

GENDER TECHNOLOGY ASSESSMENT

Appropriate Scale Mechanization Consortium

BANGLADESH: HARVESTING TECHNOLOGY

Maria Jones¹, Md. Monjurul Alam², M. Hammadur Rahman², Md. Rostom Ali², Md. Kamrul Hasan², Md. Shadhin Ibn Ali Pathan²,

University of Illinois at Urbana Champaign¹; Bangladesh Agricultural University²

August 2019

The USAID funded Appropriate Scale Mechanization Consortium led by the University of Illinois at Urbana-Champaign develops and promotes appropriate agricultural mechanization technologies for smallholder farmers in Cambodia, Bangladesh, Burkina Faso and Ethiopia. ASMC's 'eco-system of innovation' approach includes the development of local Innovation Hubs comprised of relevant stakeholders to promote and enhance suitable, sustainable, and scalable mechanization. In Bangladesh, the Innovation Hub is directed by Bangladesh Agricultural University, Mymensingh.

SUMMARY

Agricultural technologies can improve economic productivity and reduce time spent in agricultural production, processing, and transporting. Men and women have similar propensities to use technologies however; women are less likely to have access to them compared to men. Ensuring women have better access to agricultural technology, inputs, and information can help lessen the gender gap in agricultural productivity and increase agricultural output globally by 2.5-4 percent (FAO 2011).

The Appropriate Scale Mechanization Innovation Hub Bangladesh (ASMIH-BD) project conducted a Gender Technology Assessment of two harvesting technologies: the Mini-Combine Harvester and the Reaper to identify gender barriers and enablers to adoption of agricultural technologies, and understand intra-household gender norms and women's roles in household technology adoption. This report identifies gender barriers and enablers to adoption of the two harvesting technologies, understands intra-household gender norms and women's roles in household technology adoption. The report concludes with strategies for better design, dissemination, and adoption of the harvesting technologies.

Key Findings:

- As a result of generally conservative cultural norms in Bangladesh that restrict women's ability to engage in farm production and management, women face barriers in learning and being trained on harvesting technologies.
- Bangladesh's rural economy is drastically changing with the out migration of men and increased farm and household responsibilities for women. Knowing about agricultural harvesting technologies, even if women do not operate it, will make them better farm managers or joint managers.
- Owning and leasing harvesting technologies through a women's association can provide new income-generating opportunities for women run associations
- A possible unintended negative consequence of mechanization is the displacement of female (and male) landless wage laborers who perform manual harvesting. The project needs to provide alternative opportunities for male and female landless laborers.

BANGLADESH COUNTRY CONTEXT

Bangladesh is one of the world's most densely populated countries with around 159 million people living in less than 150,000 sq. km (World Bank 2015). Bangladesh has made remarkable progress in reducing poverty and is projected to have achieved the Millennium Development Goals of halving the incidence of extreme poverty (14.8 percent in 2017 from 44.2 percent in 1991). The increases in labor incomes are due to a structural shift from agriculture to industry and services, and has been a main driver of poverty reduction. Bangladesh is also amongst a select group of countries worldwide that experienced a decline in inequality. With a Gini index of 0.3 at the national level, inequality in Bangladesh is lower than India, Nepal, Sri Lanka and most East Asian countries (World Bank 2019).

More than 65 percent of Bangladesh's population live in rural areas working within the agricultural sector. Forty five percent of Bangladesh's labor force participate in the agricultural sector, which contributes to 13.82 percent to the country's GDP (BBS 2017). Around 44 percent of Bangladesh's farmers are smallholders with cultivable landholdings of 0.2-0.6 ha and 36 percent of farmers cultivate less than 0.2 ha (IFPRI BIHS 2016). According to the World Bank, 87 percent of rural households rely on agriculture for at least part of their income (World Bank 2016). Particularly during the two lean seasons (September to mid-November and mid-January to February,) many rural residents move to other nearby areas in search of work. Despite high population density, decreasing arable land, and frequent natural disasters, Bangladesh has one of the fastest rates of agriculture productivity growth in the world since 1995 (2.7 percent per year). However, in recent years, there has been a slowdown in agricultural growth (28 percent of GDP in 1990 to 13 percent in 2018), which is being attributed to lack of diversification, rice-focused agricultural policies, poor logistics and transportations, limited commercialization, weak food safety and quality regulations, natural disasters and negative effects of climate change (World Bank 2019).

