

POLDER TIDINGS

International Rice Research Institute

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**Enhancing livelihoods in the polders:
LOCAL YOUTH GET HANDS-ON WITH
LEADING-EDGE RESEARCH**



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Regional capacity building: INVESTING IN THE PRESENT AND THE FUTURE

Sudhir Yadav, Manoranjan Mondal, and S.V. Krishna Jagadish

The Coastal Zone of Bangladesh is the most vulnerable area of the eastern Ganges basin. The livelihoods of the people depend primarily on agriculture. The challenges to increase agricultural productivity include excessive flooding during the rainy season, Climatic hazards throughout the year, salinity in the dry season, and poor market development. Also, half of the children under the age of five are unable to develop to their full physical and mental potentials due to undernutrition due to an unbalanced diet. To feed its growing population, Bangladesh must double its food production by 2050. Although the cropping intensity in the rest of the country is already very high, there are no easy ways to meet the extra demand for food except to invest in the underused Coastal Zone. In recognition of these opportunities, investment in the development of the Coastal Zone is now a government priority. This includes significant investment in research for development (R4D) through its national agricultural research and extension systems. In addition, international development agencies and research centers are investing considerably in R4D in the Coastal Zone.

However, most of these initiatives operate in a rigid compartmentalization where education, research, and extension are considered to be three different wings. Most early-career individuals get an education in one area (education, research, or extension) and they fail to address the complex challenges such as those in Coastal Zone. These initiatives and programs by government and international agencies hold an important and diverse information base of disciplinary expertise, experience, networks, indigenous knowledge, etc. If there was a mechanism in place for an integrated approach to distribute this information, it could yield tremendous

benefits leading to more rapid learning and progress in improving productivity, livelihoods, and nutrition in Coastal Zone communities.

Adaptive research is a concept that looks beyond the bubble. It allows opportunities for researchers with a multiple-discipline background to converge and address a complex challenge in situ to increase the

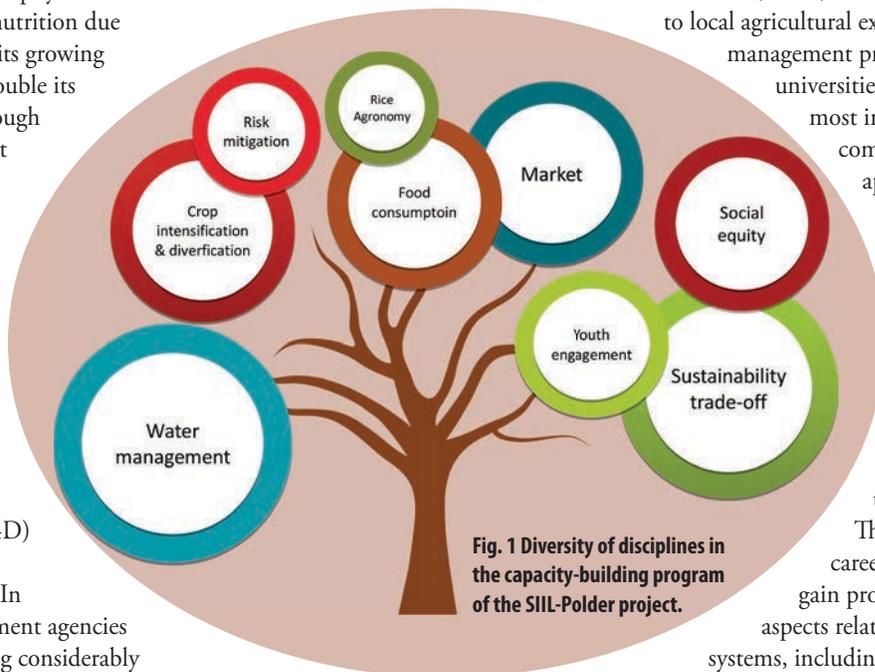


Fig. 1 Diversity of disciplines in the capacity-building program of the SIIL-Polder project.

probability of improving the situation on the ground. One example of such a dynamic and extremely complex scenario is in improving the socioeconomic conditions and the livelihoods of the farming communities in the coastal regions, specifically the polder communities.

To address these challenges, the International Rice Research Institute (IRRI) and Kansas State University (KSU) are working with the regional universities in an initiative under Feed the Future's Sustainable Intensification Innovation Lab to improve the production potential of the polders. Employing an

adaptive research approach, the program has involved 14 students (five PhD and nine MS) from five regional universities covering different disciplines (see fig. 1) including agronomy, water management, social sciences, economics, climate-crop modeling, gender, and human and livestock nutrition, needed to respond to the challenging objectives set by geographic boundaries and environmental scenarios. The platform will bring in experts from IRRI, KSU, and BRAC in addition to local agricultural extension and water management professionals, local universities in Bangladesh, and, most importantly, the farming community. This unique approach will allow the next generation of scientists to conduct off-station research by working directly with farmers in their fields to learn firsthand about the problems and prospects of the Coastal Zone.

This will help early-career individuals to gain proficiency in different aspects related to production systems, including socioeconomic, engineering, business, and policy approaches. They will develop their thought processes on the need to collaborate with researchers with different skills to innovate faster, solve problems collaboratively, and in the process share their own learning. They will be involved in evaluating the most practical issues identified jointly by the researchers and the communities. The overall goal is to gradually develop the local capacity and the skills for pragmatic, sustainable interventions for improving their socioeconomic and nutritional status in the region.

This special issue of *Polder Tidings* highlights the research areas and interesting findings of some scholars engaged with this program.

