their own fields through soil test. Through, government provides subsidized rate for farmers to have their soils tested, but the farmers can't avail the opportunity due to many inconveniences of being a farmer; it includes collection of soil samples, submission and getting results from long distant lab (SRDI) that take away their working days. Some farmers even don't know-how of soil sample collection. So, use of recommended fertilizer dose for crop yield, synonymous to yield increase policy of the government, may not be effective if farmers avoid soil test.

⑦ Though, we provided skill training to 40% of the advanced SAP farmers assuming that they would be able to transfer knowledge to their fellow farmers, but actually it did not happen evenly in some groups because of some error in farmers' selection process. Technology transfer is not easy thing to do in a limited time frame. However, we observed some progress in AWD technology transfer and Rabi crop production (e.g., 47% farmers use less irrigation practice by AWD, 94% farmers for promotion of Rabi cultivation etc.). During field visit what SAP farmers tried to convince us saying that they didn't learn as much as the resource farmers learned from formal training. Moreover, they want to learn more on new technology of commercially viable various seasonal crops to get benefitted economically. This is an important observation for paradigm shift from semi-commercialization to commercialization in agriculture.

Conclusion/Recommendation

Following are the recommendations by the participants from district annual workshop on 10 August, 2020 and final workshop on 20 September, 2020:

The Deputy Director (DD), Department of Agricultural Extension (DAE), Jhenaidah expressed satisfaction by paying on-farm field visit to SAP project areas and had dialogue with SAP project farmers accompanied by other district and Upazilla DAE officials. In the workshop on 10 August, he confirmed that both SAP farmers and non-SAP farmers had been benefitted in many ways by the SAP Approach including less water irrigation practice, Rabi crop promotional activities, vermicomposting, soil test and other appropriate technologies and as such, he emphasized the need for promotion of this approach. The approach not only helped reducing cost of production, but also contributed by increasing crop yields as well as the extent of mitigating environmental challenges. He added saying that 'seeing is believing'; falsifiable argument/statement by anyone can easily be traced by making queries. The district DAE officials (List annexed; annexure-3) underscored the necessity of large-scale Rabi crop promotion by reducing the extent of Boro rice cultivation where necessary; short duration Aus rice in Kharif season would be another option, they opined. However, the DD-DAE emphasized on increasing farmers' knowledge about the know-how of the appropriate technologies to bring significant change such as the effect of arsenic contamination, farmer to farmers exchange of this practice for its expansion and hands-on-training to gather knowledge so as to make more profit as well as meeting environmental challenges.

Some other recommendations by Jhenaidah and Magura (Spices Research Institute) district officials are summarized below-

① This SAP Approach has to be expanded in other areas with broad perspectives in collaboration with DAE;

② Drip, sprinkler and pipe irrigation system have to be introduced and promoted with this SAP Approach; Rain water harvesting would be another option.

③ Research on less water irrigation practice has to be expanded by GO-NGO partnership, more result demonstrations have to be in place to make it sustainable;

④ Farmers who want to produce quality seeds and to make sale value by seed tagging and labeling may come under joint partnership and collaboration with BADC and District Seed Certification agency;

⑤ Chuadanga and Jhenaidah district are arsenic prone area. So, the area should get priority for this SAP Approach;

⑥ Soil test is very much needed for this approach.

In the final workshop in Dhaka on 20 September, the participants (List of the participants annexed; Annexure-3) also put forwarded the following recommendations-

⑦ Sustainable agriculture practice must follow soil test even at every year; this would benefit soil health and farmers' economies as well;

⑧ Selection of the type of land is important for Rabi crop cultivation; Upazilla level manual has also inscribed the guidelines;

⑨ The crop yield potential using AWD technology (as discussed in SAP) is an important observation; appropriate research work should look into it;

⑩ BMDA (Barind Multipurpose Development Authority) has established subsurface irrigation system in Barind area for efficient use of irrigation water. Would it also be another option in the study area? Two big challenges of AWD are- i) contractual irrigation systems and uneven land topography. Use of laser land leveler can solve the second problem, which is not extensively available in Bangladesh. Despite its various advantages of AWD (BRRI experience), the technology has some drawbacks. This study has rightly identified the problem but the solution is also not so easy; BMDA has initiated prepaid meter system, which could be promoted all over the country. It needs policy from the Government. The project may continue raising voice on it and may also think about how to promote availability of laser land leveler at a cheaper price to the farmers;

⑪ Large scale sustainable agriculture practice with buried pipe system for measuring irrigation water use efficiency and demonstration of the SAP models may help understand its effectiveness; DAE may be interested with this type of project in future;

⑫ It is good, if the project interventions also look into arsenic contamination in nearby water bodies - a concern for fishes, aquatic animals etc.

ANNEXURE

ANNEXURE 1

Crop diversification helps SAP farmer increase income earning

About the SAP farmer

Name	Md. Noor-A-Alam Mustafa
Village	Monoharpur
Union	5 No. Shimla Rokonpur
Thana	Kaligonj
District	Jhenaidah
Farmer ID	1115

Md. Noor-A-Alam Mustafa

Md. Mustafa is a small farmer having 77 decimals cultivated land. His has 5 -member family including 3 children. Because of unaware of production technology of other crops, he used to cultivate only rice in his land. He was always frustrated having no fair price of rice with high input investment. He couldn't save money after family maintenance.

He joined as a SAP member in 2017 and received training on SAP and became introduced with different sustainable technologies including change of cropping pattern, less water irrigation, less water requiring crop cultivation, etc.

Rice

Expenditure

Seed	600
Irrigation	17000
Fertilizer	10000
Insecticide	3000
Labor	10000
Total	**40,600**

Incom

Total rice produced = 61 Maunds

Price of 61 Maunds rice = (BDT @700x 61 BDT) 42,700 BDT

Net profit = (42,700-40,600) = 2,700 BDT

Lentil

Expenditure

Seed	1260
Irrigation	400
Fertilizer	1800
Insecticide	300
Labor	4500
Total	**8260**

Incom

Total Lentil production = 15 Maunds

Price of 15 Maunds Lentil = (@2,400x 15) = 36,000 BDT

Profit = (36,000-8260) 27,740 BDT

Last year, in Rabi season, he cultivated one Rabi crop (Lentil) followed by Boro rice in his 77-decimal land and had the following particulars of income-expenditure.

Now, Mr. Mustafa is able to increase his income by 10 times in a Rabi season than before. At the same time, he was able to cultivate diverse crop in his land.

He is now happy and wants to follow SAP including change of cropping pattern and less water requiring crops cultivation for more income and crop diversification.

Utilization of fallow Land helps increase cropping intensity as well as income to SAP farmer

About the SAP farmer

Bane	Ms. Farida Begum
Village	Pukuria North
Union	5 No. Shimla Rokonpur
Thana	Kaligonj
District	Jhenaidah
Farmer's ID	1081

Ms. Farida Begum

Ms. Farida Begum is a hard-core poor woman farmer. As her husband is a driver of Nosimon (a nonconventional Bangladeshi vehicle), she has to look after agriculture. She runs 5- member family including 3 school going children. She has a total of 70 decimals cultivated land of which 20 decimals remained fallow as always. She could hardly maintain her family and education expenditure for her children with low income by cultivating rice in this small piece of land.

Ms. Farida once met SAP staff and joined as a group member of SAP in 2017. She then received training on both SAP and Seed production and preservation. She was motivated by the SAP staff members too. She started using 20 decimals fallow land by cultivating turmeric, chili, brinjal and bean. Her income and expenditure in 20 decimals land in one season follow-

Expenditure

Seed	1550
Irrigation	400
Fertilizer	2000
Insecticide	700
Labor	2500
Total	**7,150**

Incom

Crops	Yield (Kg)	Rate (BDT/Kg)	Total income (BDT)
Turmeric	400	15	6000
Brinjal	80	27	2160
Chili	100	30	3000
Bean	60	55	3300

Profit = (14,460-7,150) 7,310 BDT

Now, she has reduced Boro rice cultivation land from 50 decimals to 33 decimals and increased Rabi crop cultivation land to 37 decimals from 20 decimals that remained fallow earlier. Her neighboring fellow farmers are getting interested seeing at her success especially the utilization of fallow land. This initiative has helped her income increase thereby helped family and education expenses for children even added value to society.

Vermicompost helps crop productivity & income of SAP farmer

About the SAP farmer

Md. Shajahan Mondol

Name	Md. Shajahan Mondol
Village	Chutlia Moddyapara
Union	16 No. Surat
Thana	Jhenaidah Sadar
District	Jhenaidah
Farmer's ID	105

Md. Shajahan is a medium farmer who has 506 decimals cultivated land. He runs 4- member family including 2 children. He used to cultivate crops using chemical fertilizers mostly for long time. Once, he started realizing that crop productivity had been gradually declining even with the application of increased amount of fertilizer and other inputs. He had not been getting expected returns from the land and was often frustrated.

In 2017, when SAP awareness campaign launched in the villages, he became interested and joined as a SAP member, trained on SAP, received hands-on training and Red-worms for vermicompost production. He came to know about the importance of soil test and organic matter content in soil which are essential for crop productivity. So, he started testing his 46 decimals land and found the following results-

Rice cultivation using Chemical Fertilizer

Expenditure

Seed	700
Irrigation	2200
Fertilizer	2200
Insecticide	600
Labor	8100
Total	**13,800**

Incom

Total rice produced = 25 Maunds

Price of 25 Maunds rice = (BDT@650x 25) =16,250 BDT

Net income = (16,250-13,800) = 2,450 BDT

Rice cultivation using Vermicompost and Chemical Fertilizer

Expenditure

Seed	700
Irrigation	1950
Fertilizer	1200
Insecticide	400
Labor	8100
Total	**12,350**

Incom

Total Rice production = 27 Maunds

Price of 27 Maunds Rice = (@650x 27) = 17,550 BDT

Profit = (17,550-12,350) 5,200 BDT

As he found more than double the profit by using vermicompost and chemical fertilizer together, he started realizing that this could have happened after soil testing, use of recommended doses of chemical fertilizer and vermicompost. As the amount of chemical fertilizers reduced thereby cost of production was also reduced. At the same time, due to use of vermicompost, the organic matter content of the soil increased, and as a result of that water holding capacity of the soil increased thereby cost of irrigation water was also reduced. As he earned more profit, he has now increased the production of vermicompost. He has decided to use vermicompost to his total cultivated land. This will gradually improve soil health as well as environment and good economic returns.

