Progress in the polders: system intensification and gender integration
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Rice, the staple food of 165 million Bangladeshis, is the country’s most important crop. Since independence in 1971, Bangladesh has made tremendous progress in rice production, which has increased by more than 3.5-fold, from 15 million tons in 1971 to the current 52 million tons. Bangladesh now ranks as the fourth-largest producer of rice in the world and the crop accounts for 75% of its agricultural land use.

Despite this spectacular increase in rice production, Bangladesh has faced persistent challenges in sustaining rice self-sufficiency because of its high susceptibility to climate variability. Two recent reports—the global climate risk index 2017 (Kreft et al 2016) and the climate change vulnerability index 2017 (Reliefweb 2016)—ranked Bangladesh among the world’s top 10 most vulnerable countries due to the planet’s changing weather. Bangladesh largely has a flat and riparian terrain with 90% of its landmass categorized as only 10 meters above sea level. The deltaic plain of the Ganges (Padma), Brahmaputra (Jamuna), and Meghna rivers and their tributaries occupies roughly 80% of the country. The hydrological characteristics such as low-lying topography surrounded by a large network of rivers, high annual rainfall, and geographically situated at the head of the Bay of Bengal make the country highly vulnerable to floods due to rain, overflowing rivers, and coastal surges. Floods occur during the monsoon season in June to September and affect 20% of the country’s landmass annually. Flood-affected areas can reach 70% in a severe flood year (MoDMR 2017).

In Bangladesh, rice is grown over three seasons: aus (March-August), aman (June-November), and boro (December-May). It plays a vital role in food and nutrition security, rural employment, farm income, and overall economic development. Therefore, any decrease in rice production seriously affects the livelihoods of millions of people. In 2017, the country received 42% more rainfall than a normal year, which made it one of the worst flood-affected years over the past 20. Four recurring severe flash floods in 2017 (occurred in late March and early April, late June and July, mid-August, and late October) affected more than half of the country, mainly the northern, northwest, and central districts. The floods shattered the livelihoods of more than 8 million people, inflicting heavy damage on rice, vegetables, fish, livestock, food reserves, houses, and infrastructure.

The March and April floods resulted in a loss of about 1.5 million tons of boro paddy production in the northern districts where only a single rice crop is grown in a year. The severe damage to rice, the major crop cultivated in the area, negatively affected the food security and livelihood of the local people, especially the poor. Although complete information is not available, preliminary assessment indicates that the three severe monsoon flash floods are expected to decrease aman rice production by about 10%, which is equivalent to 2 million tons of paddy. Paddy rice production losses attributed to the 2017 floods during the boro and aman seasons are estimated to...
be 3.5 million tons, which is about 7% of the country’s total rice production. These losses due to the floods and subsequent market speculation resulted in about a 45% increase in rice prices in 2017 compared with 2016. The sharp increase in rice prices hampered food and nutrition supply for the poor, whose menu is rice dominated. To ensure an adequate supply of rice and to stabilize rice market prices, the government substantially increased rice imports in 2017, thereby draining the country’s economic reserves. The quantity of milled rice imports increased from 62,000 tons in 2016 to 1.2 million tons through October 2017. Total milled rice imports for all of 2017 are predicted to reach 1.6 million tons. These numbers indicate a huge negative impact of floods in the country on food security tied to rice and overall national development.

With Bangladesh being in one of the global hotspots for climate risks, rice self-sufficiency is still fragile and a single bad year with natural calamities can seriously impede it. Hence, it is very important for Bangladesh to look at options to minimize the risks so that it can continue its agricultural progress and impressive economic growth.

**Flood-tolerant Sub1 rice varieties**

Since 2012, to minimize the climate-change impact on rice production, the Bangladesh Rice Research Institute (BRRI), the Bangladesh Institute of Nuclear Agriculture (BINA), and the International Rice Research Institute (IRRI) have been working together to develop and promote flood-tolerant rice varieties. So far, four Sub1 rice varieties (BRRI dhan51 and 52 and BINA dhan-11 and -12) for the aman season have been made available to farmers. These Sub1 varieties can survive even if the plants are under water for up to 2 weeks and so are becoming very popular among the farmers in flood-prone areas.

These Sub1 varieties made a significant positive impact on the livelihoods of rice farmers vulnerable to the 2017 floods. In this year, the reduced damage to standing rice crops was mainly due to planting of the Sub1 varieties and/or fewer severe floods in some of the higher elevation regions. More than 70% of the rice crop survived after the floodwater receded.