IMPROVING COMMUNITY WATER MANAGEMENT IN THE POLDERS

Understanding organizational structure, behavior, and sustainability of water management organizations in the polders of the Coastal Zone of Bangladesh

Deb Kumar Nath, Ph.D. scholar
 Bangladesh Agricultural University
 University supervisor-Dr. M. A. Mojid

The hydrology of the Coastal Zone is quite different from other parts of Bangladesh. It is governed by the lunar tidal phenomenon and manmade sluice gates or regulators of the polder ecosystem, which was constructed by the government to increase productivity on 1.2 million ha in the Coastal Zone. The Coastal Zone is blessed with huge water and fertile land resources; both resources are underutilized despite many opportunities for increasing their contribution to the country's national food and nutritional security. The main reason for low productivity in the polders is poor water management

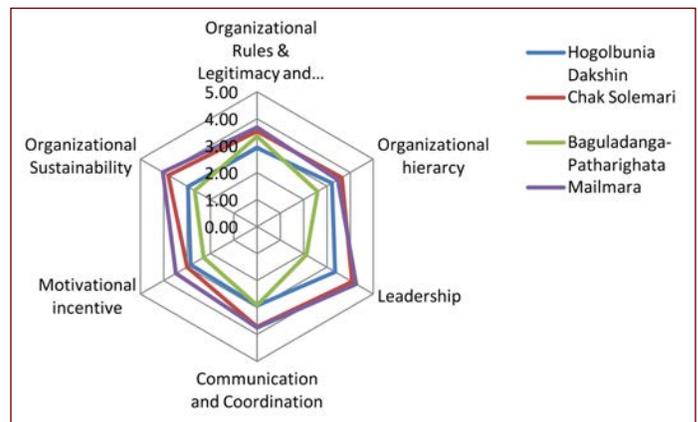


Fig2. Comparison of organizational behavior of WMGs.



Key Informant Interview of the President, WMA (middle) of Polder 30 by Deb Kumar Nath (right).

managed over a large area by operating the regulators of a polder. An individual cannot manage these water infrastructures to maintain a favorable water environment for cropping intensification and diversification. Therefore, the government started forming and empowering the Water Management Organization (WMO) to handover operation and maintenance of water infrastructure to the community to increase land and water productivity. The present study, *Water Governance Assessment to Improve the Production Potential in Polder 30 of Coastal Bangladesh*, is being conducted to understand water governance in Polder 30 in terms of organization structure and behavior and their variability within space and time; identify different biophysical and socioeconomic factors, which affect water governance within a sluice shed; investigate gender integration dynamics for sluice gate operation; delineate sluice shed area of each regulator/sluice gate; and examine correlation of water governance within the production system.

In the water management groups (WMGs), the number of members varied depending on the households of the village. But 30% being women participants is mandatory in both the WMGs and the water management associations (WMAs). There are two committees, general and executive, in each WMG. The general committee contains all members including executive committee members. The executive committee is formed with 12 members from the general committee. Four representatives from each WMG constitute the general committee of the WMA. In addition, two representatives from each WMG are selected to represent the sluice catchment subcommittee (SCSC) mainly responsible for sluice gate operation for irrigation and drainage.

There are 40 WMGs and one WMA in Polder 30. Among them, four WMGs were randomly selected to document the organizational behavior of the WMGs. It was observed that two WMGs, Chak Solemari and Mailmara, hold regular meetings with its members and possess higher transparency, especially in financial matters and strong conflict management ability (see fig. 2). Their performance was satisfactory due to good and transparent leadership, while the performance of the other two WMGs (North Hogolbungia and Bagludanga-Partighata) were very poor mainly due to mismanagement of group-savings. Although group-savings collection was emphasized for organizational sustainability, savings was found to be the breaking point of the organization such as for the Bagludanga-Patharighata WMG due to poor transparency, accountability, and mismanagement of the savings. But Chak Solemari and Mailmara WMGs are performing well in maintaining transparency in accounting. They are hopeful of continued sustainability as they have registered groups, a strong executive committee, by-laws, and overall a significant amount of group savings, which will reinforce holding the group together. Therefore, it is necessary to give more emphasis to maintaining effective organizational behavior besides the organizational structure for sustainability of the WMGs. But the performance of the WMGs was not satisfactory with water management through sluice gate operation for which they were organized. All WMGs followed traditional water management, which was not appropriate for adoption of improved production systems within the catchment area of the regulator. Capacity building of the WMGs on water management may lead to improved productivity that might act as the cementing element for sustainable water management organizations in the polders. ■

Waterlogging in the polders: looking at gravity-led and energy-fed drainage as options for food security of the polder communities

Bishwajit Baidya, MS scholar
Khulna University, Bangladesh
 University supervisor-Dr. Mohammed Ziaul Haider

Excessive water depth during the monsoon is a major constraint for the cultivation of high-yielding varieties (HYVs) of rice in the Coastal Zone. Recent studies have shown that, given the ability to drain excess water, HYVs can be successfully grown during the rainy season with yields ranging between 4 and 5 t/ha. The outfall rivers of the drainage regulators are silted up in many polders. As a result, gravitational drainage is becoming slow or sometimes impossible. In addition, due to siltation in the internal canal networks, water cannot be easily transported to the regulators of the polder ecosystem, which further exacerbates the waterlogging problem. The water is trapped on



Bishwajit Baidya is taking elevation of a study site in Polder 30.

the agricultural land and, for that most of the polders, remains waterlogged during the monsoon. Hence, HYV rice cannot be cultivated in the wet season. If excess water was drained-out as required for HYV rice, especially during topdressing of nitrogen fertilizer either by pumping or by gravitational drainage, it could be possible for farmers to grow HYV rice in the polders to improve productivity and food security.

Moreover, due to sea level rise and siltation of the river bed (the decreasing cross-sectional area of the river), the water level in the rivers during high tide has been rising more in recent

years. By contrast, the land level remains more or less constant because of poldering. As a consequence, gravitational drainage will continue to be hampered due to reduced lowering of the river water level during low tide. Since adequate drainage is the key for cropping intensification and adoption of improved production systems in the polders, energy-fed drainage (pumping out water from agricultural lands to drainage canal networks connected to the regulators to create favorable water environment for HYV rice cultivation) may be an option. This study will focus on understanding the feasibility, benefits, and trade-offs with gravitation and an energy-fed drainage system. ■

IMPROVING RICE AGRONOMY



Sujat Ahmed (right) explaining the benefits of early planting of rice to a farmer.