Agricultural Mechanization

The expansion of High Yielding Varieties of rice crop in 1970s, increased demand of mechanized irrigation, tillage, pest management and post-harvest processing of crops to attain timeliness of operations and increase cropping intensity. Mechanized land preparation in Bangladesh using two-Wheel Tractors (2WTs) has expanded significantly; and more than 550,000 two-wheeled power tillers are in use (Alam, et al., 2017; Krupnik, et al. 2013). Data from 2015 BIHS shows that 80.6 percent of farms in Bangladesh used 2WT to utilize power tiller services, supplied mainly through fee-for-service arrangements (Theis 2019). Furthermore, mechanized land preparation is nearly equally distributed among small, medium, and large-scale farmers in Bangladesh, due to the pervasive system of custom hiring service provision (Theis 2019; cf. Mottaleb, et al. 2016). Demand for 2WTs has remained high in Bangladesh for a two reasons. Firstly, power tillers or reapers can be attached to the 2WT and used for land preparation or harvesting; secondly, the implements can be removed and substituted with trailers for transportation. This highlights the importance of modular equipment and ways for farm machinery owners to bundle services and generate year-round income (Theis 2019).

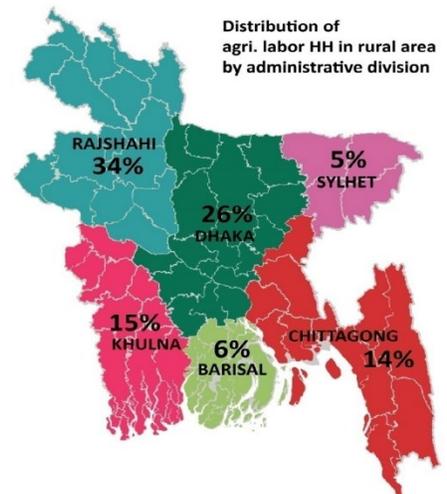
Harvesting equipment is conversely newer with a market value of \$1.2 million per year (Alam 2017). Mechanical harvesting of paddy minimizes time needed, labor, labor involvement, and reduces losses from harvest. Timely harvesting of paddy is a crucial and important process to ensure quantity, quality and production cost of paddy (Noby 2018). Unavailability of timely harvesting can lead to significant losses for farmers. For instance, post-harvest losses of paddy at farm level were at 9.49 percent, 10.51 percent and 10.59 percent for Aman, Boro and Aus seasons, respectively (Bala, et al. 2010). Appropriate farm

mechanization has been emphasized as an important policy and development goal in Bangladesh (Mandal, 2002, 2014; Zhang et al., 2014).

Projections also indicate that rice and wheat production will need to increase by 0.4 and 2.17 percent per year, to keep pace with the two million population added annually (Mainuddin and Kirby, 2015). At the same time, cropland availability in Bangladesh has declined by 68,760 ha per year (0.73 percent) since 1976 (Hasan et al., 2013). Bangladesh needs to produce more food from the same land, while at the same time easing farm labor requirements resulting from the country's increasingly profitable alternative forms of employment (Zhang et al., 2014).

Agricultural Labor

Timely harvesting of paddy is very important to reduce losses affecting the total yield. In recent years, timely harvesting of paddy has been a big challenge due to shortage and the high cost of labor caused by workers' migration, particularly in to garments and construction sectors (Zhang 2014). Just a five to ten day delay in harvest can result in three to eleven percent decrease in paddy yield, respectively (Samon and Duff 1973). According to the Yearbook of Agricultural Statistics of Bangladesh 2011, approximately 35 percent of rural households are agricultural laborers. Nationally, day labor from agricultural work provides 26 percent of income for rural households, second to agricultural self-employment at 31 percent (Rubin 2019, Ullah 2014).



Agricultural laborers tend to be comprised of landless, functional landless, sharecropper and marginal farmers. On average, an agricultural laborer is engaged annually for 162 days in agricultural activities and for 94 days in non-agricultural activities (Saha & Shahabuddin 2013). In addition to seasonal migration for agriculture work, agriculture laborers migrate in off-season to towns/cities and engage in different informal sectors like rickshaw pulling, construction work (Ullah 2014). The availability of agricultural labor varies by division (see image above), with Barisal and Chittagong having less than 6 percent of households providing agricultural labor; and 34 percent located in Rajshahi division. Divisions having less than 25 percent labor availability face labor shortages, particularly in the peak seasons, and are dependent on migratory labor (Ullah 2014).

Gender

In Bangladesh, women play important and growing, but less visible roles in agriculture than men (Zaman 1995; Mahmud, Shah, and Becker 2012; Amin 1997; Bose, Ahmad, and Hossain 2009, Theis 2019). Women's economic contributions are cost saving but may not generate cash, and these activities blend with their other tasks within the compound (Amin 1997). Women's ability to generate income in the agricultural sector is severely constrained by their limited use, ownership, and control of productive physical and human capital (Sabroni 2014). In Bangladesh, 64.84 percent of women are engaged in the agriculture sector followed by 21.89 percent in the service sector and 13.32 percent in the industry sector. Women tend to be engaged in home-based farm activities such as poultry raising, homestead gardening and non-farm services (Ullah 2014, Hossain & Bayes 2010). Women face strong social and cultural constraints to participating in paid work outside the home, including agricultural work in the field (Sabroni

2014). According to recent national statistics, the majority of rural women (71 percent in 2005-2006) work as unpaid family workers, compared to 12 percent of rural men (BBS 2015).