Less water irrigation helps increase crop productivity, income, and saves environment

About the SAP farmer

Name	Md. Ashadul Islam
Village	North Fulbari
Union	4 No. Boluhor
Thana	Kotchandpur
District	Jhenaidah
Farmer's ID	1213

Md. Ashadul Islam

Md. Ashadul Islam is a medium farmer. His family is totally dependent on income earning from agriculture. He runs 5- member family including 3 children. He was worried about cost of irrigation for rice cultivation. He joined as a SAP farmer in 2017 and trained on SAP. He started less irrigation cultivation practice (Alternate wetting and Drying method popularly known as AWD) in his 33 decimals land at first. A comparative feature of income and expenditure of Boro Rice cultivation under AWD and Non-AWD method follows

Boro Rice cultivation under Non-AWD method

Expenditure

Seed	480
Irrigation	5350
Fertilizer	3250
Insecticide	700
Labor	7200
Total	**16,980**

Incom

Total rice produced = 22 Maunds

Price of 22 Maunds rice = (BDT@880x 22) =19,360 BDT

Net income = (19,360-16,980) = 2,380 BDT

Boro Rice cultivation under AWD method

Expenditure

Seed	240
Irrigation	2480
Fertilizer	2640
Insecticide	380
Labor	6530
Total	**12,270**

Incom

Total Rice production = 26 Maunds

Price of 26 Maunds Rice = (@880x 26) = 22,880 BDT

Profit = (22,880-12,270) 10,610 BDT

AWD method encourages farmer for rice cultivation in line sowing that reduces seed rate, amount of insecticides, labor cost (due to line sowing) and fertilizer than that of non-AWD method. AWD method itself maintains an efficient water scheduling in crops as well as favors activity for both aerobic and aerobic bacteria in soil that ultimately helps crop productivity. As he earned profit 4 times more than non-AWD method, now he started using less irrigation practice to his rest of the lands. This saved environment, and income increase as well.

Seed production and preservation by SAP farmer helps quality seeds available to reach-out farmers

About the SAP farmer

Md. Robiul Islam

Name	Md. Robiul Islam
Village	Ganna
Union	6 No. Ganna
Thana	Jhenaidah Sadar
District	Jhenaidah
Farmer's ID	721

Crop	Cultivated land (dcml)	Yield (Kg)	Cost of production (BDT)	Amount of seed sold (Kg)	Income (BDT)	Profit (BDT)	Seed preserved for next sowing (Kg)	Amount of Seed exchanged (Kg)
Wheat	16	100	1940	60	4000	2060	35	5
Brinjal	2	5	1000	4.3	10000	9000	0.5	0.2
Rice	10	280	3555	160	5600	2045	70	50
Mustard	25	123	2800	18	8610	5810	80	25
Lentil	46	340	5500	280	23800	18300	48	12
Total Cultivated land	**99**							
Total production		**848**						
Total expenditure			**14,795**					
Amount of seed sold				**522.3**				
Income					**52,010**			
Profit						**37,215**		
Seed preserved for next sowing							**233.5**	
Seed exchanged with other farmers								**92.2**

Md. Robiul Islam is a solvent farmer. He has 5 family members including 3 children. He is one of the reputed farmers in his locality. At present, he cultivates vegetable, rice and Rabi crops including pulses and species in total 363 decimals land. Despite his talent and innovative capacity in crop production, he was worried about the availability of quality seeds for crop production and profitable earnings. He expressed his interest with SAP staff for joining SAP farmers' group in 2017. He was trained both in SAP and seed production and preservation training and started producing quality seeds by the demonstration plots. He is now a group leader of his SAP group. He inspires fellow farmers of his group as well as other neighboring farmers for less water irrigation practice. In addition to sale of quality seeds to local market, he used to exchange quality seeds with his group members and other reach-out farmers. As he is successful in producing quality seeds in his farm, he is able to increase more income too.

ANNEXURE 2

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

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 (%)

	OM%	
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 limit

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	0.091-0.18	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

List of resource persons (Government official/ Academician/Researcher/Scientist)

1. District annual workshop on Sustainable Agriculture Practice (SAP) held on 10 August, 2020

SL	Name	Designation	Mode of Participation
1	Mr. Saroj Kumar Debnath	Deputy Commissioner, Jhenaidah	Virtually
2	Mr. Kripangshu Shekhor Biswas	Deputy Director, DAE	Physically
3	Dr. Md. Moniruzzaman	SSO, Spices Res. Institute, Magura	Physically
4	Mr. Shankar Kumar Mojumder	District Seed Certification officer	Physically
5	Md. Jahidul Karim	Upazilla Agriculture Officer	Physically
6	Mr. Ujjal Kumar Kar	Agriculture Engineer, DAE	Physically

2. Final workshop on Sustainable Agriculture Practice (SAP) in Dhaka held on 20 September, 2020

SL	Name	Designation	Designation	Mode of Participation
1	Dr. AZM Moslehuddin	Professor	Department of Soil Science, Bangladesh Agricultural University (BAU), Mymensingh	Virtually
2	Dr. Md. Abiar Rahman	Professor	Dept. of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU)	Physically
3	Dr. Md. Nurul Islam	Professor	Dept. of Chemistry, Rajshahi University (RU)	Virtually
4	Md. Ahedul Akbor	Senior Scientific Officer	Bangladesh Council of Scientific & Industrial Research (BCSIR)	Physically
5	Md. Asadullah	Director	Field Service, Department of Agriculture Extension (DAE), Khamarbari, Dhaka	Virtually
6	Mr. Kripangshu Shekhor Biswas	Deputy Director	Office of the Deputy Director, Department of Agriculture Extension (DAE), Jhenaidah	Virtually
7	Dr. Mohammad Mujaffar Hossain	Professor	Adjunct Faculty, Interdisciplinary Institute for Food Security (IIFS), BAU, Mymensingh	Virtually
8	Dr. Mohammad Amirul Islam	Professor	Department of Agricultural and Applied Statistics, BAU, Mymensingh	Virtually
9	Dr. Harumur Rashid	Professor	Adjunct Faculty, Interdisciplinary Institute for Food Security (IIFS), BAU, Mymensingh	Virtually
10	Dr. Abdul Kader	Professor	Department of Agronomy, BAU	Written feedback on the SAP document