Early planting of HYV rice in the polder ecosystem: benefits and challenges

Sujat Ahmed, MS scholar

*Sher-e-Bangla Agricultural University, Bangladesh
University supervisor-Dr. Md. Abdullahil Baque*

The rainy season (aman) rice is the dominant crop grown in the Coastal Zone. The productivity of aman rice is particularly low in most of these coastal areas because of excessive flooding and less adoption of HYVs. Due to stagnant flooding, most farmers in the Coastal Zone grow a single rice crop during the

aman using tall, photoperiod-sensitive, local landraces, which can survive under stagnant flooding, but have a low yield (from 2.0 to 3.5 t/ha) and mature late (growth duration: from 155 to 170 days). The aman crop is often followed by late-sown, low-input, and low-yielding sesame and mungbean (from 0.5

to 1.0 t/ha) but with high probability of severe damage or crop failure due to the premonsoon rains and cyclones in May. Thus, much of the Coastal Zone remains fallow. One of the potential solutions to these problems could be appropriate timing of crop establishment that is better suited to the polders' unique environmental conditions. This study aimed to intensify polder farming systems through implementation of sustainable rice cultivation practices in the polder ecosystem.

A field experiment was carried out in Polder 30 of Batiaghata Upazila in Khulna from July 2017 to January 2018 to investigate the effect of different transplanting dates on yield attributes and yield of rice in the aman season. The experiment consisted of two levels of treatment, i.e., variety and transplanting date. The experiment was laid out in a randomized complete block design with five replications. The two varieties, BRRI dhan52 (high-yielding variety) and Kumragor (local variety), were transplanted on seven consecutive dates at 10-day intervals

from 1 July to 30 August. The study revealed that both the variety and transplanting date had a significant influence on most of the agronomic parameters.

The results showed that both varieties gave their best result on the same transplanting date, 10 August. The highest grain yield (4.04 t/ha) with the lowest straw yield (2.98 t/ha) was obtained from BRRI dhan52 while Kumragor gave the highest grain yield (3.06 t/ha) with the lowest straw yield (4.0 t/ha). Both early and late transplanting had a negative effect on grain growth and development due to the decrease in 1,000-grain weight, number of filled grains/panicle, and increase in the percent of unfilled grains/panicle. This study indicates that advancing the planting time by from 10 to 15 days compared to the traditional practice could improve productivity under current water management practices. However, planting time might be advanced in July with better community water management and synchronization of planting time. ■

Does the fertilizer requirement for HYV rice vary across the polder ecosystem?

Shakhawat Hossain, MS scholar

Sher-e-Bangla Agricultural University, Bangladesh University supervisor-Dr. A. K. M. Ruhul Amin

The tidal environment in the polders of the Coastal Zone not only brings challenges of water management and timely planting but also raises the question on what is the optimum fertilizer dose to improve productivity in the region. Fertilizer management is an important factor in the polder ecosystem that influences adoption of HYV rice, its growth and development, and its yield during the wet season. Generally, farmers in the polders cultivate low-yielding traditional rice varieties and usually do not apply much fertilizer, occasionally applying a small quantity of nitrogen. Although some farmers, who cultivate HYV rice, do apply recommended doses of fertilizer, most apply only NPK fertilizer with about 50% of the recommended fertilizer rate and harvest less than the achievable yield. But in other parts of the country, most of the farmers use recommended doses of fertilizer for HYV rice cultivation. Therefore, there is an urgent need to develop appropriate fertilizer management techniques for HYV rice cultivation under the tidal ecosystem that prevails in the polders to feed the growing population.

Towards that goal, a study was conducted in Polder 30 to understand fertilizer management in HYV rice cultivation in the wet season under the tidal environment. The results showed



Measurement of yield attributes of paddy by Shakhawat Hossain.

that HYV rice produced the highest grain yield when farmers used fertilizer and management practices recommended by the Bangladesh Rice Research Institute (BRRI). But it was interesting to note that a statistically similar yield was produced when 50% of the recommended P, K, S, and Zn and 100% of the recommended N were applied in the polders. Perhaps, the tidal water contains enough P, K, S, and Zn through the sediment that is sufficient for HYV rice. If this is true, then there is scope for reducing the production cost of HYV rice and, at the same time, reducing the environmental footprint by using only 50% of the recommended fertilizer rates for HYV rice cultivation in the polders. Further study is needed to confirm these initial findings. ■

FOREGOING FALLOW

Can maize be a potential crop in the dry season in the medium-saline polders?

Tapati Roy, MS scholar

Bangladesh Agricultural University

University supervisor-Dr. Md. Abdul Kader

Most arable land in the polders of the Coastal Zone remains fallow in the dry season due to poor water management, soil salinity, and unavailability of fresh water. Some farmers cultivate sesame/ mungbean after wet season rice from mid-February to early March, but the crops are often damaged and sometimes completely destroyed due to excessive rainfall in March and April and/or cyclonic events in May. With the given agro-environmental conditions, there are opportunities to intensify the production system with crops that can be planted early in December or January, such as maize, to utilize the residual moisture and minimize climate risks at the end of the dry season.



Tapati Roy is observing the performance of maize.

With that hypothesis, a study was conducted in farmers' fields in Polder 30 with different maize varieties established from mid-December through mid-February at 10-day intervals. The results of the study showed that maize crops established during mid-December to mid-January on moist soil with zero tillage/ dibbling performed better than those established after mid-January. The early-established maize crop was harvested from the later part of April to the first half of May before the onset of the cyclonic season. This approach can be considered to be a climate-resilient cropping adjustment for the dry season.

The highest grain yield was obtained from the hybrid variety, Don 111, grown under rainfed conditions by utilizing the soil moisture stored in the profile after the monsoon. This variety produced 7.9, 8.1, and 6.7 t/ha sown on 20 December, 30 December, and 9 January, respectively. The yield of other tested maize varieties (BARI Hybrid Maize 7, Pacific 139, and Pacific 984) sown before mid-January varied from 5.6 to 6.9 t/ha. Reduction in yield was observed with the delay in sowing, which was more pronounced with planting after the first week of January. The late-established maize plants did not obtain good root anchorage because the soil was too hard for the roots to penetrate. Yield losses with late-sown plants were primarily due to lodging and also possibly due to lower nutrient uptake from the soil. The soil was fully saturated during the early sowing dates (mid-December to mid-January), which

would have enabled the plants to uptake nutrients better than the later-sown plants. Fertilizer management is, therefore, a critical factor for higher productivity of the dry season crops in the medium saline Coastal Zone. Topdressing of nitrogen fertilizer was especially challenging for the later-sown crops due to very dry topsoil.