Within rice fields, distance of the field from the home, the technologies used and availability of adult male labor significantly affects women's participation in farming activities. Women work in pulling seedlings, transplanting, weeding and harvesting, although these activities may be restricted in many parts of the country (Pandey et al. 2010). Women also assist in manual harvesting, bundling and carrying crops to threshing centers, post-harvest rice processing, including drying, parboiling, cleaning, grading and storage of rice (Theis 2019). In contrast, men manage field-based agricultural work (such as land preparation, harvesting, threshing which are already mechanized) and market all household products, including those produced by women, and shoulder the socially assigned responsibility to support the family economically (Pandey 2010, Zaman 1995; Begum 1985). Gurung et al. (2013) showed that within family labor, men contribute significantly to rice production and management, which accounts for an estimated 70 percent of rice-related activities, compared with 15 percent performed by women and 16 percent performed jointly by men and women.

Although women's contribution to rice production is lower than that of men, women are beginning to fill roles previously assumed by men. This is due to the out-migration of men who leave rural areas to secure more remunerative employment (Pandey 2010). Between 1999-2000 and 2005-2006, men's employment in the agricultural sector declined by six percent, while female labor force participation in agriculture more than doubled from 3.8 million to 7.7 million. These dynamics are also changing as gains from female employment outweigh the potential cost to social identity (Ahmed and Sen 2018). Women are assuming managerial roles in crop production in the absence of their husbands, but the extent of women's involvement depends on the length of time that the husband is away, as temporary and seasonal migrants will often return to their farms for key activities in the crop production cycle (Jaim and Hossain 2011).

Despite discouragement from engaging in the cultivation of field crops, for many women in poor households it is not possible to avoid fieldwork. To secure their family's subsistence, poor and landless women, widows, and female heads of household often take an active role in field-based activities on their own farms, and landless women often work as wage laborers on the farms of others (Zaman 1995). Between 2005–2006, about 17 percent of rural men and three percent of rural women worked as agricultural day laborers (BBS 2015). Rahman et al. (2016) showed that despite the positive role of women in the production activities, their contribution was often neglected in terms of wage rate. Female wage laborers work at lower wages compared to their male counterparts, and can be paid irregularly and/or in food or in kind (Amin 1997; Rahman and Routray 1998; Kelkar 2009).

ASMIH BANGLADESH

The Appropriate Scale Mechanization Innovation Hub Bangladesh (ASMIH-BD) works with researchers, academicians, extension agencies, farmers, and private companies to disseminate technologies. The project has focused on identifying and promoting planting, transplanting and harvesting technologies for the southern regions of Bangladesh.

The Harvesting team at ASMIH-BD identified promising “on-the-shelf” and effective harvesting technologies using a participatory value chain assessment that involved multiple stakeholders. Next, the technologies were assessed for their technical performance and financial feasibility at farmer's fields. Based on the evaluation, suitable regional harvesting technologies were identified, and promoted through field

days and demonstrations. The activities involved male and female farmers, lead farmers, machine operators, local service providers, mechanics, and field-level extension workers.

Reapers and Mini Combine Harvesters (MCH) are the two harvesting technologies promoted by ASMIH-BD. The first set of experiments and demonstrations on MCH were conducted in Wazirpur, Barisal and Dumuria, Khulna. The MCH was found to be most appropriate based on field performance and farmer's satisfaction after two harvest seasons (Aman 2016 and Boro 2017). Building on the results from the first two regions, the MCH and Reaper were tested and promoted in Subarnachar, Noakhali and Kalapara, Patuakhali upazilas to harvest rice in the seasons of Aman 2017 and Boro 2018.

In last three years, ASMIH-BD's Harvester Team has conducted 10 hands-on training and 13 field days program in Dumuria, Wazirpur, Subarnachar and Kalapara upazilas. In total, 104 participants were present at the various trainings and 575 (105 women) participants at the field day program. Trainings are catered towards farmers, operators, mechanics, workshop owners and DAE extension agents. Field day programs are open to the public, and farmers can see how the technologies work, and exchange knowledge on the benefits of mechanical harvesting. The project also utilized machinery fairs to introduce technologies to wide range of farmers including school-age children. ASMIH-BD is also exploring introducing an agricultural subsidy program in partnership with DAE to assist farmers in purchasing technologies. As a result of ASMIH-BD activities, three farmers/entrepreneurs (one each in Khulna, Barisal and Patuakhali) have purchased MCHs through government subsidy programs. Many others are renting Reapers and MCHs for harvesting paddy.