Using the 6% adoption rate of the Sub1 varieties in the aman season, the 70% postsubmergence survival rate, and 90% of the normal yield without floods, the value of the Sub1 varieties across the flood-affected areas after the floods is estimated to have affected 170,000 ha, resulting in around 610,000 more tons of paddy and more than an additional USD 215 million in crop value. After adjusting for counterfactuals, such as retransplanted rice, the extra benefit obtained from Sub1 variety cultivation is estimated to be about USD 125 million. The reduced damage to the rice crop due to the growing of the Sub1 varieties directly benefited about 5 million people, assuring them of adequate food, employment, and income.

**Other opportunities**

Wide-scale adoption of Sub1 varieties will certainly be most beneficial in the aman season during which floods affect rice during the early growth stages. However, different solutions will be required for the aus and boro seasons during which flooding affects the crop at or near maturity. Short-duration high-yielding varieties (shorter than current HYVs), combined with cold-tolerance to mitigate the adverse effects of flash floods in the boro season in the northern part of the country, must be developed. Improved water and crop management strategies also need to be adopted to minimize flood damage. Some of these strategies include:

- transplanting boro rice in synchronization with floodwater recession,
- introducing mechanization to reduce transplanting and the harvesting time of boro rice to overcome flooding,
- introducing floating rice nursery beds,
- providing seed availability in the local market during the flood season, and
- doing community seedbed preparation on fallow lands of public institutions to mitigate the adverse effects of flooding in the aman season.

These strategies will improve the rice crop’s climate resilience to sustain food security in Bangladesh.

**References**


Sub1 rice (BRRI dhan52) performs better than non-Sub1 rice (BR-11) after flooding.
Learning hub: A four-dimensional model for knowledge sharing on improved production systems in the polders of the coastal zone of Bangladesh

Manoranjan Mondal, Sudhir Yadav, S.V. Krishna Jagadish, and Sirajul Islam
Bangladesh’s coastal zone is characterized by both challenges and opportunities. The government has constructed 139 polders (enclosing approximately 1.2 million hectares) to enable crop production and protect people from tidal surges and cyclonic storms. The polders are home to 8 million of the country’s most vulnerable people whose livelihood primarily depends on subsistence agriculture.

Although appropriate and improved agricultural technologies (such as improved crop varieties and production systems) are available in Bangladesh, many factors constrain their introduction and adoption in the coastal polders despite significant investment to date. Among them is a lack of knowledge and information flow to the farming community. There is also little understanding of the societal and household dynamics that drive decision-making among polder farmers.

To face these challenges, the International Rice Research Institute (IRRI) managed SII (Sustainable Intensification Innovation Lab)-Polder Project has introduced a four-dimensional learning approach that has established eight learning hubs (LHs) in polder 30 in Batagata subdistrict (see map). Collaboration between researchers and farmers is bringing innovations to farmers’ fields. The researchers are sharing new and improved technologies with the LH farmers. Together, they are exploring informally where the technologies can be effectively implemented. This is ascertained after gauging the advantage of the improved technologies over traditional practices, taking into consideration available resources. The LH farmers will be implementing some production packages based on their preferences, land topography, and hydrology.

During the implementation phase, the farmers are learning from the researchers while the researchers are obtaining feedback from the farmers on some of the promising technologies. After a few years of testing, the most appropriate production packages will be jointly identified for the polder ecosystems.

The third dimension involves farmers interacting with their counterparts in each of the eight LHs, neighboring farmers, and local leaders on the prospects and benefits of the tested technological packages. Thus, the entire community will be identifying appropriate production systems in the various polder ecosystems by actively being involved throughout the decision-making process.

The fourth dimension involves building regional capacity for the researchers and practitioners. Postgraduate students working on their theses at local universities are interacting closely with the researchers and farmers. This unique approach will allow the next generation of scientists to conduct research off station 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 hydrology, mechanization, marketing, socioeconomic, 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 LHs are evaluating improved packages of water management and agricultural technologies to test the efficiency of the LH model. Thirteen postgraduate students are conducting adaptive research across these LHs and the rest of the polder area. Using a systems-based approach, different technologies are tested under different socioeconomic and biophysical environments of the LHs. This LH platform is not only designed to help in successful testing of the technologies but it is also considering these interventions when analyzing market and policy perspectives. By including women and young people, the LHs are also exploring employment and business opportunities in a more diverse system.