Despite many challenges, it was possible to harvest from 6 to 8 t/ha of maize under the rainfed environment and effective utilization of residual soil moisture. Adoption of such a climate-resilient cropping system provides benefits to the farmers in two ways: (1) no irrigation cost as the plants attain normal growth and development by utilizing residual soil moisture from the profile and (2) little or no risk of crop damage by cyclonic events that usually occur in late May. Although heavy soil cracks developed when maize plants were established by dibbling or zero tillage on nonplowed land, this did not impede the growth and development of early-established maize, but had a significant negative impact on the growth and development of the later-established crop. Therefore, there is a potential to improve dry-season productivity in the polders by early crop establishment and intelligent management of the residual soil moisture in the medium saline Coastal Zone. ■



Nibir Saha (left) observing the yield attributes of paddy.

INTENSIFY AND DIVERSIFY THE PRODUCTION SYSTEMS IN THE POLDERS

Is triple rice a feasible option in the low-saline Coastal Zone?

Nibir Saha, Ph.D. scholar

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University supervisor-Dr. Harun-Or-Rashid*

The south central region of Bangladesh is enriched by large rivers where the water remains nonsaline all year. Interestingly, a dense network of small rivers, called canals, is seen across the landscape and embankments, called polders, protect the land from tidal flooding during the rainy season. Furthermore, the rivers surrounding the polders are tidal and the dense networks of small canals inside the polders create the opportunity to distribute fresh river water across the landscape in the dry season. The same network provides the opportunity to drain excess water by gravity during low tide during the rainy season. This is done by the strategic opening of the sluice gates connecting the canals to the rivers. Good drainage management provides the entry point for the production of modern, high-yielding aman rice varieties, while irrigation provides the entry point for the production of boro crops

and early establishment of aus crops. We hypothesized that, with good water management and modern high-yielding rice varieties, it is possible to grow three rice crops and produce from 16 to 20 t/ha of grain per year, in the low-salinity Coastal Zone.

A cropping system field study conducted at Patuakhali Science and Technology University located in the low-saline Coastal Zone demonstrated the feasibility of producing three high-yielding rice crops within a 12-month period with adequate turnaround time between crops. Over the 2 years, aus-aman-boro system yields from 13 to 17 t/ha/yr were achieved, which was 2 to 3 times higher than the present production of the farmers. All the tested aman and aus varieties were able to withstand submergence for periods of up to 10 days and

gave high yields (aman ~6 t/ha; aus ~4 t/ha). This was true for varieties both with and without submergence tolerance (*SUB1* gene). System yields in the first year (13 to 16 t/ha) were generally lower than in the second year (15 to 17 t/ha). This was mainly due to lower boro yield (by 1 to 2 t/ha), which was associated with brown spot infestation under the unusually low temperatures in December 2012 and January 2013. The highest yields (as much as 17.2 t/ha/yr) were obtained in the system with a 25 April sowing of the aus crop, followed by the HYV aman crop, and sowing of the boro crop before 15 December. These planting dates in a three-rice-crop system provided the

best turnaround time between all crops (from 16 to 28 days) and highest profitability. However, all combinations of the aus-aman-boro plantings used in this study were profitable in terms of gross returns (USD 558-1,413/ha), net return (USD 234-1,008/ha), and benefit cost ratio (1.08-1.38). The results demonstrate the opportunity to adopt triple rice in a 12-month cycle to significantly increase rice production and improve livelihoods by investing in improved water management and the adoption of modern HYVs and production methods in the polders of the south central Coastal Zone. ■

Feasibility of highly productive and profitable aus-aman-rabi systems in low-salinity areas of the Coastal Zone

Jayanta Bhattacharya, Ph.D. scholar

Patuakhali Science and Technology University, Bangladesh University supervisor-Dr. Harun-Or-Rashid

There is a general perception that water in the Coastal Zone is saline and agricultural intensification is not possible there due to high soil and water salinity. In reality, the south central Coastal Zone is supplied by large volumes of fresh river water throughout the year. We hypothesized that, with good water management, it is possible to grow three crops in a 12-month cycle and produce from 16 to 20 t/ha/yr, in the low-salinity Coastal Zone. With this hypothesis, a study was conducted at Patuakhali Science and Technology University to evaluate, under good water management, the feasibility of intensifying high-yielding aus-aman-rabi cropping systems in the Coastal Zone.

The results revealed that it is possible to grow three crops in a 12-month cycle utilizing available rainfall and river water. There was variability in yield of the individual crop, consequently affecting the system productivity due to variable crop establishment periods and climatic factors during the study periods. Growing three crops in sequence produced an annual rice yield of about 8.2 to 9.8 t/ha, maize yield of 6.9 to 8.8 t/ha, and sunflower yield of 2.8 to 3.8 t/ha. Thus, annual rice equivalent yield (REY) of the aus-aman-rabi cropping systems ranged from 13.7-20.0 t/ha over the range of sowing dates and seasonal conditions, which was much higher than the existing farmers' productivity.

The productivity of an HYV aus-aman-rabi cropping system decreases as aus sowing is delayed beyond early April. While the yield of the aus and aman crops also declined with delayed sowing, the proportion of yield decline and its impacts on REY and system profitability were significantly lower. Therefore, in designing high-yielding aus-aman-rabi cropping systems for the



Jayanta Bhattacharya is measuring soil moisture by tensiometer.

Coastal Zone, the first priority should be to optimize the sowing date of the rabi crops.

The total gross margin of the aus-aman-maize system (USD 1,256/ha) was slightly higher than that of the aus-aman-sunflower system (USD 1,175/ha), mainly due to the lower profitability of sunflower. Variability in cropping system profitability was mainly due to variation in profitability of the rabi crops. With either maize or sunflower in the system, the profitability declined by about 50% when sowing of the rabi crop was delayed from mid-December to mid-January. Therefore, the rabi crops should be sown around mid-December for maximum yield and profitability of the year-round cropping. For adequate turnaround time between all crops, the aus crop should be sown in mid-April and the aman crop in mid-August. Thus, with good water management, it is possible to implement highly productive and profitable aus-aman-rabi cropping systems in areas with low salinity in the Coastal Zone. ■

Trade-offs among different cropping systems in the polders of the Coastal Zone

Priyanka Saha, MS scholar

Khulna University, Bangladesh

University supervisor-Sk. Sharafat Hossen

The sustainable improvement in agricultural and livelihood of the community is hindered in the polders of the Coastal Zone because of climate change, rising sea level, increasing level of soil and water salinity, cyclone and storm surges, floods and waterlogging, and drainage congestion. However, in recent times, with support from many national and international agencies' initiatives, some farmers in the polders have started producing HYV rice along with low-yielding traditional rice in the aman season and sunflower along with sesame in the rabi season. Therefore, the present study was conducted to understand the trade-off with individual crops and different cropping patterns in Polder 30 located in Batiaghata-upazila of Khulna district. One hundred eighty farm households were selected from three villages of Polder 30 for this study. Farmers, who grow traditional and HYV rice in the aman season and sesame and sunflower in the rabi season, were selected purposefully as the respondents for this research.