Box 1: Reapers & Mini-Combine Harvesters

Relative to other agricultural technologies such as power tillers and seeders, **reapers** formally entered the Bangladesh market in the last decade. Two types of reapers are common in Bangladesh: the self-propelled 'walk behind' model and the two-wheel tractor-attachable and rideable models (Theis 2019). Both technologies reduce drudgery and accelerate the rate at which crops can be cut for drying and/or carrying from the field at maturity. Reapers can reduce the harvesting time by 80 percent and harvesting cost by 60 percent, and enable the rapid clearing of land so that farmers can sow the next crop by the recommended planting date (Theis 2018). Reapers can cost between BDT 42,000 to 170,000 (USD 500 to 2,000), depending on the make and model.

Combine harvesters get their name from their combining of three separate operations (reaping, threshing, and winnowing) into a single process. A Mini-Combine Harvester (MCH) is smaller in size, light in weight, easy in travel, and offers control. It is simple to disassemble, convenient to maintain, and is highly adaptable to operate in both dry and wet paddy fields. After six seasons of harvesting, using an MCH on average can save farmers 97.50 percent of time, 61.5 percent of costs and minimize grain loss by 4.9 percent (over manual harvesting). In Bangladesh, several companies import the 4LBZ-110 model produced by Chinese manufacturer, KYM Machinery. The price of a MCH ranges from BDT 720,000 to 750,000 (USD 8500 to 9000). The Ministry of Agriculture's Department of Agricultural Extension (DAE) played an initial role in the dissemination of the mini-combine harvester through the Farm Mechanization Project. DAE distributed MCHs to farmer cooperatives such as Integrated Pest Management (IPM) clubs free of cost and conducted field demonstrations and field days. The project also provided 50-70 percent subsidy to encourage farmers to purchase the machines.

GENDER TECHNOLOGY ASSESSMENT

Technologies/mechanization can improve the timing of tasks, reduce drudgery, make labor more efficient; and improve the quality and quantity of food, feed, and fuel. However, they are not inherently gender neutral and differential changes are not always immediately evident (Manfre 2017). Developers need to ensure that new technologies will benefit both men and women farmers. Closing the gender gap in women's access to agricultural technology is considered a key strategy for rural women's economic empowerment (FAO 2011).

ASMIH-BD conducted a Gender Technology Assessment (GTA) of two harvester technologies: the Reaper and Mini-Combine Harvester. The GTA aimed to understand gender barriers and enablers to adoption of the harvesters; understand intra-household gender norms and identify women's roles in household technology adoption; and identify strategies for better dissemination and adoption. The GTA methodology was adapted from the Technology Assessment toolkit developed by Cultural Practice, LLC within the INGENAES project (Manfre et al., 2017) and the Guidance for Inclusive Irrigation Interventions tool developed by IFPRI-REACH project (Theis et al., 2018). The GTA was conducted over a period of seven days, which included a two-day workshop to train 17 participants that included BAU faculty and graduate students representing ASMC and Post-Harvest Loss Innovation Lab, and research scientists from Bangladesh Agricultural Research Institute. After the training, a four-member team spent four days in data collection and one day in group analysis to organize key findings and develop recommendations for the harvester.

Key informant interviews were conducted with nine households in Wazirpur, Barisal and seven households in Dumuria, Khulna, sites where ASMIH-BD has conducted numerous trainings on the harvesters. Three categories of respondents were targeted: farming households using harvesters, farming households not using harvesters, and co-operatives providing harvesting service. Within households, both men and women were targeted. The team also interviewed four extension workers, service providers, lead farmers and conducted focus group discussions with associations. Data was collected through semi structured qualitative interviews. Interviews were conducted in Bangla, and translated into English when needed. The next section of the report discusses agricultural production and access to service provision along three key areas of inquiry: Time & Labor, Income & Assets, and Intra-household gender norms

Time and Labor

Men perform most agricultural activities related to rice production such as land preparation, planting, transplanting, inter-cultural operations¹, pesticide applications, irrigation, harvesting, transporting the grain to the mill and market. Men are involved in hiring service providers (custom hiring business), and operate machines and perform machine maintenance if they use machinery. Women are responsible for post-harvest activities including winnowing, parboiling, drying, storing and sometimes threshing in rice fields. Especially in betel leaf production, post-harvest activities are seen as women's responsibilities. Multiple women respondents mentioned that female neighbors or relatives assist in post-harvest activities during harvest season. In addition to post-harvest activities, women participate in all aspects of homestead vegetable gardens such as planting, weeding, and harvesting (pesticide application is seen as men's role). Women also tend cattle, goats and poultry since they are considered as part of household tasks. Domestic activities women perform include cooking, cleaning and caring for children, the sick and elderly.