Preliminary results are showing that the farmers in each LH are keenly observing what is happening in the other LHs. Some have identified a few options (e.g., mechanical rice transplanting) tested in other LHs that could be attractive to help improve farming in polder ecosystems. This model should provide evidence to policymakers, local extension and development professionals, and the farming communities for adopting appropriate policies and production packages for food and nutritional security in the polder communities.
What mechanization means to women: Case studies from polder communities of Bangladesh

Rokhsana Parvin Ratna, Sudhir Yadav, Manoranjan Mondal, and Ranjitha Puskur

The rapidly growing economy of Bangladesh has fueled demand for labor in nonagricultural sectors, resulting in a scarcity of rural agricultural workers. This has driven wages up and is affecting farm productivity and profitability. Although women have always played a critical role in the agricultural sector, their identity has been only that of unpaid family labor. There is a widespread perception that women’s role in farming is limited to the homestead and some postharvest operations. However, in the polders of the coastal zone, women are involved in almost all agricultural activities. Along with their contributions to agriculture, they do all other household work. Even so, they face several constraints, such as restricted access to inputs, resources (land and labor), assets (machinery and equipment), and services (extension and advice, financial products), which restrict them from playing a leading role in most activities.

Agricultural mechanization in the coastal zone is almost absent except for two-wheel tractors in land preparation mostly operated by men. The poor road network, waterlogging, canal networks, and undulating topography are considered the main barriers to agricultural mechanization in this coastal region. Most farmers in the polders cultivate a single low-yielding rice crop in a year, and agriculture is considered as a low-input, low-risk business. Generally, poor and landless women are engaged in the annual rice harvest on family-cultivated land and on neighboring farms as wage-earning day laborers. During rice harvest, which is done mostly in December, women work for 8 to 9 hours daily. At the same time, they are also responsible for all domestic chores and family care.

In the SIIL (Sustainable Intensification Innovation Lab)-Polder Project, a mechanical harvesting using a reaper was introduced to small and marginalized farmers to ease the physical burden on women and increase their contribution to household earnings. The project organized hands-on training in collaboration with the ACI Motors Ltd. on using the reaper for 84 male and 65 female farmers during the 2016 aman season and for 50 men and 35 women during the 2016-17 dry season.

The team worked closely with five women who showed strong interest in learning about being service providers. The project purchased one reaper for them to work with. Of these, two, Nomita Golder and Madhuri Mondal, actually became service providers (Fig. 1). A key informant interview with them provided additional background on their feelings about the importance of mechanization for their livelihood. These women contribute to their respective landless family’s earnings by raising livestock and poultry and providing child care services or tutoring the children of neighboring families.

During the peak harvesting time, both women tended to spend the majority of their time harvesting paddy followed by raising livestock and poultry as a source of income, while still spending significant time for family care. Nomita worked 22 days in the previous season to manually harvest paddy (Fig. 1) and she earned BDT 6,000 (USD 72). Another service provider, Madhuri Mondal, had a similar experience.

Nomita and Madhuri were happy to try mechanical harvesting. Using the reaper not only reduced their drudgery but also saved significant time. These young women reckoned that it generally took 48 hours to manually harvest a 1-acre paddy field while it could be harvested in only 3 hours with the reaper. As the project has only one machine, which was used extensively for training and demonstrations at an early stage of the harvesting period, Nomita and Madhuri were able to use the machine for only a few days to provide harvesting services to other farmers.

It was interesting to see the behavior and priorities of these entrepreneurs. Instead of harvesting all day, both decided to work in the field during the morning hours only. This was sufficient for them to harvest the area that they used to harvest in 5 to 6 days. In the afternoons, Nomita decided to continue providing child care services to neighborhood families, which she did before harvesting started. Using the reaper helped her earn money in a shorter time while continuing other
income-generating activities. Madhuri spent time on family care and some time for herself. Having some leisure time has significant implications for women’s health and well-being. Spending more time on family care, particularly children, contributes significantly to overcoming the household’s nutrition and health challenges.

Both Nomita and Madhuri used a significant part of their harvesting services income to pay for school/college fees of their children (Fig. 2). Nomita used 26% of her extra earnings for the payment of a bank loan. The money she earned through manual harvesting was used to purchase 137 kg of rice for the family. Madhuri used her income to repair a livestock shelter and to purchase some more ducks to increase family income.

Although there is a long way to go, mechanization has shown promise in helping increase household incomes, reducing women’s drudgery, and improving their health and overall household well-being. Without mechanization, women either need to spend significantly more time on manual harvesting as wage laborers to meet the expenses of the family or reduce family expenses, which might include stopping the education of their children or limiting other important family needs.