The results of this study showed that more than half of the farmers cultivated only traditional rice, whereas only 7% cultivated HYV rice in the aman. It is evident that traditional rice is the most dominant crop in Polder 30. About 58% of the farmers cultivated only sesame and 28% cultivated both sesame and sunflower in the rabi. Only 6% of the farmers have adopted sunflower since most of the farmers are not familiar with its cultivation requirements. Among the cropping patterns, traditional rice–sesame (80.5%) is the most dominant pattern in Polder 30, followed by HYV rice–sesame (50%), traditional rice–sunflower (32.2%), and HYV rice–sunflower (21.7%).

In Polder 30, the productivity of HYV rice (4.2 t/ha) was much higher than traditional rice (2.4 t/ha) in the aman while the average yields of sesame and sunflower were only 123 kg/ha and 1,215 kg/ha, respectively, in the 2016-17 dry season. The yields of dry-season crops were very low due to major damage by excessive rainfall. The net incomes of traditional rice, HYV rice, and sunflower were USD 338, 510, and 65 per ha, respectively. The production cost of sesame (USD 202) was more than the gross income (USD 69), meaning the farmers incurred a huge loss with sesame cultivation.

The rice equivalent yield (REY) of the traditional rice–sunflower pattern is higher than that of traditional rice–sesame because sesame, as a dry-season crop, could not increase the system productivity over the newly introduced sunflower crop. The main reason is the crop failure with sesame, while sunflower was only partly damaged. Sunflower seems to be a promising



Priyanka Saha (right) interacting with farmers to understand their production system

dry-season crop as it increased the system yield in both traditional and improved production systems. The REY of the HYV rice–sunflower pattern yielded almost double that of the traditional rice–sesame. The main reason is that the average yield of HYV rice is higher than traditional rice and the yield of sunflower is also higher than sesame.

In the profitability context, per hectare net income of traditional rice–sunflower is higher than that of traditional rice–sesame because sesame was completely damaged by waterlogging and failed to contribute to the system's profitability. The net income of HYV rice–sunflower (improved pattern) is almost three times higher than traditional rice–sesame (farmers' pattern). This is because the yield and net income of HYV rice are higher than traditional rice and those of sunflower are higher than sesame. Therefore, sunflower, as a dry season crop, can increase the system profitability with both traditional and HYV rice.

The improved cropping pattern (HYV rice–sunflower) can be considered to be more acceptable than the traditional cropping pattern (traditional rice–sesame) in the context of both productivity and profitability (see Fig. 3). However, most farmers in Polder 30 continue to practice the traditional cropping system because more fertilizer is required to cultivate HYV rice and sunflower compared to the traditional system. Farmers in Polder 30 are still reluctant to adopt HYV rice because its harvested yield is reduced due to the delay in drainage from surrounding low-lying agricultural lands in the polder ecosystem. Due to limited knowledge about the cultivation of

sunflower, lack of irrigation water, and lack of proper market information or access, the farmers have not incorporated sunflower in the rabi season on a large scale.

The improved cropping pattern is seen to be less environmentally friendly than the traditional cropping pattern (see Fig. 3). However, there is an opportunity to reduce the environmental footprints and therefore address the food security of the region by optimizing the management practices of the new cropping pattern. By considering trade-offs among different cropping patterns, the improved cropping pattern should enhance food availability and put us on the right path towards attaining food and nutritional security for the growing population of Bangladesh. ■

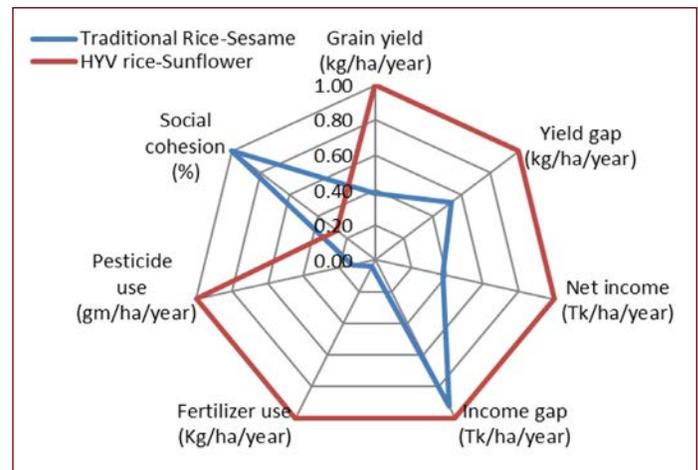


Fig. 3. Trade-off analysis of improved and traditional cropping patterns

MARKETING AND FOOD CONSUMPTION PATTERNS

Market response to improved rice varieties in coastal Bangladesh

Puja Roy, MS scholar

Khulna University, Bangladesh

University supervisor-Sk. Sharafat Hossen

Bangladesh's agriculture sector has been functioning as a catalyst for sustainable development and growth. The country faces enormous challenges to maintain food self-sufficiency to meet its growing population. With declining availability of agricultural land, there is little scope to further intensify agricultural production, except in the underutilized 1.2 million ha of polder lands in the Coastal Zone. The dominant crop grown in the polders is rice, usually traditional varieties (TVs) in the aman season. Improved production systems have not

been widely adopted by the farmers in the polders. Among many reasons, low adoption of HYV rice includes hydrology of the polder zone and the market dynamics playing an important role for its poor adoption. The price of TV rice has mostly been double that of the HYVs. However, in the last 2 years (2016-17), there has been a sudden shift in the market price of HYV rice. Following such a market response, farmers and traders have shown increased interest to produce and trade HYV rice.