¹ Intercultural operations refers to weeding, pruning, mulching, fertilizing

There is a strong cultural expectation that women should not work or be seen in the fields, and it is perceived as inappropriate for women to operate agricultural machinery. However, the principle is not held closely to female laborers. In Khulna, female laborers performed the same activities as that of the men. Specific tasks include land clearing, weeding and seedling transplantation. One male farmer mentioned that female laborers also collect grains, and carry them to mills. Female laborers are paid 150 BDT (\$ 1.7) per bigha in comparison to male laborers who were paid 300 BDT (\$3.5) per bigha. This discrepancy was due to the perception that “[female laborers] perform less work due to physical weakness.” In fact, due to the variation in price, female laborers were preferred. Male and female respondents said that female laborers were preferred for harvesting mung beans and potatoes, weeding in jute production. For example, a male farmer in Dumuria stated that hiring female laborers was more profitable than hiring male laborers. In contrast, Barisal did not have availability of female laborers and had stronger expectations of women staying away from the rice fields. In cases where women were hired in Barisal, the wage gap was non-existent.

The high rate of male migration from rural to urban areas was also bringing about challenges for women, who had to balance traditional household roles and managing the farm. Such female-headed households mentioned that they depended on brother-in-laws or hired labor. For instance, a woman respondent said, “I pay my brother-in-law [for managing my farm] through sharing 50% of harvests”. In some cases women sent sons, once they were of age, to oversee farm laborers. Female-headed households tend to use and supervise hired labor; however, they tend to be dependent on male relatives such as brother-in-laws to help in negotiating terms and agreements.

Income and Assets

Rice is a prominent cash crop in Khulna region, and Betel leaf a prominent cash crop in Barisal. Men generated income through selling cash crops such as rice, betel leaf, leasing land, selling livestock, and providing labor. Women earned income from selling vegetables, poultry (meat and eggs), rearing goats and sometimes providing labor. Women who generated income said that it brings them dignity and position in the household and the society.

In many households, women stored the household income. The men handed over the household money to the women, although, decisions on expenditure were ultimately made by men. Multiple women mentioned, “My husband informs me and then takes decisions.” Women only controlled income gained from selling eggs and chicken. Women’s income was used towards purchasing household goods like furniture, gifts for children and grandchildren. Some women respondents said they made decisions on purchase of jewelry, goats and cows. Joint decisions by men and women were taken on household expenses incurred during religious festivities and special occasions. This included buying new clothes and other gifts for relatives. Some women respondents said they paid for hired laborers. In female-headed households, women had more control and agency in making financial decisions. A woman respondent from a female-headed household said that she took multiple financial decisions including on building onto her existing home. However, major purchases or decisions were still discussed with husbands (if they had migrated) or immediate male relatives.

The Constitution of Bangladesh provides that all citizens are equal before the law and entitled to equal protection of the law, which prohibits discrimination based on gender. Despite these pronouncements, women in Bangladesh rarely have equal property rights and rarely hold title to land. Fewer than 10% of women have their name included on any documentation of property rights. In rural areas, women access

land almost exclusively through their relationships with male family members such as husbands, fathers, or brothers (USAID 2010). In interviews, most respondents said that men inherit land and control its use. Multiple women respondents said that although by law they should inherit land from their parents, they do not claim the land in order to maintain good relationships with their brothers. Some women said that their husbands discourage them from demanding land from their brothers. These statements are corroborated by literature (Sourav 2015; Taslima 1998). Some women access to farmland under rental or share cropping system. For instance, a women respondent said she owned one acre and leased one acre. This land might be purchased or rented utilizing credit.

Multiple women farmers mentioned they had access to microcredit through NGOs such as ASA and BURU Bangla, which support women run micro-enterprises. Although there is a negative perception of using micro-credit, farmers preferred it to institutional credit for its easy availability, flexible repayment through small installments. Banks providing institutional credit are also physically inaccessible by those in villages. Typical microcredit repayment was BDT 200/ week, which was easily repaid through daily income. Multiple male respondents said they accessed micro-credits through their wives.

Intra-Household Gender Norms

In rural Bangladesh, the practice of purdah restricts women's inter action with men outside the family, with important implications for women's mobility, economic activity, and well-being (Feldman and McCarthy 2006; Kabeer 1990; Amin 1997; Bose, Ahmad, and Hossain 2009; Ahmed and Sen 2018). Observing purdah often concentrates rural women's work on home-based or near-home activities such as homestead gardening, postharvest processing, livestock and poultry rearing, and a range of other domestic activities (Theis, et al. 2019). Women do not go to the markets to buy or sell.