The success of this service provision model using mechanization depends on awareness, training, and access to credit to purchase machines, among other aspects. Although the capital cost of the machines is seen as a major limitation, it can probably be addressed through pooled investment of the community under existing organizational structures such as water management groups or through loans from self-help groups/NGOs. Linking these groups to financial institutions might also be an option in the future. The government has introduced from 50 to 70% subsidies to acquire agricultural machinery. Linking women to these subsidies will help empower them and move the country closer to ensuring food security and better family health.
The polders in southern Bangladesh are unique ecosystems having a huge potential for agricultural and aquaculture intensification. Intelligent management and use of polder resources offer food and nutritional security for the communities residing there. The polders have many canals inside with various dimensions (500 m to 1 km in length, 5 to 20 m in width, and 1−2 m deep) where fish thrive naturally during the wet season (extended up to a few months into the dry season when the fish take shelter in the canals). During the rainy season, the rice fields in the polders are flooded for 3 to 4 months, with the water depth ranging from 10 to 100 cm, depending on the geographic location of the landscape. Sufficient water control structures exist through which tidal river water and rainfall are managed by the community for agriculture and domestic uses.

Fish occur naturally in the rice fields, coming in with the river water during high tide (through sluice gates installed on the earthen embankment of the polders) that is used to flood the land prior to the start of the rainy season for washing out salts from the topsoil and for irrigating wet-season rice. Fish productivity could be much higher with improved management (e.g., stocking, feeding). Although fish culture in paddy fields is a proven technology, no attempts had been made earlier to raise fish by managing the water within the hydrological boundary inside the polders.

The International Rice Research Institute (IRRI) with NARES partners and other international agencies has been testing integrated rice + fish culture in the polders since 2015 by involving the community. The hypothesis is that managed fish culture with wet season aman rice will provide more income, improve the community’s nutrition needs, and might reduce weeding costs in rice production.

Rice + fish production system
Over 3 years, the integrated rice + fish production system has been tested at three different sites within the hydrological units of the catchment area of the Katakhali regulator in polder 30 (see map). In the first year (2015), the experiment was implemented on site 1 with 63 farm families from two villages on 18 ha having a long perennial canal (350 m) and a few small ditches within the hydrological unit where fish could take shelter during water shortages. In 2016, the site 2 community consisted of 21 families from three villages; the 7.7-ha hydrological unit had a small canal (100 m) with two to three small depressions. In 2017, community rice + fish culture was tested on site 3, a village consisting of 35 households with a command area of about 6 ha. This site has a better canal network (300 m) for rice-fish culture than the other two sites.

At all three sites, the community formed cultural management committees for the selection of fingerlings and stocking, clearing of vegetation from internal canals, poststocking management, harvesting and selling, profit sharing, and
The fingerlings were released in the watershed 2 to 3 weeks earlier than in previous years.

**Lessons and challenges**

The fish grew well in the floodplains and canals within the hydrological units. The fish took shelter in canals when farmers applied fertilizer and pesticides. There are auxiliary benefits attributed to integrated rice + fish culture in the polders. There were few pest and disease problems in the rice, perhaps because of the fish, and weed infestation was minimal because fish feed on the weeds.

Under supervision of the management committee, landless men did most of the fish harvesting and marketing. Because of storage canals inside the hydrological unit, the community in 2015 adopted staggered harvesting. The fish harvesting started in December 2015 and continued up to March 2016. The community harvested 3.5 tons of fish of which approximately 3 tons were sold for about BDT 265,000; the rest were consumed, being distributed among 161 households, including relatives in neighboring villages. Some fish were kept in the internal canal as stock for the next season.

In 2016, the community harvested and sold fish just once before the rice harvest due to the small storage canal inside the hydrological unit. Community members consumed 120 kg of fish and sold 291 kg for BDT 20,370. The income was very low because most of the fish escaped to the nearby canal when the bamboo bana was slightly lifted up from the ground by an unknown person during the last week of October. The lower part of the bana was under water so the escaping fish could not be seen. Also, the market price was low at harvest because many people were harvesting at the same time. This community also distributed fish among its neighbors and relatives.

Community fish culture in polders is biophysically simple to implement, however, the main challenge for implementation is community coordination. There also appears to be a lack of willingness to implement the fish culture for the benefit of all, which includes landless persons residing nearby. Although the management committee at the 2015 and 2016 sites distributed some fish among the households living around the fish culture area and their relatives in neighboring villages, profit sharing and yield distribution among the households are still a big challenge for successful implementation.

Social conflicts (village and national politics), unauthorized harvest by the landless persons who traditionally have caught fish from the rice fields for their livelihood, and controlling fish escape through rat holes in the village road are additional constraints to proper implementation of the system. We observed that the community was divided toward the end of the 2015 growing season because of a local government election and so profits were not shared with everyone. For proper implementation and transparency in profit sharing, social workers, local dignitaries, and leaders may have to address these challenges. Wider adoption of rice + fish culture might lower the intensity of such incidents that defeat the community spirit.

Also, capacity building needs to be done to assure a successful production system. Many agencies are working on rice and fish as separate production systems. However, farmers are not familiar with the best management practices for integrating the two systems. Polder ecosystems provide the greatest opportunity for a community rice + fish system. The polders have many canals and depressions. Water-controlling structures and rural road networks divide the polder area into several hydrological units, which can be used for the system with minimal investment.