The price of TV and HYV paddy in 2015 varied from BDT 15,000 to 20,000 and from 12,000 to 15,000 per ton, respectively. During 2016 and 2017, the price of HYVs increased substantially compared to TVs. It was interesting to note that the prices increased a few months after paddy harvests, which is generally opposite to how a market responds after a crop harvest. However, in both 2016 and 2017, the price of paddy increased immediately after harvest and continued to remain high until the next harvest, mainly due to severe crop damage by floods in the northern parts of Bangladesh. Besides the above scenario, improved grain quality and early market delivery (early harvest due to short duration) are the most important factors for the rising price of HYV rice. Although the price of TVs was higher than HYVs, total income from TVs was less than HYVs because of significantly lower yield of the TVs compared to HYVs. The yield of HYV rice was from 4 to 5 t/ha and, in contrast, it was less than 3 t/ha for TVs. For this reason, farmers are considering to cultivate HYVs



Puja Roy (with scarf) interacting with wholesalers in paddy market

where land is suitable. Because of higher yield and increase in price of HYV rice, farmers have allocated more hectares to HYVs to increase their profit. In 2015, area allocated to TVs was about 50% higher than HYVs. But in the following year, the proportion of area allocated to HYVs increased substantially. Almost similar land area was allocated to TV and HYV rice cultivation.

The key actors engaged in rice marketing are the farmers, middle persons, and wholesalers. The wholesalers and middle persons act as the traders, collectors, processors, and distributors. Most farmers in the polders sell their paddy to both wholesalers and middle persons (see Fig. 4). Farmers with large areas, representing only 12% of the farming community, sold their paddy to the middle persons directly from their homestead. The middle

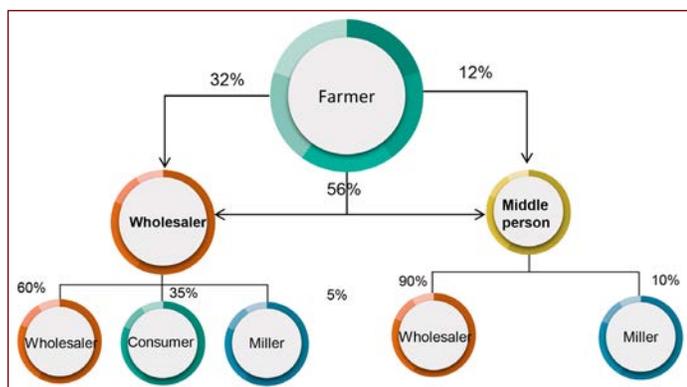


Fig. 4. Market linkages of the farmers in Polder 30

persons and about one-third of the farmers sell their paddy directly to the wholesalers carrying their paddy in the local market. Most of the wholesalers sell their purchased paddy to the big merchants or millers in the cities and about one-third to local consumers. The consumers purchase paddy, mill it, and keep it for their own consumption because it saves money as compared to directly buying milled rice from the market.

Rice marketing in the Coastal Zone is generally dominated by the middle persons and wholesalers. They determine rice price based on current market price and negotiate with the producers. If the number of intermediaries in the marketing channel can be reduced by transporting products to big wholesale markets or even to consumers, the farmers can make more profit than they are currently. Market information and communication technology can help the farmers, either by improving their bargaining power or by enabling direct sales and removal of the middle persons' market monopoly. Development of marketing infrastructure, such as road networks, access to information, and agro-processing facilities, is expected to ensure better access to the market and fair prices for the farmers.

The coverage of HYV rice in the Coastal Zone is relatively low—lower than other parts of the country. The development and promotion of appropriate HYVs complemented by improved management practices and efficient marketing systems will minimize food insecurity of the country's growing population. ■

Food availability and consumption pattern of the polder communities of Bangladesh

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Food and nutritional security of the poor and marginalized population has emerged as a critical concern, especially in developing countries. In Bangladesh, about 25% of the population lives below the poverty that subjects it to varying levels of food insecurity and malnutrition. The challenges are even higher in the country's polders in the Coastal Zone, which is highly vulnerable to many environmental challenges including salinity, flood, waterlogging, a long fallow dry season, and almost annual natural disasters. These cause low agricultural productivity (a single traditional rice crop in most parts of the region), food and nutrition insecurity, and precarious livelihood. Nevertheless, a large potential exists to improve food and nutrition security using improved agricultural technologies and management practices.

A study was conducted in Polder 30 of the Coastal Zone using 156 randomly selected households in the polder communities



Monoj Roy (right) interviewing a women on household food consumption.

to assess their food availability and consumption patterns and factors affecting the consumption. The study indicated that about 25% of the total population is moderately to severely food insecure despite recent increasing trends in productivity. Only about 11% of the households surveyed produce enough food, while 89% suffer from food deficiency to varying degrees.

The polder communities need to purchase food to fulfill their basic nutritional needs. The majority (58%) of the households had from 1 to 2 months of food deficiency while about one-third experienced from 3 to 10 months of food deficiency. Both secure- and insecure-food groups have limited dietary diversity, which is dominated by the staple rice, with about 80% of the community having an unbalanced diet.

Such scenarios with limited food availability, low dietary diversity, and consuming patterns affect their nutrition status leading to poor physical and cognitive growth in the long run. Most of the households produce almost sufficient rice, fish, and egg to satisfy their needs; they need to purchase not more

than 15% of their total consumption to meet their household requirements. But for potato, pulses, vegetables, and edible oil, the polder community mostly depends on the market to satisfy these food requirements. Thus, about 42% of the households in Polder 30 have on average sufficient nutrition and the rest suffer from varying degrees of malnutrition.

In the final analysis, intervention is needed to increase production and consumption through a nutritional awareness campaign, of more nutritious crops such as zinc-biofortified rice, pulses, sunflower, vegetables, and fruits and production of fodder for livestock to improve food and nutritional security of the polder communities. ■



Nasiba Akter (second from left) is with the community in Polder 30

SOCIAL EQUITY

Gender dimensions of improved agricultural technologies and practices in the Coastal Zone

Nasiba Aktar, Ph.D. scholar
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Although the Coastal Zone is based on an agrarian economy, most of the people living there are enormously vulnerable, food insecure, and socioeconomically challenged. This is attributable to the region's high frequency and intensity of climatic hazards, deteriorating quality of natural resources, population pressure,

and inadequate employment and economic opportunities. The polders are enormously important as they are considered to be the mainstay for the survival of 1 million farm families living in the Coastal Zone by producing crops albeit of low productivity. While farm productivity and profitability have

greatly increased through intensification and diversification of agricultural systems over the past 30 years, compared to the rest of Bangladesh the polders are left behind with the farmers still relying on traditional practices.