ANNEXURE 4

SAP - AAN Investigation on Arsenic in Irrigation Water

Survey Area: Three Upazilas in Jhenaidah District

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
1	Jhenaidha Sadar	Ganna	Khalkula	West Para	Shahidul Islam	STW	120	1997	Individual	Oil	No	460	12	3-Jan-18	0	
2	Jhenaidha Sadar	Ganna	Khalkula	West Part	Israil Hossin	STW	120	1994	individual	Oil	No	184	7	20-Jan-19	0	
3	Jhenaidha Sadar	Ganna	Khalkula	West Part	Israil Hossin	STW	135	1990	individual	Oil	No	138	3	20-Jan-19	0	
4	Jhenaidha Sadar	Ganna	Khalkula	West Part	Rabiul Islam	STW	110	2000	individual	Oil	No	130	3	20-Jan-19	0	
5	Jhenaidha Sadar	Ganna	Khalkula	West Part	Subid Ali	STW	160	2011	individual	Oil	No	299	11	20-Jan-19	0	
6	Jhenaidha Sadar	Ganna	Khalkula	West Part	Md.Shohide	STW	120	2002	individual	Oil	No	138	3	20-Jan-19	0	
7	Jhenaidha Sadar	Ganna	Khalkula	West Part	Whomion Ahamad	STW	120	2017	individual	Oil	No	69	2	20-Jan-19	0.01	
8	Jhenaidha Sadar	Ganna	Khalkula	West Part	Haruin or Rashid	STW	120	1995	individual	Oil	No	200	4	21-Jan-19	0	
9	Jhenaidha Sadar	Ganna	West Narayanpur	Santi para	Arnab (Prokas)	STW	110	2007	Individual	Oil	No	414	15	3-Jan-18	0.25	
10	Jhenaidha Sadar	Ganna	West Narayanpur	Macho Khal Math	Md. Ayub Hossain	DTW	290	2010	Cooperative	Electricity	No	5,980	110	3-Jan-18	0.1	0.076
11	Jhenaidha Sadar	Ganna	West Narayanpur	West Part	Rasidul Islam	STW	120	2016	Individual	Oil	No	460	10	3-Jan-18	0.01	
12	Jhenaidha Sadar	Ganna	West Narayanpur	Middle Para	Sultan Ali	STW	100	2006	Individual	Electricity	No	990	23	3-Jan-18	0.025	
13	Jhenaidha Sadar	Ganna	Chanderpur	West Part	Md. Faruk Hossain	STW	100	2000	Individual	Oil	No	330	10	3-Jan-18	0.025	
14	Jhenaidha Sadar	Ganna	Ganna	Paik Para	Yidris Ali	DTW	280	1990	Cooperative	Electricity	No	3,960	92	2-Jan-18	0.025	
15	Jhenaidha Sadar	Ganna	Ganna	Paik Para	Saju	STW	150	2005	Individual	Oil	No	231	5	2-Jan-18	0	
16	Jhenaidha Sadar	Ganna	Ganna	West Math	Md. Rahim	DTW	200	2016	NGO	Solar	Yes	264	52	2-Jan-18	0.025	
17	Jhenaidha Sadar	Ganna	Ganna	East Math	Mamun Hossain	STW	150	2003	Individual	Oil	No	330	3	2-Jan-18	0.25	
18	Jhenaidha Sadar	Ganna	Madhabpur	Tetul Para	Motiar Rahman	STW	120	1990	Individual	Oil	No	1,380	15	3-Jan-18	0.01	
19	Jhenaidha Sadar	Ganna	Madhabpur	Tetul Para	Mofizul Mondal	STW	120	2006	Individual	Oil	No	1,380	15	3-Jan-18	0.025	
20	Jhenaidha Sadar	Ganna	Madhabpur	West Math	Safiqul Islam	STW	120	2005	Individual	Oil	No	264	8	3-Jan-18	0.025	
21	Jhenaidha Sadar	Ganna	Madhabpur	Middle Para	Tomij Uddin	STW	140	2012	Individual	Electricity	No	230	5	3-Jan-18	0.05	0.060
22	Jhenaidha Sadar	Ganna	Madhabpur	South Side	Farid Sarkar	STW	135	2003	Individual	Oil	No	322	7	3-Jan-18	0.05	
23	Jhenaidha Sadar	Ganna	Madhabpur	West Math	Abdus Sattar	STW	120	2004	Individual	Oil	No	460	8	3-Jan-18	0.05	
24	Jhenaidha Sadar	Ganna	Madhabpur	North Side	Abdul Kadir	STW	130	2000	Individual	Oil	No	460	10	3-Jan-18	0.025	
25	Jhenaidha Sadar	Ganna	Basipara	Khalerdharer Math	Md. Ismile Hossain	DTW	280	1987	Cooperative	Electricity	No	6,600	200	2-Jan-18	0.025	0.035
		Number of surveyed ITWs in this Union: 25														
26	Jhenaidha Sadar	Kalicharanpur	Uttar Kashtasagara	Math	Subol chandra Ghosh	STW	110	2000	Individual	Electricity	No	690	11	27-Dec-17	0.025	
27	Jhenaidha Sadar	Kalicharanpur	Uttar Kashtasagara	Bele Math	Salma Begam	STW	160	2016	Individual	Oil	No	230	4	27-Dec-17	0	
28	Jhenaidha Sadar	Kalicharanpur	Uttar Kashtasagara	West	Mr.Zahid	STW	120	1997	Individual	Electricity	No	368	4	25-Dec-17	0.1	
29	Jhenaidha Sadar	Kalicharanpur	Badanpur	East	Sourav Sardar	STW	120	1997	Individual	Oil	No	920	7	6-Jan-18	0.01	
30	Jhenaidha Sadar	Kalicharanpur	Badanpur	Sardar	Moshiur Rhaman	STW	160	2017	Individual	Oil	No	460	10	6-Jan-18	0.025	
31	Jhenaidha Sadar	Kalicharanpur	Badanpur	East	Aroz Ali	STW	100	1997	Individual	Oil	No	276	1	6-Jan-18	0.01	
32	Jhenaidha Sadar	Kalicharanpur	Badanpur	East Side	Samsur Biswas	STW	120	1997	Individual	Oil	No	230	1	6-Jan-18	0.01	
33	Jhenaidha Sadar	Kalicharanpur	Badanpur	West Para	Md.Joynal Abdin	STW	110	2009	Individual	Oil	No	115	2	26-Jan-19	0.01	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
34	Jhenaidha Sadar	Kalicharanpur	Badanpur	Purbo Para	Md.Triqul Islam	STW	120	1998	Individual	Oil	No	322	4	26-Jan-19	0.01	
35	Jhenaidha Sadar	Kalicharanpur	Badanpur	Uttar Para	Jahangir	DTW	150	2000	Individual	Electricity	No	46	1	13-Jan-19	0.01	
36	Jhenaidha Sadar	Kalicharanpur	Joyrampur	Purbo Para	Abu Bakkar	STW	110	2014	Individual	Oil	No	100	1	26-Jan-19	0.01	
37	Jhenaidha Sadar	Kalicharanpur	Joyrampur	Purbo Para	Abdul Rahim	STW	110	2014	Individual	Oil	No	328	2	26-Jan-19	0.01	
38	Jhenaidha Sadar	Kalicharanpur	Joyrampur	Purbo Para	Abder	STW	90	1998	Individual	Oil	No	138	3	26-Jan-19	0.025	
39	Jhenaidha Sadar	Kalicharanpur	Joyrampur	Uttar Para	Md. Idris Ali	DTW	120	2010	Individual	Electricity	No	276	7	27-Jan-19	0	
40	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	Mistre Para	Amrit Biswas	STW	100	2005	Cooperative	Electricity	No	368	4	6-Jan-18	0.05	
41	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	Mistri Para	Suvashis Mukhopaddhay	STW	140	1987	Individual	Electricity	No	69	1	6-Jan-18	0	
42	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	Biswash Para	Rony Biswas	STW	150	2002	Individual	Electricity	No	276	2	6-Jan-18	0.01	
43	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	West Side	Tohid Biswas	STW	150	1997	Individual	Electricity	No	460	9	6-Jan-18	0.25	0.199
44	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	Bazzar	Md.Anowar Kabir	STW	160	1980	Individual	oil	No	276	2	9-Jan-19	0	
45	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	Purbo Para	Md.Shadat	DTW	120	2013	Individual	Electricity	No	276	3	25-Jan-19	0.01	
46	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	Purbo Para	Selim Hossin	STW	90	1994	Individual	oil	No	138	5	8-Jan-19	0	
47	Jhenaidha Sadar	Kalicharanpur	Kalicharanpur	West Para	Sree. Omrito Biswash	STW	100	2000	Individual	oil	No	92	4	9-Jan-19	0.01	
		Number of surveyed ITWs in this Union: 22														
48	Jhenaidha Sadar	Kumrabaria	Nagar Bathan	Gosh Para	Alim Shekh	DTW	300	1987	Cooperative	Electricity	No	3,680	200	5-Jan-18	0.05	0.063
49	Jhenaidha Sadar	Kumrabaria	Nagar Bathan	Gosh Para	Osman Mondol	DTW	240	2004	Individual	Electricity	No	1,150	15	5-Jan-18	0.25	0.154
50	Jhenaidha Sadar	Kumrabaria	Nagar para	Gosh Para	Mintu Mia	STW	250	2003	Individual	Electricity	No	1,610	25	5-Jan-18	0.25	0.160
51	Jhenaidha Sadar	Kumrabaria	Nagar Bathan	West	Badsha Mulobi	STW	110	1995	Individual	Oil	No	322	7	5-Jan-18	0.01	
52	Jhenaidha Sadar	Kumrabaria	Nagar Bathan	West	Md. Abdur Rohim	STW	110	1990	Individual	Oil	No	920	7	5-Jan-18	0	
53	Jhenaidha Sadar	Kumrabaria	Nagar para	Sardar	Ashraful Sardar	STW	140	2013	Individual	Oil	No	690	10	5-Jan-18	0.01	
		Number of surveyed ITWs in this Union: 6														
54	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda		Jamal Uddin	STW	100	2010	Individual	Electricity	No	920	9	4-Jan-18	0	
55	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	Barir Paser Math	Md. Rashedul Islam	STW	95	2001	Individual	Electricity	No	368	6	4-Jan-18	0	
56	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	Chara Math	Partu Mia	STW	170	2000	Individual	Electricity	No	1,150	10	4-Jan-18	0	
57	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	Darir Par	Salam	STW	90	1997	Individual	Electricity	No	920	20	4-Jan-18	0.025	
58	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Md. Rashidul Islam	STW	90	2009	individual	Electricity	No	644	1	14-Jan-19	0	
59	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Md. Halim	DTW	95	1985	individual	Electricity	No	552	4	26-Jan-19	0.025	
60	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	Purbo Para	Abdul Rashid	DTW	120	1990	individual	Electricity	No	1,380	20	27-Jan-19	0.01	
61	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Minto	DTW	100	1997	individual	Electricity	No	552	15	25-Jan-19	0	
62	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Golam Mostofa	DTW	90	2003	individual	Electricity	No	270	15	25-Jan-19	0	
63	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Md.Jamal	DTW	90	1995	individual	Electricity	No	230	1	12-Jan-19	0	
64	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Shahjan	DTW	90	2000	individual	Electricity	No	276	2	25-Jan-19	0.01	
65	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Mizinur Rahman	DTW	90	1998	individual	Electricity	No	230	2	26-Jan-19	0.01	
66	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Md.Atiur	DTW	90	2000	individual	Electricity	No	276	3	14-Jan-19	0.01	
67	Jhenaidha Sadar	Paurashava	Chhota Kamarkunda	South Para	Latif	STW	110	2000	individual	oil	No	138	2	14-Jan-19	0.025	
68	Jhenaidha Sadar	Paurashava	Power house	Islam Para	Rasal	DTW	120	2007	individual	Electricity	No	276	2	28-Jan-19	0	
69	Jhenaidha Sadar	Paurashava	Kalikapur	Math Para	Oajid	DTW	120	1995	individual	Electricity	No	1,610	23	28-Jan-19	0	