The greatest opportunity lies with the semi-diurnal rivers (high and low tides occur twice daily) in the coastal zone. The rivers offer ample availability of water (either saline or fresh) all year free of cost. In addition, the fish market is well developed and women can take care of fish integration with rice as a new livelihood opportunity. Therefore, integrated rice + fish culture will provide more income and nutrition for the polder communities. It will also conserve indigenous fish species because the environment is not disturbed, which enhances breeding opportunities.
An innovative model for the introducing new crops: Sunflower production and marketing in the coastal zone of Bangladesh

The population of Bangladesh has one of the world’s lowest fat intake levels. Only 12% of the people’s total energy requirement is derived from fats. This is far below the recommended 35% for children and from 20 to 35% for pregnant and lactating mothers. Current domestic edible oilseed production meets only one-third of the national requirement, which results in less than half the per capita oil intake compared with the recommended 22 g/day. Because of undernutrition and an unbalanced diet, half of the children under age five are unable to develop to their full physical and mental potentials. The status is comparatively worse in the polders of the coastal zone where farmers generally grow a single low-yielding traditional rice variety annually.

A recent survey done by the SIIIL (Sustainable Intensification Innovation Lab)-Polder Project in polder 30 showed that more than 50% of the agricultural land remained fallow during the 2016-17 dry season. The farmers had to abandon the harvest of dry season crop due to crop damage (consequently a huge loss) from 2013 to 2017. The constraints to growing a second crop are linked partially due to long-duration aman varieties but are mostly attributed to poor water management, including terminal drainage.

The SIIIL-Polder project team members, working with the community, developed an innovative model to introduce growing nutritious crops such as sunflower in the dry season. Farmers

Manoranjan Mondal, Sudhir Yadav, and Mahbubur Rahman
were concerned about input resources, training, management practices, and marketing this new crop. So, the team shared information with 385 farmers (male and female) in polder 30 on the yield and oil quality of sunflower and the importance of consuming edible oil in the household. Among these, 218 farmers (38% women) agreed to try growing sunflower along with sesame (the main dry season cash crop) in 2016-17. The farmers were taught to practice terminal drainage in aman rice and then to plant sunflower in January. As the common practice of growing dry-season crops in the polders is in late February or early March, the farmers were not confident about seeding sunflower in January, so instead they did so during the first week of February. Approximately 160 mm of rainfall occurred in late April and early May, causing waterlogging, which destroyed most of the dry season crops, especially sesame in polder 30. But, in most cases, early-seeded sunflower survived. The mean yield of sunflower was about 2.5 t/ha, which was less than expected mainly because of late seeding, waterlogging, and the farmers’ inexperience with cultivating the new crop.

In addition to convincing the community of the value of sunflower to provide edible oil for better nutrition at home, the project team connected the farmers with the market to promote wider adoption of sunflower as a viable dry-season crop in the polders. In 2017, one wholesaler from Khulna City indicated great interest in purchasing all that was produced by the farmers. However, he was able to convince only 35% of the farmers to sell their sunflower seeds to him. In May, he purchased 6 tons of seeds at BDT 40 per kg (USD 0.50 per kg). The buyer had offered a much higher price for the early-harvested sunflower (BDT 50 per kg) if the farmers could supply him with the seeds in April. Unfortunately, this did not happen due to lower seed production than anticipated and the farmers’ desire to keep the sunflower oil for home consumption. However, this interaction did develop future linkages for marketing the new crop.

About 60% of the polder 30 farmers kept their sunflower seeds for home consumption. They extracted the oil by crushing the seeds at a local crushing mill. The farmers obtained 4.5 liters of oil from every 10 kg of crushed seed. They were happy to use the edible oil harvested from their own farms just as with rice. Depending on family size, the edible oil requirement ranges from 3 to 5 liters per month. In the past, families usually purchased imported soybean oil costing from BDT 300 to 500 per month. So, by using their home-grown oil, a household can save, on average, BDT 5,000 annually. The women were very satisfied with the use of the healthy edible oil for their children. Sunflower cake, a byproduct after oil extraction, was used for homestead vegetable, poultry, and fish production, which contributed even more to the availability of nutritious food for the household.

The project team suggested a marketing model in which buyers/wholesalers initiate contract farming in the polders where they can provide input support for sunflower production and guarantee a minimum support price to purchase the seeds. As already indicated, one buyer has proposed a viable business model and has expressed willingness to further explore the opportunity. The project team is trying to bring more private sector players to the polders to create a more competitive market for sunflower and other new crops.