Over the last decades, numerous research and extension initiatives have been testing new cropping patterns to counteract the vulnerability of farm households to achieve food security and reduce poverty. Some of the initiatives are introducing high-yielding and stress-tolerant rice varieties, new crops such as sunflower and maize, integration of aquaculture with wet-season rice, and farm mechanization through improved water management involving women. Bangladesh's Department of Agricultural Extension (DAE) has started working with WMGs for the adoption of improved production systems through better water management at a sub-polder scale. The goal of adoption of improved agricultural technologies is to raise earnings of the rural poor. However, the growth in the agriculture and rural sectors in many developing countries, including Bangladesh, is undermined by gender-related constraints and unequal access to productive resources. Although all improved agricultural technologies are intended to be productivity enhancing, value-adding, and cost-saving, not all technologies are beneficial and responsive to the needs of the poor, both women and men. Rather than performing better, new technologies sometimes may change the division of labor and can be more harmful to poor women and the real can explain why technologies are adopted (or not) by the community.

In Polder 30, traditional agricultural production systems are mostly practiced. The levels of knowledge of women and men with regard to practices and technologies are varied. Decision-making ability is influenced by different cultural norms laid in the same society and this influences production decisions, workload, household income-expenditures, and the overall livelihood. But it might be a matter of hope that improved technologies and practices have taken place in the polders in lieu of traditional ones.

Women's roles in the agricultural sector in the polders have increased and have continued to grow, although they are plagued with many problems such as poverty, inequality, unemployment, disempowerment, and under development. We cannot afford to misplace human resources by discrimination based on sex. Women are not paid with deserved compensation; they cannot enjoy the benefits of rural economic development; and there are barriers for them to be empowered both at the household and community levels. Factors including lack of access to land, education, employment opportunity, lower wages, psychological backwardness, and lack of decision-making power in household affairs have been stumbling blocks to properly empowering women in the polders of the Coastal Zone. It has already been recognized that sustainable agricultural development is not possible without the well-remunerated participation of women in agriculture. Although the participation of women in agriculture is growing, feminization in agriculture is still not adequately acknowledged. However, there is an increasing trend to educate girls, which hopefully will enhance women's overall participation in intra-household decisions. ■

Time use by gender of farm households in the polders of the Coastal Zone

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In the agrarian polders of the Coastal Zone where climatic conditions present a major challenge, farm activities vary in response to seasonality, labor requirements, crop practices, social norms, socioeconomic status, and household composition. Generally, women in Bangladesh tend to engage in a more diverse range of activities than men. But with increased food demand, the farming communities are trying to intensify and diversify cropping, especially in the polders. This might have an impact on the workload of the women in the polders' rural households.

A study was conducted to help reveal gender gaps, roles, and responsibilities by understanding the time utilization pattern of



Umme Habiba (right) is discussing with a woman on her time use pattern

farm household members in two villages of Polder 30. In total, 130 men and 114 women in 54 households were interviewed during two peak and two lean cropping periods. The study provides some understanding of seasonal trade-offs of women in farm households regardless of their tasks through their time commitments in simultaneous daily activities where time serves as a critical resource. The major findings of the study describe the consequences of the introduction of improved cropping practices on the workload and additional benefits derived by the household members through their time commitments in their daily farm and nonfarm activities.

The men and women in the households that adopted improved cropping practices worked about an hour more in agriculture

than their counterparts who practiced traditional farming during both the peak and lean periods. In general, men slept about an hour more than the women and also spent two hours more in their personal care and leisure than women members of the household. In domestic work, women (9 hours/day) spent the most time in this activity, irrespective of peak or lean periods. But during peak agricultural periods, such as transplanting and harvesting, the men spent only 1 hour for domestic work. Therefore, cropping intensification and diversification with improved practices increased the workload of the women and they had to sacrifice their leisure and sleeping hours to satisfy the needs of their households (see more on this subject in *Polder Tidings*, Vol. 2, No. 2). ■

Participation and perceptions of young people in agriculture

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Most of the food in Asia is produced by elderly farmers who are less likely to adopt the latest technologies for a sustainable increase of productivity required to keep the continent food secure. It is unfortunate that few young people see a future for themselves in agriculture. The youth in Bangladesh are no exception to this phenomenon. There is a general perception that the literacy rate and level of education of the younger generation are higher than in the past and that they are less likely to prefer farming as their ultimate profession. It is a matter of concern that, without involving young people in agriculture, the demand for food may not be met from domestic sources in the country. Therefore, youth involvement in agriculture is an urgent issue for policy and decision makers.

The current generation of youth is defined by the United Nations to be in the 15- to 24-year age bracket. The National Youth Policy of Bangladesh, set in 2003, defines youth to be from 18 to 35 years old. According to the United Nations Population Fund's most recent *State of the World Population Report*, 30% of the 162.9 million people living in Bangladesh are from 10 to 24 years of age. So, Bangladesh's 48.87 million young people (using the 10- to 24-year age range with 73% in rural areas), including males and females, do not view agriculture as a favorable livelihood option.