70	Jhenaidha Sadar	Paurashava	Kalikapur	Math Para	Ayeb Ali	DTW	90	2010	individual	Electricity	No	460	4	27-Jan-19	0.01	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Well	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
71	Jhenaidha Sadar	Paurashava	Kalikapur	Math Para	Mokades Ali	DTW	90	2012	individual	Electricity	No	1,610	20	27-Jan-19	0.025	
72	Jhenaidha Sadar	Paurashava	Islampur	Islam Para	Aslamuddin	STW	110	1996	individual	Electricity	No	690	12	26-Jan-19	0	
73	Jhenaidha Sadar	Paurashava	Islampur	Islam Para	Broin Gosh	STW	150	2007	individual	oil	No	230	2	27-Jan-19	0	
74	Jhenaidha Sadar	Paurashava	Butiargati	Biswash	Md. Mito	DTW	160	2003	individual	Electricity	No	782	12	26-Jan-19	0.01	
75	Jhenaidha Sadar	Paurashava	Shakir pur	Jodder Para	Hafijur Rahman	STW	90	2009	Cooperative	Electricity	No	552	13	13-Jan-19	0	
76	Jhenaidha Sadar	Paurashava	Shakir pur	Middle Para	Nabche Mondol	DTW	90	1997	individual	Electricity	No	460	7	10-Jan-19	0	
77	Jhenaidha Sadar	Paurashava	Shakir pur	Hajam Para	Md.Akbar Ali	STW	130	2009	individual	Electricity	No	552	22	23-Jan-19	0	
		Number of surveyed ITWs in this Union: 24														
78	Jhenaidha Sadar	Porahati	Bhupatipur	Math Para	Md. Abu Kalam	STW	160	2000	Individual	Electricity	No	460	10	27-Dec-17	0.05	
79	Jhenaidha Sadar	Porahati	Rupdaha	Poler Math	Md. Ezabul (Pump-2)	DTW	220	2016	NGO	Solar	Yes	1,840	20	26-Dec-17	0.05	0.042
80	Jhenaidha Sadar	Porahati	Rupdaha	Poler Math	Md. Ezabul (Pump-3)	DTW	220	2016	NGO	Solar	Yes	1,840	20	26-Dec-17	0.1	0.065
81	Jhenaidha Sadar	Porahati	Rupdaha	South	Motaleb Hossain	DTW	220	2016	NGO	Solar	Yes	920	18	26-Dec-17	0.25	
82	Jhenaidha Sadar	Porahati	Rupdaha	Uttor Math	Md. Rasel	DTW	220	2016	NGO	Solar	Yes	920	16	26-Dec-17	0.05	0.043
83	Jhenaidha Sadar	Porahati	Chapri	Darir Math	Md. Rafiqul Islam	DTW	200	2015	NGO	Solar	Yes	1,840	16	25-Dec-17	0.025	
84	Jhenaidha Sadar	Porahati	Chapri	Mandol Para	Nowsher Ali	DTW	200	2016	Cooperative	Solar	Yes	1,840	40	26-Dec-17	0	0.023
85	Jhenaidha Sadar	Porahati	Chapri	Mondol Para	Rasel	STW	120	2015	individual	Electricity	Yes	460	10	16-Jan-19	0.01	
86	Jhenaidha Sadar	Porahati	Chapri	Mondol Para	Afjal	STW	140	2017	individual	Electricity	Yes	920	20	19-Jan-19	0.01	
87	Jhenaidha Sadar	Porahati	Chapri	Mondol Para	Rafiqul Islam	STW	2oo	2015	Cooperative	Electricity	Yes	1,380	30	23-Jan-19	0.01	
88	Jhenaidha Sadar	Porahati	Chapri	Mondol Para	Moyna	DTW	120	2009	individual	Electricity	No	460	10	20-Jan-19	0.01	
89	Jhenaidha Sadar	Porahati	Chapri	Mondol Para	Nosher Mondol	STW	200	2015	Cooperative	Solar	Yes	1,840	40	20-Jan-19	0.01	
90	Jhenaidha Sadar	Porahati	Chuadanga	South	Mosaoraf Hossain	STW	120	2017	Individual	Electricity	No	690	5	27-Dec-17	0.025	
91	Jhenaidha Sadar	Porahati	Chuadanga	South	Razaul Islam	STW	110	2012	Individual	Oil	No	138	1	27-Dec-17	0.01	
92	Jhenaidha Sadar	Porahati	Chuadanga	South Para	Md.Yearul Islam	STW	110	1995	Individual	Electricity	No	920	6	27-Dec-17	0.025	
93	Jhenaidha Sadar	Porahati	Kestosagra	Shah Para	Nur Alom	STW	90	2016	Individual	Oil	No	92	2	27-Dec-17	0.05	
94	Jhenaidha Sadar	Porahati	Bijoypur	East Side	Md. Roich Uddin	STW	120	1996	Individual	Electricity	No	230	4	26-Dec-17	0.1	
95	Jhenaidha Sadar	Porahati	Bijoypur	East	Md. Roich Uddin	DTW	200	2015	NGO	Solar	Yes	1,610	35	26-Dec-17	0.025	
96	Jhenaidha Sadar	Porahati	Bijoypur	South Para	Sabder Hossin	DTW	140	2009	individual	Electricity	No	368	6	20-Jan-19	0.01	
97	Jhenaidha Sadar	Porahati	Bijoypur	South Para	Sodor Ali	STW	120	2010	individual	Electricity	Yes	690	25	21-Jan-19	0.01	
98	Jhenaidha Sadar	Porahati	Bijoypur	South Para	Hobibor	STW	140	2017	individual	Electricity	Yes	920	20	20-Jan-19	0.01	
99	Jhenaidha Sadar	Porahati	Bijoypur	South Para	Roshid	STW	120	2006	individual	oil	No	368	6	20-Jan-19	0.01	
100	Jhenaidha Sadar	Porahati	Bijoypur	Purbo Para	Raishuddin	STW	200	2015	Cooperative	Solar	Yes	1,380	30	16-Jan-19	0.01	
101	Jhenaidha Sadar	Porahati	Bijoypur	West Para	Naib Ali Mondol	STW	150	2015	individual	Electricity	Yes	920	20	20-Jan-19	0.01	
102	Jhenaidha Sadar	Porahati	Bijoypur	Fotik Khali	Sojoruddin Molla	STW	135	2002	Individual	Oil	No	276	5	26-Dec-17	0.1	
103	Jhenaidha Sadar	Porahati	Madhupur	Purbo Para	Billal Mollah	DTW	120	2009	individual	Electricity	No	460	8	20-Jan-19	0	
104	Jhenaidha Sadar	Porahati	Madhupur	Purbo Para	Nasir	DTW	120	2009	individual	Electricity	No	264	5	20-Jan-19	0.01	
105	Jhenaidha Sadar	Porahati	Madhupur	Purbo Para	Hassan	DTW	150	2015	individual	Electricity	Yes	460	10	15-Jan-19	0.01	
106	Jhenaidha Sadar	Porahati	Madhupur	Purbo Para	Abdul Aziz Mollah	DTW	150	2015	individual	Electricity	Yes	690	15	20-Jan-19	0.01	
107	Jhenaidha Sadar	Porahati	Madhupur	West Para	Sultan	DTW	120	2006	individual	Electricity	No	272	5	21-Jan-19	0.01	
108	Jhenaidha Sadar	Porahati	Madhupur	East	Md. Kabir Molla	STW	130	2008	Individual	Electricity	No	1,150	20	26-Dec-17	0.1	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
109	Jhenaidha Sadar	Porahati	Madhupur	East	Md. Abdul Halim	STW	160	2002	Individual	Electricity	No	1,150	20	26-Dec-17	0.25	0.103
110	Jhenaidha Sadar	Porahati	Madhupur	Jarpara	Md. Alom Shek	DTW	310	2002	Individual	Electricity	No	828	5	26-Dec-17	0.025	
111	Jhenaidha Sadar	Porahati	Madhupur	Purbo Para	Abdul Gaffur Molla	STW	120	2016	Individual	Electricity	No	552	10	26-Dec-17	0.05	
112	Jhenaidha Sadar	Porahati	Madhupur	West Para	Sojed Ali	DTW	120	2009	individual	Electricity	No	368	5	15-Jan-19	0.01	
113	Jhenaidha Sadar	Porahati	Aruakandi	South Side	Md. Fazlur Rahaman	STW	120	2007	Individual	Electricity	No	276	6	27-Dec-17	0.01	
114	Jhenaidha Sadar	Porahati	Aruakandi	South Side	Md. Abul Kalam	STW	120	2007	Individual	Electricity	No	322	4	27-Dec-17	0.025	
115	Jhenaidha Sadar	Porahati	Aruakandi	South Side	Md. Milon Uddin	STW	90	2000	Individual	Electricity	No	506	10	27-Dec-17	0.01	
116	Jhenaidha Sadar	Porahati	Aruakandi	Mucs Para	Shofi Uddin	STW	100	2006	Individual	Electricity	No	920	10	27-Dec-17	0.1	
117	Jhenaidha Sadar	Porahati	Porahati	Middle Para	Yusif Ali	DTW	120	1999	individual	Electricity	Yes	230	5	25-Jan-19	0.01	
118	Jhenaidha Sadar	Porahati	Porahati	Purbo Math	Noor Mohomad	STW	150	2004	Individual	Electricity	No	460	5	25-Dec-17	0.05	
119	Jhenaidha Sadar	Porahati	Porahati	North	Md. Shafiuddin	STW	120	2016	Individual	Electricity	No	720	10	25-Dec-17	0.01	
120	Jhenaidha Sadar	Porahati	Porahati	East Math	Md. Amirul Islam	STW	120	2006	Individual	Electricity	No	138	2	25-Dec-17	0.25	0.154
121	Jhenaidha Sadar	Porahati	Porahati	East	Salaiman Hossain	STW	120	2008	Individual	Electricity	No	460	10	25-Dec-17	0.25	0.098
122	Jhenaidha Sadar	Porahati	Porahati	Nathani Para	Md. Aslam Uddin	STW	120	2012	Individual	Electricity	No	322	5	25-Dec-17	0.01	
123	Jhenaidha Sadar	Porahati	Porahati	East	Md. Yusup Ali	STW	160	2011	Individual	Electricity	No	920	12	25-Dec-17	0.1	
124	Jhenaidha Sadar	Porahati	Porahati	South	Md. Abu Talab	STW	95	2010	Individual	Electricity	No	184	6	25-Dec-17	0.01	
125	Jhenaidha Sadar	Porahati	Porahati	Purbo Para	Nurul Islam	DTW	140	2000	individual	Electricity	Yes	460	10	26-Jan-19	0.01	
126	Jhenaidha Sadar	Porahati	Porahati	Mondol Para	Nasir	DTW	120	2009	individual	Electricity	No	414	8	26-Jan-19	0.01	
127	Jhenaidha Sadar	Porahati	Porahati	Mondol Para	Soliman	DTW	120	2009	individual	Electricity	No	414	5	20-Jan-19	0	
		Number of surveyed ITWs in this Union: 50														
128	Jhenaidha Sadar	Surat	Chutlia	North Side	Abdul Lotif	DTW	350	2013	Cooperative	Electricity	Yes	3,680	50	4-Jan-18	0.01	
129	Jhenaidha Sadar	Surat	Chutlia	West Para	Monjurul Islam	STW	100	2011	Individual	Oil	No	138	4	5-Jan-18	0.025	
130	Jhenaidha Sadar	Surat	Chutlia	South Side	Md. Shahin	STW	90	1995	Individual	Oil	No	460	1	5-Jan-18	0.05	
131	Jhenaidha Sadar	Surat	Chutlia	South Side	Abdus Samad	STW	150	1990	Individual	Oil	No	276	1	5-Jan-18	0	
132	Jhenaidha Sadar	Surat	Chutlia	Uttar Para	Md.Shahajan Mondol	DTW	90	2010	Individual	Electricity	Yes	598	10	10-Jan-19	0.01	
133	Jhenaidha Sadar	Surat	Chutlia Mor	East	Md. Khairul Islam	STW	90	2005	Individual	Electricity	No	460	20	5-Jan-18	0.01	
134	Jhenaidha Sadar	Surat	Chutlia	North	Khalil	STW	90	2014	Individual	Oil	No	92	1	5-Jan-18	0.05	
135	Jhenaidha Sadar	Surat	Chutlia	Middle Para	Md. Motir	STW	95	1996	Individual	oil	No	104	3	26-Jan-19	0.01	
136	Jhenaidha Sadar	Surat	Chutlia	West Para	Md.Anowar Kazi	DTW	90	2011	Individual	Electricity	No	35	2	10-Jan-19	0.01	
137	Jhenaidha Sadar	Surat	Chutlia	Middle Para	Sowkot	STW	90	1990	Individual	Oil	No	92	2	4-Jan-18	0.025	
138	Jhenaidha Sadar	Surat	Laudia	West Side	Mintu Mia	STW	80	2013	Individual	Electricity	No	460	15	4-Jan-18	0	
139	Jhenaidha Sadar	Surat	Laudia	North Side	Abdul Mannan	STW	90	2015	Individual	Oil	No	230	6	4-Jan-18	0.025	
140	Jhenaidha Sadar	Surat	Laudia	North Side	Abdullah	STW	90	2005	Individual	Electricity	No	598	13	4-Jan-18	0	
		Number of surveyed ITWs in this Union: 13														
141	Kaliganj	Roygram	Bhatghara		Md. Saheb Ali	STW	90	1990	Individual	oil	No	396	1	22-Dec-17	0.01	
142	Kaliganj	Roygram	Bhatghara	East-Math	Md. Murad Ali	STW	90	1984	Individual	oil	No	132	1	22-Dec-17	0	