Many farmers in polder 30, now recognizing the opportunity to grow sunflower during the dry season, expressed their willingness to cultivate sunflower earlier during the next dry season (2017-18)—and on a much larger scale. Cultivation of sunflower on the underused coastal lands and adoption of the production-consumption-marketing model (see figure) will, not only benefit individual households, but also help the country save a huge foreign currency expense by significantly reducing the need to import edible oil.
Responding to women’s needs by exploring time-use patterns of farm households in coastal Bangladesh

Umme Habiba, Sadika Haque, and Ranjitha Puskur

The dynamics of intrahousehold time-use patterns are specific to context and culture. For farm households, these dynamics can provide insights into how much time men and women spend in farm and nonfarm activities during different agricultural seasons. The amount of time spent by household members varies based on agricultural production systems. The intrahousehold division of roles is usually based on cultural and social norms, socioeconomic status, household composition, and migration patterns, among others.

The coastal zone of Bangladesh is agrarian and extremely vulnerable because of high population pressure, the increasing frequency and intensity of climate-related risks, dwindling quality of natural resources, and limited employment and economic opportunities. Women in these households tend to engage in a more diverse range of activities than men. Men are responsible for agricultural production and marketing and are normally the key decision makers. Women contribute to a range of agricultural activities while being mainly (or even solely) responsible for domestic chores such as cooking, cleaning, and caring for the family (children and adults).

Over recent decades, research and extension initiatives have been testing new cropping patterns with climate-resilient crop varieties to better enable farm households to achieve food security and reduce poverty. The interventions include the introduction of high-yielding rice varieties (HYVs) and new crops such as sunflower, watermelon, maize, and vegetables. In addition, several development programs targeting poverty reduction through income generation have been introduced into these areas. Most of the programs have women as a key target group to contribute to their economic empowerment. This means that women...
must participate in the meetings and related activities that increase their workload. It is important to understand the implications of such changes, particularly for the intrahousehold distribution of labor and benefits.

Time-use patterns of farm household members vary during the crop season, notably during peak periods (transplanting and harvesting) and the lean period (between transplanting and harvesting). Data were collected from 244 members (130 males and 114 females) of 54 households spread across two villages (Gongarampur and Hetalbunia) in polder 30 of southwest Bangladesh during one rice transplanting and one lean season in 2017 to understand the seasonal time-use patterns of men and women (Fig. 1).

The mean age of the respondent is 32 and the mean level of education about 6 years. About 90% of the households are Hindu and the rest are Muslim. About 8% of the household members (mostly men) have received training mainly on improved production practices and pond fish culture.

During transplanting, men and women from households that have adopted improved production practices spend more time on agricultural activities than household members relying on traditional methods. On average, men and women spend 12 and 9 hours daily, respectively, on farm activities, whereas farm households using traditional practices dedicate 10 and 6 hours, respectively. This is mainly because these farmers are cultivating more land than the others. The use of short-duration HYVs allows the cultivation of a second crop (usually vegetables) or raising fish for the market. The additional labor requirements, therefore, have to be weighed against the benefits generated from additional high-value crops. Raising vegetables or fish also has implications for improving household nutrition through a more diverse diet either directly through consumption or indirectly through additional income.

The post-transplanting period does not include much agricultural work. Both men and women enjoy more free time during this period and engage in nonfarm income-generating activities (Fig. 1). Men tend to engage in rickshaw or van pulling, or business activities involving small-scale trading, street vending, etc. The women sew, make toys with jute sticks and other handicrafts, process food, sell cow-dung cake, and collect firewood. Almost all of the women are involved in both farm and nonfarm income-generating opportunities.

Although both men and women benefit from additional leisure time during the off-season, women nonetheless have comparatively less as they take part in diversified domestic and nonfarm activities. Throughout the year, on average, women sleep 1.5 hours per day less than the males. Men enjoy leisure time for 3 and 4.3 hours in the peak and off seasons, respectively, whereas it is 2 and 1.6 hours for females. This has implications for women’s health and well-being even though they do not contemplate these activities as a burden but as a necessity for their families’ overall well-being. The men generally make the decisions about the women’s time allocations for various activities.

Time allocation appears to be a significant indicator that reveals gender gaps, roles, and responsibilities. Irrespective of the extent of participation in farm and nonfarm activities, the burden of women’s domestic unpaid family care work, regardless of peak or off season, does not change. Household women engage unquestioningly in domestic chores and contribute to agricultural activities to fulfill social expectations and economic compulsions to contribute to the well-being of their families.