A study involving 270 youths (64% male and 36% female) from farm families of Polder 30 in Khulna District showed that only 43% of the members are directly engaged in farming. The participation of men and women of different age group is shown in Fig. 5. The respondents who are single, very young,

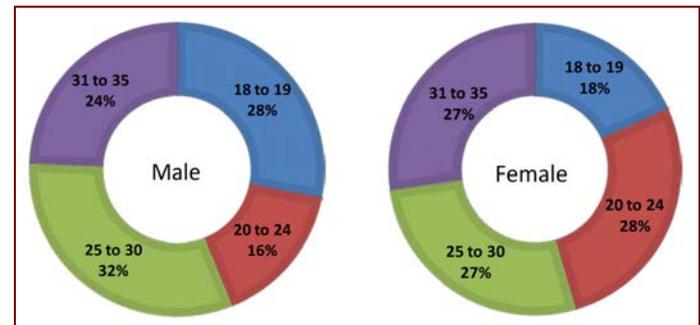
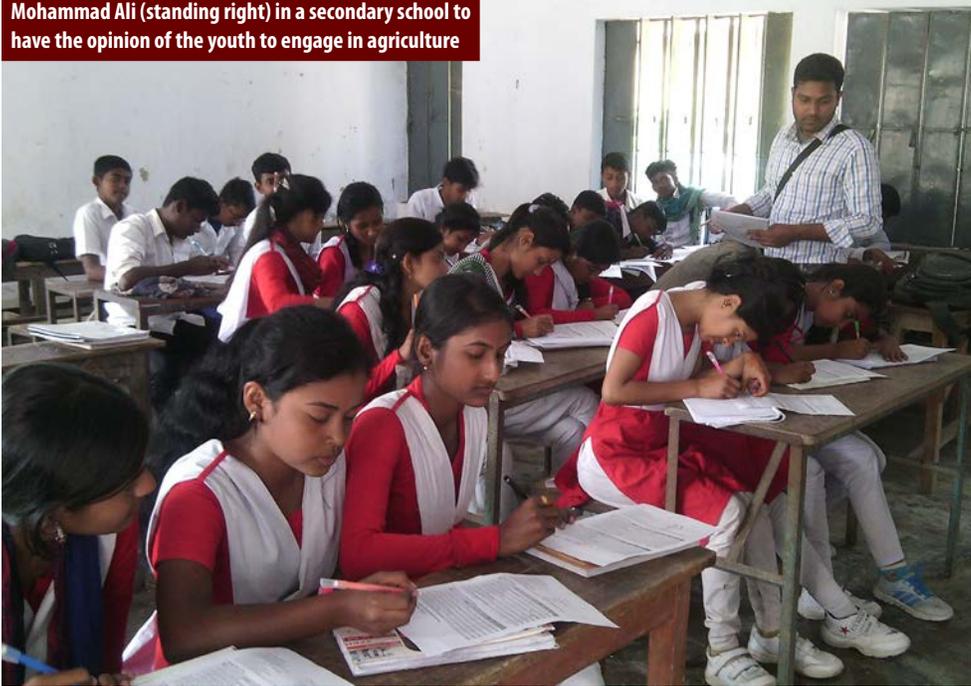


Fig.5 Participation in agriculture by age group.

or from small farm families were less likely to be engaged in farming. Although it is very difficult to find employment in nonfarm sectors, the common perception is that the farming profession is mainly for less literate people and those who could not be employed in other sectors due to the tight job market. The majority (93%) of the youth believe that acquiring an official job is a matter of pride and prestige in society. They feel that agriculture demands too much hard work with limited rewards.

A majority of farmers do not earn enough income from agriculture for other things beyond food. Farmers' underprivileged living standard influences young people to work in the nonfarm sectors. Most youth in coastal Bangladesh consider that the agriculture sector is not modernized like the nonfarm sectors. As a result, few youths are planning to engage in farming but instead prefer to obtain employment

Mohammad Ali (standing right) in a secondary school to have the opinion of the youth to engage in agriculture



in the socio-culturally respectable job market in the public and private sectors. Moreover, even 90% of parents want their children to work in the urban sector, which is linked to a better social reputation. Many school-age children dream of being a doctor, engineer, or lawyer or of accept any official job (58.9%), but they seldom want to be in the agriculture sector (15.6%).

If this tendency continues, it will have a major impact on the country's food production. However, 42% of the respondents indicated that they don't want to migrate and so are considering agriculture as a last resort for livelihood.

The youth who are engaged in farming face many challenges, such as lack of access to and control over resources (land, capital) and the market, inadequate skills and knowledge on production processing and business, the uncertainty of weather, and variability in market prices. The youth can be more easily attracted to agriculture when these obstacles are minimized and resources are made available. In addition, the introduction of practical farming courses in the

formal academic curriculums, farm mechanization, and rights and access to land for women may also aid in attracting youth to agriculture. This is necessary to meet the ever-increasing food demand and sustainable and inclusive growth of society. The time is to act now if we want to have an adequate number of farmers to feed Bangladesh's future generations. ■

SUSTAINABILITY

Sustainable intensification of agriculture: opportunities and challenges for food security and agrarian adaptation to environmental change in Bangladesh

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Sustainable agricultural intensification (SAI) can be characterized as a framework for disentangling "wicked problems" in modern agriculture. SAI is critical to meeting food security needs in the coming decades, especially in countries such as Bangladesh where population growth, reduction in arable land and resources, and ongoing climatic changes coincide. SAI is a framework for evaluating the nexus of human-environmental relationships in agricultural systems

and a platform for improving their short- and long-term productivity. Previous studies of SAI have focused on global intensification of extensive agricultural systems or outline environmental sustainability issues in case studies of small-scale agricultural production. To extend the learnings on SAI, a study was conducted using 1025 households' surveys in Polder 30. The study helps to characterize polder demographics, current cropping systems, water management practices and



Aaron Shew (standing in the middle) interacting with the farming community.

food security issues were outlined. It was found that the most significant opportunities for SAI in the polders are to bolster community involvement in water management, make evident the potential of flood tolerant HYVs of rice and identify diverse crops for dry season.

Another study was done to investigate food security and environmental impacts associated with rice intensification practices. Two practices- (1) double-cropping rice and (2) growing HYVs of rice were highly correlated with food security and environmental impacts. The results show a 12.6% increase in Bangladeshi consumption associated with HYV rice adoption, which equates to enough rice for nearly 26 million people

annually. Moreover, the life cycle assessment results suggest that HYVs were more input- and water use-efficient per kg of rice produced and double-cropped systems were more land-use efficient. Global warming potential associated with double-cropped systems was 20% less in HYV-HYV compared to TV-TV systems. These results demonstrate the importance of promoting improved seed technology adoption and double-cropped systems as key pathways for addressing food insecurity and reducing environmental impacts from agriculture.

Overall, the findings from this investigation of SAI support continued efforts to improve food security, increase agricultural output, and decrease environmental impacts in Bangladesh. ■



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