143	Kaliganj	Roygram	Bhatghara	Middle	Md. Rof Uddin	STW	100	2002	Individual	oil	No	99	1	22-Dec-17	0	
144	Kaliganj	Raypur	Bhatghara	Purbo Math	Montaj	STW	150	2012	individual	oil	No	132	5	17-Jan-19	0	
145	Kaliganj	Raypur	Bhatghara	Purbo Math	Md.osman Goni	STW	110	2003	individual	oil	No	132	1	7-Jan-19	0	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
146	Kaliganj	Raypur	Bhatghara	Honnikuror Math	Md. Koysir	STW	100	2012	individual	oil	No	165	1	7-Jan-19	0	
147	Kaliganj	Raypur	Bhatghara	Purbo Math	Md.Eakbal	STW	110	1998	individual	oil	No	165	1	7-Jan-19	0	
148	Kaliganj	Raypur	Bhatghara	South Math	Md. Idris Ali	STW	100	2015	individual	oil	No	165	1	21-Jan-19	0.01	
149	Kaliganj	Raypur	Bhatghara	South Math	Md. Aroj Dhoni	STW	100	1998	individual	oil	No	330	1	21-Jan-19	0	
150	Kaliganj	Raypur	Bhatghara	South Math	Farque Hossin	STW	150	1998	individual	Oil	No	330	1	21-Jan-19	0	
151	Kaliganj	Raypur	Bhatghara	Purbo	Khairul	STW	160	2010	individual	oil	No	330	4	17-Jan-19	0	
152	Kaliganj	Roygram	Ektarpur	Rishipara	Md. Saiful Islam	STW	140	2007	Individual	oil	No	165	1	22-Dec-17	0.025	
153	Kaliganj	Roygram	Ektarpur	North	Shahajahan	STW	100	1997	Individual	oil	No	330	5	22-Dec-17	0.025	
154	Kaliganj	Roygram	Ektarpur	North	Md. Yusuf Ali	DTW	200	1995	Individual	oil	No	528	4	22-Dec-17	0	
155	Kaliganj	Raypur	Ektarpur	West para	Md. Milon Mondol	STW	100	2001	individual	oil	No	82	3	7-Jan-19	0	
		Number of surveyed ITWs in this Union: 15														
156	Kaliganj	Simla Rokonpur	Monoharpur	Bill Math	Morad Ali	STW	130	1998	individual	oil	No	231	4	25-Jan-19	0	
157	Kaliganj	Simla Rokonpur	Monoharpur	Bill Math	Md. Ariful Islam	STW	90	1998	individual	oil	No	231	3	17-Jan-19	0.01	
158	Kaliganj	Simla Rokonpur	Monoharpur	Balkuri Math	Sagor	STW	180	2014	individual	oil	No	330	10	23-Jan-19	0	
159	Kaliganj	Simla Rokonpur	Monoharpur	Chokir Math	Asriful Islam	STW	90	1998	individual	oil	No	231	3	17-Jan-19	0.01	
160	Kaliganj	Simla Rokonpur	Monoharpur	Purbo Math	Md.Sharjed	STW	200	1998	individual	oil	No	231	5	17-Jan-19	0	
161	Kaliganj	Simla Rokonpur	Monoharpur	Purbo Math	Saliman	STW	120	1998	individual	oil	No	264	3	14-Jan-19	0.01	
162	Kaliganj	Simla Rokonpur	Monoharpur	Purbo Math	Sonto Miya	STW	150	1998	individual	oil	No	132	3	14-Jan-19	0	
163	Kaliganj	Simla Rokonpur	Monoharpur	Solavara	Akram Hossain	STW	300	2018	individual	oil	No	231	10	23-Jan-19	0	
164	Kaliganj	Simla Rokonpur	Monoharpur	Choto Dhai	Motaleb	STW	150	2004	individual	Oil	No	330	3	23-Jan-19	0.01	
165	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Dollar	STW	180	2011	individual	oil	No	396	10	23-Jan-19	0	
166	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Md.Nazrul Islam	STW	120	1995	individual	oil	No	99	4	24-Jan-19	0.025	
167	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Md.Akterujaman	STW	130	2007	individual	oil	No	231	4	17-Jan-19	0	
168	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Monirul Mollah	STW	150	1990	individual	oil	No	396	6	17-Jan-19	0.025	
169	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Md.Milon	STW	180	1998	individual	oil	No	132	5	23-Jan-19	0	
170	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Ripon Malita	STW	130	1995	individual	oil	No	231	2	17-Jan-19	0.01	
171	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Shidul	STW	150	2004	individual	oil	No	330	5	14-Jan-19	0	
172	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Shokur Ali	STW	150	1985	individual	oil	No	231	5	17-Jan-19	0.01	
173	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Ghusur Rahman	STW	140	2015	individual	oil	No	231	10	14-Jan-19	0.01	
174	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Golom Quddis	STW	120	2018	individual	oil	No	264	3	17-Jan-19	0	
175	Kaliganj	Simla Rokonpur	Monoharpur	West Para	Paplu	STW	150	2004	individual	Oil	No	165	2	23-Jan-19	0	
176	Kaliganj	Simla Rokonpur	Monoharpur	West Para	Rabiul Islam	STW	150	1992	individual	oil	No	264	2	17-Jan-19	0	
177	Kaliganj	Simla Rokonpur	Monoharpur	West Para	Mojifor	STW	140	1990	individual	oil	No	264	6	22-Jan-19	0	
178	Kaliganj	Simla Rokonpur	Monoharpur	West Para	Mosiar Rahman	STW	150	2012	individual	oil	No	330	5	17-Jan-19	0.025	
179	Kaliganj	Simla Rokonpur	Manoharpur		Md. Kuddus	STW	160	1997	Individual	oil	No	660	8	21-Dec-17	0.025	
180	Kaliganj	Simla Rokonpur	Manoharpur		Rabiul Islam	STW	180	1993	Individual	oil	No	726	12	21-Dec-17	0.025	
181	Kaliganj	Simla Rokonpur	Monoharpur	South Math	Ohidul	STW	150	2000	individual	oil	No	396	10	17-Jan-19	0	
182	Kaliganj	Simla Rokonpur	Manoharpur	East	Md. Rokibul Hasan	STW	150	2004	Individual	oil	No	495	10	21-Dec-17	0.05	0.047
183	Kaliganj	Simla Rokonpur	Manoharpur	South	Md. Shahabudduin	STW	140	2002	Individual	oil	No	363	6	22-Dec-17	0.01	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
184	Kaliganj	Simla Rokonpur	Manoharpur	West	Md. Nasim Reza	STW	130	1995	Individual	oil	No	198	6	22-Dec-17	0.05	0.066
185	Kaliganj	Simla Rokonpur	Pukuria uttar	West Para	Allauddin	STW	120	2004	individual	oil	No	330	3	9-Jan-19	0	
186	Kaliganj	Simla Rokonpur	Pukuria uttar	South Math	Lalto Chowdary	STW	120	2004	individual	oil	No	660	25	24-Jan-19	0	
187	Kaliganj	Simla Rokonpur	Pukuria uttar	Uttar Para	Din Mohamad	DTW	150	2004	individual	Electricity	No	264	5	6-Jan-19	0.01	
188	Kaliganj	Simla Rokonpur	Pukuria	West Para	Abul Kasim	STW	130	1995	individual	oil	No	165	5	13-Jan-19	0.01	
189	Kaliganj	Simla Rokonpur	Pukuria	West Para	Abul Kasim	STW	120	2009	individual	oil	No	132	5	24-Jan-19	0	
190	Kaliganj	Simla Rokonpur	Pukuria	South Para	Kamrujaman	STW	150	2009	individual	oil	No	396	5	24-Jan-19	0	
191	Kaliganj	Simla Rokonpur	Pukuria	South Para	Shoyed Ali	STW	150	2000	individual	oil	No	330	6	19-Jan-19	0	
192	Kaliganj	Simla Rokonpur	Pukuria	Tillair Math	Alom	STW	150	2012	individual	oil	No	396	10	24-Jan-19	0	
193	Kaliganj	Simla Rokonpur	Pukuria	South Math	Amirul	STW	150	2009	individual	oil	No	264	5	9-Jan-19	0	
194	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Md. Razzak	DTW	120	2006	individual	Electricity	No	330	10	6-Jan-19	0.01	
195	Kaliganj	Simla Rokonpur	Pukuria	Pubro	Md.Amjed Ali	DTW	140	2006	individual	Electricity	No	660	25	6-Jan-19	0.01	
196	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Md.Asgir Ali	DTW	150	2008	individual	Electricity	No	990	30	6-Jan-19	0.01	
197	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Jabed Ali	STW	150	2000	individual	oil	No	396	6	22-Jan-19	0	
198	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Sampado	STW	150	1980	individual	oil	No	165	1	24-Jan-19	0	
199	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Rima Akter	STW	150	2002	individual	oil	No	165	5	24-Jan-19	0	
200	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Golam Rosul	STW	130	1980	individual	oil	No	264	3	24-Jan-19	0	
201	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Monirul Islam	STW	150	2004	individual	oil	No	165	2	24-Jan-19	0	
202	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Md. Yaqube Ali	STW	150	2002	individual	oil	No	990	20	6-Jan-19	0	
203	Kaliganj	Simla Rokonpur	Pukuria	Uttar Para	Rebika	STW	120	2015	individual	oil	No	231	10	24-Jan-19	0	
204	Kaliganj	Simla Rokonpur	Pukuria	School Side	Md. Abjal Hossain	DTW	300	1987	Individual	Electricity	No	6,600	150	22-Dec-17	0.025	0.028
205	Kaliganj	Simla Rokonpur	Pukuria	South	Montu Sharma	STW	140	2011	Individual	Electricity	No	462	20	23-Dec-17	0.01	
206	Kaliganj	Simla Rokonpur	Pukuria	South	Aakub Ali	STW	140	2008	Individual	Electricity	No	660	25	23-Dec-17	0.01	
207	Kaliganj	Simla Rokonpur	Pukuria	West	Md. Mostafizur Rahman	STW	120	2000	Individual	Electricity	No	495	15	23-Dec-17	0	
208	Kaliganj	Simla Rokonpur	Pukuria	West	Atiyer Rahman	STW	120	2003	Individual	Electricity	No	595	10	23-Dec-17	0	
209	Kaliganj	Simla Rokonpur	Pukuria	West	Md. Mahbub Biswas	STW	150	2003	Individual	Electricity	No	165	3	23-Dec-17	0	
210	Kaliganj	Simla Rokonpur	Pukuria	West	Md. Mohidul Biswas	STW	110	2003	Individual	Electricity	No	330	10	23-Dec-17	0	
211	Kaliganj	Simla Rokonpur	Pukuria	West-Math	Md. Shahajan Ali	STW	150	2001	Individual	Electricity	No	990	30	23-Dec-17	0	
212	Kaliganj	Simla Rokonpur	Pukuria	Bill Math	Mohon Hossain	STW	120	2001	Individual	oil	No	660	10	22-Dec-17	0	
213	Kaliganj	Simla Rokonpur	Pukuria		Md. Alimul Islam	STW	170	2017	Individual	Electricity	No	660	10	22-Dec-17	0.01	
214	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Md.Jabbar	STW	150	2011	individual	oil	No	231	9	13-Jan-19	0.01	
215	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Mosiar Rahman	STW	140	1996	individual	oil	No	375	10	8-Jan-19	0.01	
216	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Shidul Islam	STW	140	2007	individual	oil	No	231	4	12-Jan-19	0	
217	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Akram Hossain	STW	130	2016	individual	oil	No	330	10	12-Jan-19	0	
218	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Abdul Aziz	STW	150	2010	individual	oil	No	165	5	13-Jan-19	0.01	
219	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Shokjan	STW	120	2018	individual	oil	No	165	5	24-Jan-19	0.01	