In the short run, they might benefit economically but, in the long run, their “no choice” lifestyle may influence their well-being and self-image. Therefore, socio-cultural attitudes toward sharing family care work need to change to provide a level playing field for rural women. Research and development programming should account for these dynamics to be able to design interventions that respond to women’s needs and aspirations. They should not be overly burdened with their farm and nonfarm activities and they should obtain a fairer share of the benefits.

Fig. 1. Dynamics of time-use patterns by male and female members of households during the (a) off lean season and (b) peak season.
Sustainable intensification of farming systems in Bangladesh continues to be heavily emphasized and significant resources are being invested to make progress. The overall aim is to enhance economic benefits at the farm level by using locally available resources, thus simultaneously improving the nutrition and health of the target populations. Developing and implementing a robust indicators-based framework will help establish an appropriate baseline for the current scenario. This can be used as a platform on which to gauge progress achieved through multiple programs or projects from different funding agencies.

The Sustainable Intensification Innovation Lab (SIIIL; http://www.k-state.edu/siil/) and its partners have developed a structured and evolving indicator framework that is being implemented in the SIIIL-Polder Project in coastal Bangladesh. Targeting a farming systems approach, the SIIIL sustainable intensification framework involves five domains: productivity, economic, environmental, human condition, and social. Each domain includes a wide range of indicators that operate at multiple scales going from the plot to farm level and extending up to the household and landscape (Fig. 1).

We identified two case studies: (1) a community-level rice + fish production system and (2) introduction of mechanization for rice transplanting and harvesting. We then implemented the domains and indicators at different scales, which set the stage for an analysis of the subsequent trade-offs.

As an example case study, we will provide some details on the rice + fish production system (also see the article in this issue on Opportunities and challenges for integrated rice + fish culture in the polder ecosystems of Bangladesh’s coastal zone). The polder ecosystems in southern Bangladesh are ideally suited for integrated rice + fish culture. Many canals and depressions exist inside the polders where fish usually take shelter when the rice field is dry and during the dry season after the rice harvest. In these ecosystems, fish occur naturally in the popularly grown traditional rice fields, coming in with the river water through sluice gates installed in polder embankments. Although fish culture in paddy fields is a proven technology, no attempts were made earlier to raise fish by managing water infrastructure inside the polders.

The SIIIL-Polder Project team is looking to improve fish culture by adding more nutritious fish species in high-yielding rice fields within a hydrological boundary. The community is being involved to help increase crop productivity and protein sources to enhance economic and household nutritional status. The community-level rice + fish system was introduced to spread this improved technology further to benefit a large number of small, marginalized, and tenant farmers within a hydrological unit. Compared with the single-farmer system (common in most parts of the coastal zone), community-level interventions are more complex and bring in a range of societal concerns to address.

Although this approach increased rice and fish productivity and improved household nutrition, many other aspects had to be dealt with, such as social distrust for produce and profit sharing, unauthorized harvesting, controlling fish escape through rat holes in the village road, and questions related to marketing versus household consumption. Success also depends on rice management practices, especially fertilizer and pesticide applications. So, new and improved technologies that minimize negative impacts on social cohesiveness and, at the same time, lead to higher productivity will be effective and sustainable.

Information related to key indicators for the five domains needs to be collected to help carry out trade-off analyses. These analyses can potentially
capture other unintended changes along with the intended change. The rice + fish production system and mechanization of rice cultivation do not provide extensive unintended aspects with the introduction of the technologies. They are mere examples to demonstrate the complexity underlying technology introduction. There is also a need to ascertain other associated changes before technologies can be adopted on a wide scale.

The planting of a single crop of low-yielding, tall traditional rice varieties has been the norm in the polders. This minimizes yield losses that come with continuous water stagnation, which of course favors fish culture and obviously disfavors cultivating HYV rice. However, the topographical diversity of the polders does allow growing recently released HYVs at higher elevations, which has the potential to cause a quantum leap in the region’s rice productivity. The challenge is dealing with the mosaic of land at high elevations dispersed among land at lower elevations. This makes it difficult, if not impossible, to give blanket recommendations for introducing HYVs into the polders.

So, in addition to giving the community advice on coordinating water management to create an environment for more HYV rice cultivation, the SIIL-Polder Project is working on identifying proportion of land within the command area where mechanized HYV production is feasible. Better coordinated water management would increase the area that could be brought under HYV rice. Having rice transplanted and the harvest uniformly will provide an opportunity to successfully cultivate a rabi crop, which, at the moment, is not widely practiced. More than 50% of the land remains fallow in the dry season. The community has greatly appreciated the introduction of mechanization for rice transplanting and harvesting—especially the transplanter by the youth and mat bed nurseries and reapers by the women. as they see these as a means to reduce their drudgery and also as additional sources of income.