The system of purdah has implications on household decision-making. For instance, men control farm



Box 2: Maksud Begum is a 45-year-old female farmer and the president of a farmer association a farmer association formed out of the Integrated Agriculture Productivity Project (IAPP). The association has 40 members, 9 male and 31 female, with multiple leadership positions held by women. Members are engaged in different income generating activities such as raising and selling poultry and growing vegetables. The association provides a collection point where middlemen buy and women members sell, thereby providing women access to the market. From the shared earnings, 60 percent of the profits go back to the women farmers and 40 percent of the profits are invested back into the association to serve the association's microcredit system. Yearly profits are shared amongst all members. She invests her earnings on her children's education by hiring private tutors and purchasing a computer. Maksud says, *“Before [making money through the association] we had less dignity in society. Now we have more dignity and recognition in the society.”* She believes that the women in her association have full decision-making power in their households on the income they earn from the association. Husbands also have seen the benefit of the additional income the wives bring, and encourage wives to be a part of the association. The success and reach of the association has brought awards and recognition. Maksud is also using her recognition to fight for social causes such as preventing child marriage in her community (she was married at the age of 14). In this photo she proudly displays the association winning first place in Barisal division under the economic development category.

decisions such as marketing, selling, how much to sell and how much to keep for households’ consumption, crop variety, and hiring labor. In some situations, men discuss with their wives regarding seed variety or regarding vegetable production. Joint decisions are taken on children’s education, getting daughter’s married and purchasing household furniture or appliances such as televisions.

Women said they took a lead in decisions involving seed variety and hiring labor for the vegetable gardens. In some cases, women played a role in household decision making behind the adoption of new technologies. While women did not make the final decisions, men discussed the decision to purchase land or technologies with their wives.

In female-headed households, women said they controlled the decisions both in the farm and in the household. Female-headed households mentioned that they buy, sell and control income from all income-generating activities. However, they did not buy or sell land “*due to complicated procedures*”. If the husband had migrated for work, a female respondent said she discussed with her husband over the phone and then made the decision. In other cases, a women respondent said her husband trusts her to make decisions.

Public extension officers organize events such as field days. Village level extension events are attended by men and women, however, upazila level events are targeted towards male farmers. In Khulna, extension agents mentioned that they conduct training programs targeted towards men.

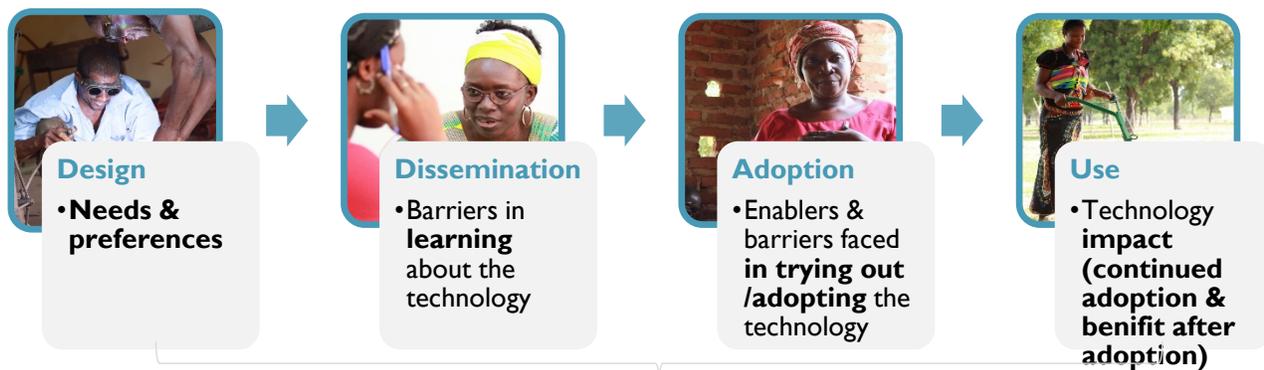
GENDER CONSIDERATIONS WITHIN TECHNOLOGY ADOPTION

Technology design and dissemination reflects the current priorities, perceptions, and norms both about agricultural systems and about gender. Technologies are not inherently gender neutral and there is a need to understand the needs of the users – both male and female prior to design. While the most visible gender gaps between men and women appear in the hands-on use of technologies, in the case of agricultural machinery, gender differences also arise in farmers’ ability to learn about, rent or hire machinery.

This section explores harvester technologies’ adoption by men and women through the four stages of technology adoption: design, dissemination, adoption, and use (see figure below). For this report, we do not address ‘use’ because the technology is still in its early stages.