220	Kaliganj	Simla Rokonpur	Choto Pukuria	South Math	Tajar Ali	STW	150	2006	individual	oil	No	165	3	24-Jan-19	0	
221	Kaliganj	Simla Rokonpur	Choto Pukuria	Bari Math	Khokan	STW	150	1980	individual	oil	No	165	5	24-Jan-19	0	
222	Kaliganj	Simla Rokonpur	Choto Pukuria	Purbo Math	Reazul Islam	STW	160	2004	individual	oil	No	208	5	23-Jan-19	0	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
223	Kaliganj	Simla Rokonpur	Tilla	Uttar Para	Sharif Islam	STW	200	2004	individual	Solar	No	660	10	10-Jan-19	0	
224	Kaliganj	Simla Rokonpur	Tilla	Islam Para	Bazlur rahman	STW	200	2015	individual	Electricity	No	330	10	24-Jan-19	0	
225	Kaliganj	Simla Rokonpur	Tilla	Uttar Para	Ismail Hossin	STW	200	2015	individual	Electricity	No	330	10	22-Jan-19	0	
226	Kaliganj	Simla Rokonpur	Tilla	Purbo Math	Mannan	DTW	200	2015	individual	Solar	No	264	4	24-Jan-19	0	
227	Kaliganj	Simla Rokonpur	Tilla	Purbo Math	Rakibul	STW	150	2010	individual	Electricity	No	465	12	14-Jan-19	0	
228	Kaliganj	Simla Rokonpur	Tilla	South Para	Rakibul	STW	120	2004	individual	oil	No	465	10	10-Jan-19	0	
229	Kaliganj	Simla Rokonpur	Tilla	West Para	Sharaj Sarder	STW	120	2004	individual	oil	No	330	10	9-Jan-19	0	
230	Kaliganj	Simla Rokonpur	Tilla	South Para	Selim	STW	120	2004	individual	oil	No	264	10	9-Jan-19	0.01	
231	Kaliganj	Simla Rokonpur	Tilla	South Para	Chancal	STW	120	2012	individual	oil	No	264	5	9-Jan-19	0.01	
232	Kaliganj	Simla Rokonpur	Tilla	Middle Para	Ramjan Ali	STW	120	2000	individual	oil	No	330	7	6-Jan-19	0.01	
233	Kaliganj	Simla Rokonpur	Tilla	South Para	Shogh	STW	120	2015	individual	oil	No	375	10	9-Jan-19	0.01	
234	Kaliganj	Simla Rokonpur	Tilla	West Para	Aynul Hoque	STW	120	2008	individual	oil	No	264	5	9-Jan-19	0.025	
235	Kaliganj	Simla Rokonpur	Tilla	West Para	Shidul	STW	120	2004	individual	oil	No	165	10	10-Jan-19	0	
236	Kaliganj	Simla Rokonpur	Tilla	South Para	Abdul Motin	STW	150	1980	individual	oil	No	330	10	24-Jan-19	0	
237	Kaliganj	Simla Rokonpur	Tilla	West Para	Mohidul	STW	120	2009	individual	oil	No	165	2	10-Jan-19	0	
238	Kaliganj	Simla Rokonpur	Tilla	Purbo Para	Abu Tahir	STW	200	2004	individual	oil	No	330	10	10-Jan-19	0	
239	Kaliganj	Simla Rokonpur	Tilla	South Math	Ali Ahamad	STW	120	205	individual	oil	No	495	10	9-Jan-19	0	
240	Kaliganj	Simla Rokonpur	Tilla	South Math	Soliman	STW	150	2006	individual	oil	No	330	4	24-Jan-19	0	
241	Kaliganj	Simla Rokonpur	Tilla	South Math	Alitaf	STW	150	2000	individual	oil	No	264	6	24-Jan-19	0	
242	Kaliganj	Simla Rokonpur	Tilla	purbo mart	Santi	STW	150	2004	individual	Oil	No	231	4	18-Jan-19	0	
243	Kaliganj	Simla Rokonpur	Tilla	East	Abdur Razzak	STW	120	2008	Individual	Electricity	No	495	8	22-Dec-17	0.01	
244	Kaliganj	Simla Rokonpur	Tilla	East	Sherazul Islam	DTW	250	1982	Cooperative	Electricity	No	6,600	100	22-Dec-17	0.025	
245	Kaliganj	Simla Rokonpur	Tilla	Middle	Md. Haider Ali	STW	210	2015	Individual	oil	No	759	7	22-Dec-17	0	
246	Kaliganj	Simla Rokonpur	Tilla	North	Nikil Shikdar	STW	110	2000	Individual	oil	No	132	3	22-Dec-17	0	
247	Kaliganj	Simla Rokonpur	Tilla	West	Md. Asgor Ali	STW	120		Individual	oil	No	165	3	22-Dec-17	0	
		Number of surveyed ITWs in this Union: 92														
248	Kaliganj	Sundarpur Durgapur	Kandirkol	Bazaar	Md. Abdul-Al-Mamun	DTW	240	2017	Cooperative	Electricity	No	6,600	100	21-Dec-17	0.025	
249	Kaliganj	Sundarpur Durgapur	Kandirkol	North	Md. Shajahan Alam	DTW	250	2007	Individual	Electricity	No	11,500	200	22-Dec-17	0	0.025
250	Kaliganj	Sundarpur Durgapur	Kandirkol	Soliar Math	Md.Liton	STW	180	1996	individual	oil	No	150	1	13-Jan-19	0	
251	Kaliganj	Sundarpur Durgapur	Kandirkol	Soliar Math	Shidul Islam	STW	180	2003	individual	oil	No	69	1	13-Jan-19	0	
252	Kaliganj	Sundarpur Durgapur	Durgapur	Middle	Md. Bokdar Ali	STW	200	1994	Individual	oil	No	230	5	21-Dec-17	0.01	
253	Kaliganj	Sundarpur Durgapur	Durgapur	Utttar Bilpar	Momin Mondol	STW	180	1998	individual	oil	No	200	1	13-Jan-19	0	
254	Kaliganj	Sundarpur Durgapur	Durgapur	Mosque Para	Moshiur Rahman	DTW	310	2014	BADC	Electricity	Yes	6,900	70	6-Jan-18	0	0.003
255	Kaliganj	Sundarpur Durgapur	Dumurtala	North	Mizanur Rahman	STW	190	2004	Individual	oil	No	690	6	21-Dec-17	0	
256	Kaliganj	Sundarpur Durgapur	Dumurtala	North	Akkas Ali	STW	180	1992	Individual	oil	No	161	1	21-Dec-17	0	
257	Kaliganj	Sundarpur Durgapur	Dumurtala	North	Mohammad Ali	DTW	220	1975	Individual	oil	No	184	1	22-Dec-17	0	
258	Kaliganj	Sundarpur Durgapur	Bathgura	Purbo Math	Md. Khokon	STW	110	1998	individual	oil	No	132	1	7-Jan-19	0	
		Number of surveyed ITWs in this Union: 11														
259	Kotchandpur	Baluhar	Moritiya	West Para	Amidul	STW	100	2009	individual	oil	No	132	1	13-Jan-19	0	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
260	Kotchandpur	Baluhar	Moritiya	West Para	Rojob Ali	STW	100	2005	individual	oil	No	264	4	12-Jan-19	0.01	
261	Kotchandpur	Baluhar	Moritiya	West Para	Anowar	STW	100	2000	individual	oil	No	165	3	13-Jan-19	0	
262	Kotchandpur	Baluhar	Moritiya	West Para	Foyzar	STW	100	1985	individual	oil	No	330	7	12-Jan-19	0	
263	Kotchandpur	Baluhar	South Fulbari	East para	Asidul	STW	100	1985	individual	oil	No	99	2	7-Jan-19	0.025	
264	Kotchandpur	Baluhar	South Fulbari	West Para	Monto	DTW	220	1990	BADC	Electricity	No	2,620	130	19-Jan-19	0.025	
265	Kotchandpur	Baluhar	South Fulbari	West Para	Monto	STW	200	2018	individual	oil	No	429	7	7-Jan-19	0.01	
266	Kotchandpur	Baluhar	South Fulbari	Parlar Math	Ismail Hossin	STW	100	2010	individual	oil	No	307	8	6-Jan-19	0.01	
267	Kotchandpur	Baluhar	South Fulbari	East Para	Asidul	STW	100	1990	individual	oil	No	495	15	7-Jan-19	0.025	
268	Kotchandpur	Baluhar	South Fulbari	East Para	Ismail Hossin	STW	120	2000	individual	oil	No	330	8	7-Jan-19	0.025	
269	Kotchandpur	Baluhar	South Fulbari	East Para	Shofiuddin	STW	100	1990	individual	oil	No	276	10	7-Jan-19	0.025	
270	Kotchandpur	Baluhar	Utter Fulbari	East Para	Motiar Rahman	STW	120	2000	individual	Electricity	No	690	12	7-Jan-19	0.01	
271	Kotchandpur	Baluhar	Utter Fulbari	East Para	Golam Mostofa	STW	220	2000	individual	Electricity	No	825	25	13-Jan-19	0.01	
272	Kotchandpur	Baluhar	Utter Fulbari	East Para	Uzzal	STW	120	2010	individual	oil	No	460	5	7-Jan-19	0.01	
273	Kotchandpur	Baluhar	Baluhar	East Para	Eabidat hossin	STW	120	2000	individual	oil	No	891	20	12-Jan-19	0	
274	Kotchandpur	Baluhar	Baluhar	West Para	Abdulla	STW	100	2010	individual	oil	No	66	1	7-Jan-19	0.01	
275	Kotchandpur	Baluhar	Baluhar	Mondol	Motiyer Rahman	STW	210	1987	Individual	Electricity	No	1,650	30	23-Dec-17	0.01	
276	Kotchandpur	Baluhar	Baluhar	Mondol	Tophon	STW	200	2013	Individual	Electricity	No	330	10	23-Dec-17	0	
277	Kotchandpur	Baluhar	Baluhar	Uttar Fulbari	Kalom Biswsah	STW	220	2000	individual	Electricity	No	495	10	19-Jan-19	0.01	
278	Kotchandpur	Baluhar	Baluhar	Uttar Fulbari	Shoquir Ali	STW	120	1995	individual	oil	No	330	7	7-Jan-19	0.01	
279	Kotchandpur	Baluhar	Fulbari	East	Md. Faruk Hossain	DTW	260	2015	Cooperative	Electricity	Yes	6,600	200	24-Dec-17	0	0.003
280	Kotchandpur	Baluhar	Fulbari	East Math	Md. Aabdur Razak	STW	110	1995	Individual	Electricity	No	330	10	24-Dec-17	0.05	0.056
281	Kotchandpur	Baluhar	Fulbari	South Side	Md. Omar Ali	STW	200	1990	Individual	Oil	No	500	35	24-Dec-17	0	
282	Kotchandpur	Baluhar	Fullbari	North	Md. Shafiuddin	STW	100	2007	Individual	Oil	No	165	7	24-Dec-17	0.1	
283	Kotchandpur	Baluhar	Badidorpur	Purbo South Math	Abul	STW	100	2012	individual	oil	No	264	8	19-Jan-19	0.01	
284	Kotchandpur	Baluhar	Badidorpur	Bill Math	Asiruddin	STW	100	2002	individual	oil	No	396	10	19-Jan-19	0.01	
285	Kotchandpur	Baluhar	Badidorpur	Gair Math	Midul	STW	100	2005	individual	oil	No	165	4	19-Jan-19	0	
286	Kotchandpur	Baluhar	Badidorpur	Gair Math	Triqul	STW	100	2014	individual	oil	No	132	5	19-Jan-19	0	
287	Kotchandpur	Baluhar	Badidorpur	Uttar Math	Monto	STW	100	2015	individual	Electricity	No	660	25	20-Jan-19	0	
288	Kotchandpur	Baluhar	Badidorpur	Uttar Math	Mokul	STW	100	2000	individual	oil	No	231	8	20-Jan-19	0	
289	Kotchandpur	Baluhar	Badidorpur	Bill Math	Altaf	DTW	200	2015	NGO	oil	Yes	2,640	60	20-Jan-19	0	
290	Kotchandpur	Baluhar	Badidorpur	Bill Math	Chandu bBswash	STW	100	2000	individual	oil	No	330	7	20-Jan-19	0.01	
291	Kotchandpur	Baluhar	Hardanga Bidyadharpur	East	Md. Aynal Haque	STW	200	2005	Individual	Electricity	No	1,650	50	23-Dec-17	0.025	0.014
292	Kotchandpur	Baluhar	Hardanga Bidyadharpur	East	Bozlur Rahman	STW	90	2011	Individual	oil	No	66	1	23-Dec-17	0.025	
		Number of surveyed ITWs in this Union: 34														
293	Kotchandpur	Elangi	Balarampur	West	Md. Bapparaz	STW	100	1993	Individual	Oil	No	660	10	24-Dec-17	0	
294	Kotchandpur	Elangi	Balarampur	Kuskuri	Rojob Ali	STW	110	2000	individual	oil	No	330	6	21-Jan-19	0	
295	Kotchandpur	Elangi	Balarampur	Middle-Chock	Md. Shahidul Islam	DTW	200	2016	NGO	Solar	Yes	990	30	26-Dec-17	0.025	
296	Kotchandpur	Elangi	Balarampur	Purbo Math	Abul Hossain	STW	120	1993	individual	oil	No	264	5	24-Jan-19	0.01	
297	Kotchandpur	Elangi	Balarampur	Purbo Math	Raihan	STW	120	1990	individual	oil	No	330	15	24-Jan-19	0	