However, several problems have been observed. These include the community’s initial hesitation to try new technologies, poor roads and infrastructure that hinder moving machinery, knowledge on how to operate the machinery, and intrahousehold decision-making on whether to plant traditional or HYV rice varieties. And, in some locations, HYV rice plots surrounded by neighbors’ plots with traditional rice have made it impossible for farmers to harvest the HYVs on time, resulting in yield losses.

When introducing an improved technology, there is often no reliable means to quantify its impact unless there is a baseline or impact assessment framework. Hence, the sustainable intensification indicator framework developed by the SIIL team is allowing the capture of other dimensions of change that are occurring in the five domains because of an intervention. Subsequent trade-off analyses will allow the team to identify the bottlenecks and provide options to ascertain the degree to which trade-offs can be minimized.

Not all interventions will be equally successful, so trade-off analysis is an ideal tool to evaluate decisions aimed for success. For the SIIL-Polder project, data collected take into account at least the major indicators for each of the five domains, which will allow extensive trade-off analysis to categorize technologies into groups such as successful + sustainable, successful + unsustainable, etc., and, where possible, indications to adjust the technology to meet local needs.

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**Fig. 1. Interlinkages across the five domains of sustainable intensification and spatial scales.**
Agriculture plays a key role in Bangladesh’s economic growth and is the most important sector for decreasing poverty in the country. It is also a major source of rural jobs. Around 87% of rural people derive at least a portion of their income from agriculture. Since the Green Revolution of the 1960s, Bangladesh has made commendable progress in achieving food security. With one of the fastest rates of productivity growth in the world, the country’s agricultural sector has benefited from a strategic policy framework backed up by substantial investments in technology and infrastructure. However, most of this progress has taken place in the central and northern parts. This has left behind the southern coastal zone, which is most vulnerable to climate change and natural disasters. For example, most dry-season crops grown by a few coastal zone farmers were destroyed by waterlogging (due to rainfall) from 2013 to 2017.

To feed its growing population, Bangladesh must double 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 (NARES) to study agriculture, aquaculture, and water management. In addition, international development agencies and research centers are investing considerably in R4D in the coastal zone. However, most of these national and international projects operate in isolation and know very little about the science and development work underway in other concurrent initiatives. These projects and programs all hold a great diversity of disciplinary
expertise, experience, networks, indigenous knowledge, etc. If there were a mechanism in place for greater information sharing and networking across the projects and programs, this could bring tremendous benefits leading to more rapid learning and progress in improving productivity, livelihoods, and nutrition in coastal zone communities.

To overcome these gaps, the International Rice Research Institute (IRRI) organized a workshop, Towards better integration of R4D for improved food production systems in the coastal zone of Bangladesh in Thailand in October 2016. It was supported by various CGIAR Research Programs (CRPs), the Australian Centre for International Agricultural Research (ACIAR), Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification (SIIL), and other national research and development agencies. The goal was to explore establishing a platform for improved sharing, networking, complementarities, and synergies across the many R4D projects on production systems and water management in the Ganges coastal zone. The participants were enthusiastic about the idea of forming a knowledge-sharing platform (KSP) for the coastal zone.

Based on strong interest and the recommendation of participants during the 2016 workshop, the Bangladesh Agricultural Research Council (BARC) and IRRI jointly organized a second workshop in Dhaka in May 2017 with financial support from the RICE CRP and SIIL. Participating were prominent national and international agricultural scientists, water management and agricultural extension professionals from different institutions of the NARES and universities, development partners, and NGOs. The workshop brought together the key actors of the many current R4D projects on agricultural cropping systems, water management, and aquaculture operating in the coastal zone.

The participants reiterated the need for establishing a KSP to assist in better policy formulation for the overall development of the vulnerable coastal zone. The KSP could be an informal hub for sharing new knowledge being accumulated by various initiatives. As resources in most of the initiatives are limited, some activities could be done jointly. Everyone agreed that a KSP is critical to bringing together the knowledge of different initiatives under a common umbrella to improve the livelihoods of coastal zone communities through appropriate use of research results.

For more on knowledge sharing, also see in this issue the article on A four-dimensional learning hub for knowledge sharing in the polders of Bangladesh's coastal zone.

Prof. Vara Prasad, SIIL director (far left), emphasized collaborative learning and knowledge sharing to boost agricultural growth in the coastal zone.
Polder Tidings is a platform that highlights challenges and opportunities in coastal Bangladesh. It is published by the International Rice Research Institute (IRRI) with the support from the Sustainable Intensification Innovation Lab, a new Feed the Future initiative funded by USAID.

The materials in this newsletter do not necessarily reflect the official views of IRRI, the Kansas State University, BRAC, SIIL, USAID, or any collaborating institutes of the project.