Design

Both the reaper and MCH reduce the time and labor associated with manual harvesting. The machines reduce harvesting losses and are calculated to save 52 percent of the costs (Hasan et al. 2019). The MCH



Gender Dimensions Framework

Key areas of inquiry: Time & Labor; Income & Assets; Intra-Household Gender Norms

can save women's time in cleaning rice and winnowing. In our interviews, farmers stated preference for the MCH because it performs three operations (harvesting, threshing, winnowing & cleaning) simultaneously. In earlier interviews, farmers said that using the MCH reduces harvesting losses; however, they were unable to state how much rice was saved and how it was used.

However, the MCH does have a big disadvantage in its price. The MCH has a high initial investment cost of approximately 700,000 BDT (8,250 USD). The reaper also is not cheap at BDT 170,000 (2,000 USD). With 50 percent subsidy provided by the government, the MCH can cost BDT 350,000 (4,000 USD) which is still more expensive than the reaper which with subsidy costs BDT 85,000 (~1000 USD). MCH's also pose a constraint for smallholder rice farmers due to its size and weight. The heavy weight restricts MCH usage to rice fields that do not have muddy soils (puddled soils) or stagnant water. The size makes it unsuitable for small plots that are only accessible by narrow paths. It is also difficult to combine several fields in one harvesting operation since neighboring farms may grow different varieties that have different planting days and different harvest times. Multiple farmers said that after using the MCH, bundling straw was difficult because of how the straw fell and the height at which it was cut. This could be due to a lack of technical knowledge amongst operators. Operators also stated that trouble shooting was not easy, and they were unable to solve all technical problems. Some operators also mentioned the unavailability of spare parts.

Farmers prefer the reaper for its lightweight design and maneuverability. However, with the reaper, farmers have a perception that straw binding after reaper operation is tedious and requires hiring extra laborers. Labor is also needed to thresh rice after using a reaper. In Barisal, women who use labor said they pay 5 percent in grain of the total threshed amount (for e.g. 15 kg per 300 kg).

A possible unintended negative consequence of mechanization is the displacement of female (and male) landless wage laborers who perform manual harvesting. While this does not indicate the need to stop mechanization, it does indicate the risks to vulnerable populations' livelihoods that must be considered. Finally, women farmers have participated in field demonstrations; however, usability of the technologies has not been tested with them.

Design Recommendations

- **Service Providers or Operators:** Provide operators training and long-term technical assistance in operating and maintaining the machines, even if they have previous experience with power tillers or tractors. Train operators on business skills.
- Engage private companies to provide training. Build public-private partnerships with organizations such as ACI Motors to provide better warranty and machine services.
- Provide **alternative opportunities for female landless laborers:** This could include training female landless laborers to be machine operators. Since female laborers have already overcome social norms by working in rice fields, they might be early adopters of machinery. This should include testing the usability of the technologies with women, and training to be female operators. These laborers can also be connected to a women's club (e.g. IPM clubs) that are specifically oriented towards landless laborers.

Dissemination

ASMIH disseminated information on the reaper and MCH through a mix of trainings and field demonstrations (see [ASMIH Bangladesh](#)). Due to social norms (see [Intra-Household Gender Norms](#)) that require women to be separate from men, women respondents attended field demonstrations but did not attend trainings. In fact, women respondents self-identified the lack of access to formal training as a barrier to technology knowledge and adoption. Women respondents in Barisal and Khulna cited training location requiring travel as a barrier. The further the distance, women were required to get permission from their husbands or elderly household members to attend the training. Furthermore, the distance and duration of training could affect their household responsibilities or childcare. In fact, Maksuda Begum (see box 2), leader of the Integrated Agricultural Productivity Project (IAPP) in Wazirpur, Barisal said that men and women are not equally selected to participate in trainings due to social barriers and perceived lack of physical capacity. Some women respondents said they could use the MCH or reaper if they received training and support.

In addition to trainings, men and women learn and adopt new technologies through farmers associations such as Integrated Pest Management (IPM) or IAPP clubs (see [Barriers and Enablers to Adoption](#)). Women, specifically cited neighbors as sources of information. Female-headed households cited brothers-in-law as trusted sources of information.

Dissemination Recommendations

Knowing about the harvesting technologies puts women in a better position to manage farms alongside their husbands, if the farms are jointly managed. Additionally, with the out-migration of men, Bangladesh's rural economies are changing with women becoming more involved in farming. Training both women and men on technology usage can enable women to access information and ensure the project's activities are gender transformative. Specific demographics of women to train include female-headed households and female landless laborers. During trainings, ensure:

- Separate trainings for men and women
- Accessible location (or provide transportation) and appropriate timing (not mornings)
- Tailored content that caters to participants needs. E.g., train women on overall knowledge about the technology and its benefits
- Training caters to lower literacy among women by using local dialect, simplified concepts and visuals
- Provide training on starting service provision business

Barriers & Enablers to Adoption

Individual Ownership

Due to social norms, men and women perceive women operating machines as unacceptable behavior. This poses a barrier to women's adoption and ownership of mechanization technologies. Furthermore, the price of both the reaper and the MCH, even with subsidy, are beyond the financial capacity of most women. While women have access to credit through Village Savings and Loans Associations, these are

typically insufficient for large capital investments. [Intra-household gender dynamics](#) also prevent women from being decision makers on purchasing technologies.