Sl. No	General Information					Information on Irrigation Well								Arsenic Concentration		
	Upazila	Union	Village	Para	Name of Well Owner	Type of Irrigation Welll	Well Depth (ft)	Year of Installation	Installed by	Operated by	Submercible Pump Attached?	Coverage of Supply Area (Decimal)	How Many Farmers Use This Well Water	Sampling Date	Arsenic Concentration by FK (mg/L)	Arsenic Concentration by AAS (mg/L)
298	Kotchandpur	Elangi	Balarampur	School Math	Rojob Ali	STW	119	1998	individual	oil	No	330	8	24-Jan-19	0	
299	Kotchandpur	Elangi	Balarampur	South Para	Md.Shofi	STW	120	1990	individual	oil	No	330	12	21-Jan-19	0	
300	Kotchandpur	Elangi	Balarampur	Uttar Para	Abdul Rahman	STW	180	2018	individual	Electricity	No	660	15	21-Jan-19	0	
301	Kotchandpur	Elangi	Balarampur	West	Md. Mojammel Haque	STW	90	2008	Individual	Oil	No	297	1	24-Dec-17	0	
302	Kotchandpur	Elangi	Balarampur	Purbo Math	Hafijur Rahman	STW	100	2000	individual	oil	No	264	10	24-Jan-19	0	
		Number of surveyed ITWs in this Union: 10														
303	Kotchandpur	Kushna	Sherkhali	Math	Md. Kamrul Islam	STW	100	1997	Individual	oil	No	920	20	23-Dec-17	0.1	
304	Kotchandpur	Kushna	Sherkhali	Gair Math	Homion	STW	85	2017	individual	oil	No	274	6	8-Jan-19	0.025	
305	Kotchandpur	Kushna	Sherkhali	Gair Math	Shidul	STW	85	2010	individual	Electricity	No	330	10	8-Jan-19	0.01	
306	Kotchandpur	Kushna	Sherkhali		Shamim Reza	STW	85	2005	Cooperative	Electricity	No	495	20	23-Dec-17	0.1	0.169
307	Kotchandpur	Kushna	Mohanpur	West	Md. Nobis Uddin	STW	100	2002	Individual	Electricity	No	495	8	23-Dec-17	0.1	
308	Kotchandpur	Kushna	Mohanpur	Gair Math	Uzzal	STW	100	2005	individual	oil	No	274	5	6-Jan-19	0.025	
309	Kotchandpur	Kushna	Mohanpur	Jamtalor Math	Shobdul Hossain	STW	85	2017	individual	oil	No	330	5	8-Jan-19	0.05	
310	Kotchandpur	Kushna	Mohanpur		Robiul Islam	STW	95	2000	Individual	oil	No	495	15	23-Dec-17	0.1 +	0.253
311	Kotchandpur	Kushna	Mohanpur	Battalor	Fijur	STW	120	1992	individual	oil	No	660	20	16-Jan-19	0.05	
312	Kotchandpur	Kushna	Mohanpur	Center Math	Mosharif	STW	80	1998	individual	oil	No	660	10	9-Jan-19	0.01	
313	Kotchandpur	Kushna	Mohanpur	Jamtalor Math	Md. Ahamad Ali	STW	100	2015	individual	oil	No	330	8	9-Jan-19	0.01	
314	Kotchandpur	Kushna	Mohanpur	Jamtalor Math	Md. Reazul Islam	STW	100	2015	individual	oil	No	132	3	16-Jan-19	0.025	
		Number of surveyed ITWs in this Union: 12														
315	Kotchandpur	Paurashava	Bajibamon dha	Battalor	Sharafat Hossain	STW	120	2005	individual	Electricity	No	660	25	6-Jan-19	0.01	
316	Kotchandpur	Paurashava	Bara Bamanda Para	East Math	Mijanur Rahaman	DTW	210	1988	Cooperative	Electricity	No	8,250	100	24-Dec-17	0.025	0.019
317	Kotchandpur	Paurashava	Bara Bamanda Para	Machigan Math	Md. Rofiqual Islam	DTW	220	2007	Individual	Electricity	No	594	18	24-Dec-17	0.01	
318	Kotchandpur	Paurashava	Barobamon dha	Bill Math	Abdur Biswash	STW	120	2010	individual	Electricity	No	274	10	24-Jan-19	0	
319	Kotchandpur	Paurashava	Barobamon dha	Narin Bill	Samsul	STW	120	2004	individual	Electricity	No	1,650	35	7-Jan-19	0.01	
320	Kotchandpur	Paurashava	Barobamon dha	East Math	Mukul	STW	200	1990	individual	Electricity	No	1,980	60	9-Jun-19	0.01	
321	Kotchandpur	Paurashava	Barobamon dha	Jamtalor Math	Rabiual	STW	120	1990	individual	oil	No	495	10	6-Jan-19	0.01	
322	Kotchandpur	Paurashava	Bajibamon dha	Battalor	Gopal	STW	120	2014	individual	Electricity	No	495	10	7-Jan-19	0	
323	Kotchandpur	Paurashava	Barobamon dha	Moci Gari Math	Robiual Islam	STW	70	1995	individual	oil	No	165	3	6-Jan-19	0.01	
324	Kotchandpur	Paurashava	Barobamon dha	Ballah Bari Math	Mazed	STW	100	2015	individual	oil	No	396	10	6-Jan-19	0.01	
325	Kotchandpur	Paurashava	Barobamon dha	Ballah Bari Math	Asidul	STW	220	1995	individual	oil	No	2,600	200	6-Jan-19	0	
326	Kotchandpur	Paurashava	Motlad	Kanapukir	Motlab	STW	120	2013	individual	oil	No	396	5	24-Jan-19	0	
327	Kotchandpur	Paurashava	Ruddropur	Barobmon Math	Altaf	STW	120	1995	individual	oil	No	660	15	25-Jan-19	0.01	
328	Kotchandpur	Paurashava	Ruddropur	Gair Math	Imdidul	STW	110	2000	individual	oil	No	330	4	21-Jan-19	0.01	
		Number of surveyed ITWs in this Union: 14														

Appendix

1) **Standard of Irrigation water for As-contamination:** There is no standard for irrigation water in a world except Japan as far as we know. The standard in Japan is 0.05mg/L that is equal to the Bangladesh drinking water standard. So, we will here use the standard of 0.05mg/L for irrigation water.

2) **Standard of farm land soil for As-contamination:** There is no international standard for arsenic contamination in farmland soil. But there are national standards in some countries in a world. Japanese standard is 15mg/kg and the recommended reference value of EPA is 20mg/kg. Many countries such as Australia, Netherlands, Spain and Denmark have adopted the EPA value. Additionally, 10mg/kg, 19mg/kg and 43mg/kg are used in Sweden, France and England, respectively. The difference of standard may be caused from the variety of crop in the countries. So, we will here use provisionally the value of 20mg/kg.

3) **Standard of vegetable for As-contamination:** There is no international standard of vegetable for the allowable limit of As-intake through vegetable. So, we have provisionally set two kinds of standard of 0.1mg/kg and 0.5mg/kg as follows:

   (a) **Dietary intake of Rabi vegetable:** It is assumed that the intake of Rabi vegetable is 200g/day /person by investigating the diet of Bangladesh people.

   (b) **Allowable limit of Rabi vegetable No.1 (denoted as Y mg/kg):** We assume that a) the dietary intake of arsenic through Rabi vegetable is equal to that through drinking water of As=0.01mg/L (WHO standard) and b) the dietary intake of groundwater is 2L/day/person in Bangladesh people. In the case, as the As-intake through Rabi vegetable and drinking water become 200Y/1000=0.2 Y(mg) and 0.01x2=0.02(mg), respectively, the allowable limit becomes Y=0.1(mg/kg). This value is suitable for vegetable produced in Japan without As-contamination in farm land.

   (c) **Allowable limit No.2 (denoted as Z mg/kg):** When we apply the As-contaminated water of 0.05mg/L to the above 2), the allowable limit becomes Z=0.5(mg/kg).

4) **Standard of seed for As-contamination:** It may be naturally considered that we have no standard of seeds in a world for As-safety after their growth to crops. So, we tentatively set here the standard of 0.5mg/kg.

5) **Arsenic concentration in fertilizers:** We may also naturally consider no standard of fertilizer in a world for As-safety of crops growing through the fertilizer. Here, we will check only the influence of arsenic in fertilizer on surrounding farm land, for example, by leaching the arsenic into soil. Therefore, it is checked whether the maximum content of arsenic in fertilizer is beyond the Standard of farm land of 20mg/kg or not.

Web Documents

1. https://www.youtube.com/watch?v=0r-7uJT46-o
2. https://www.youtube.com/watch?reload=9&v=SpRI2Fu2RWs&feature=share&fbclid=IwAR3tppLIb4wrJFlNxOcJTTY84hXTCkNgoqMdP3PXx2yTnINjeZ92uTxWpbo
3. https://www.youtube.com/watch?v=ekV53OwkVyw&feature=share

Prepared by
Asia Arsenic Network (AAN), Japan
Share the Planet Association, Japan
AID Foundation, Bangladesh

Financed by
Ministry of Foreign Affairs, Japan