On the other hand, men have an innate advantage in learning and adopting technologies such as the reaper or MCH. Men find operating the technologies easier since they are building upon on prior knowledge on operating technologies such as power tillers and tractors. Furthermore, men have access to information from extension agents and training opportunities from a wide range of providers (private companies, NGOs, etc.). Men finance the machine through a combination of cash, trade in crops, taking loans from NGOs such as BRAC, renting-out land, and receiving loans from machinery dealers.

Service Providers

Fee-for-service arrangements have made technologies substantially more accessible to resource-constrained farmers who no longer need to purchase capital-intensive machinery to make use of technologies. Additionally, there are employment opportunities in operating, repairing and maintaining technologies. However, especially in Bangladesh, men hold these positions. Of the farms that use 2WT-operated power tiller services, 82.5 percent of service provision businesses are exclusively male-managed. A similar gender disparity exists in terms of the providers of custom-hire machine services in Bangladesh. Of the 257 2WT power tiller service providers identified in the 2015 BIHS, 98 percent are male (Theis 2019). A male farmer stated that he only hires men as mechanics or as a driver because he perceives that women are not capable with motorcycle/power tiller repair and driving. Although some women were open to being a mechanic or driver, they also perceive barriers in performing “heavy work”.

Farmer Associations

Khulna and Barisal have active farmer’s groups or associations such as Integrated Pest Management (IPM) clubs, Integrated Crop Management (ICM) clubs and organizations formed out of the Integrated Agricultural Productivity Project (IAPP). Most organizations have both men and women as members and do not charge a fee. IPM clubs are very active, meet in farmers’ households and receive training on a variety of topics such as agriculture and livestock production, health, and gender based violence prevention training.

One of the IPM clubs in Wazirpur, with multiple women members operated a custom hire service with a reaper, MCH, transplanted and thresher by working with local service providers. The club received the technologies free from DAE’s Farm Mechanization Project and in return had to use local resources to build a storage shed. The club provides services to 70 - 80 farmers each season and charge BDT. 800 – 1000 per 0.20 acre for offering MCH services. The operators are younger male members of the club who are paid BDT 400/ day. The operator interviewed had a Facebook account through which over 35 young farmers have contacted him for accessing services. The profits from the business are invested back into the club, and a portion of funds was used towards machine maintenance.

Maksuda Begum’s association (see box 2) received a power tiller and pump five years ago from government. However, without maintenance support the technologies are currently not working. The association is very interested in operating a custom hire service using the reaper; however, Maksuda believes that even with the subsidy the association will not be able to purchase the technology.

Adoption Recommendations

- **Women-led farmer associations** are interested in investing in machinery to run a service provider business. Provide tailored assistance to women led associations to own and operate custom hire service of MCH or reaper. Connect associations to subsidies.
- **Work with female-headed households** to promote technology ownership and manage service provision business. Female headed households with men who have out-migrated, are severely time and resource-constrained and will most directly benefit from reapers or MCHs, especially in comparison to women who are less involved in agriculture and come from wealthier or male-headed households (Theis, 2019). Encourage such women to become service providers (manage service provision business).
- Similarly, **engage female landless laborers** in training them to become machine operators. These women are already breaking social norms given the necessity of their involvement in agriculture and economic activities, and will most likely be open to learning and operating machinery.
- Help interested farmers in getting **government subsidy**. Connect farmers with credit providing organizations (gaining information and help in procurement).

CONCLUSION

Agricultural technologies are never gender neutral. While the most visible gender gaps between men and women appear in the hands-on use of technologies, in the case of agricultural machinery, gender differences also arise in farmers' ability to rent and hire machinery (Manfre 2017). When assessing how agricultural technology can serve women's strategic interests in Bangladesh, it is important to recognize that women play important and growing, but less visible, roles in agriculture than men.

While conservative cultural norms in Bangladesh restrict women's ability to engage in farm production and management, women represent untapped potential in agricultural technology markets as both clients of service providers and as business providers. Especially female-headed households with men who have migrated for work and female laborers serve as target demographics encourage owning/ leasing the technology or operating the technology. Knowing about the technologies puts women farmers in a better position to manage the farms alongside their husbands, especially if the farms are jointly managed. Machine dealers, extension agents, and service providers can play a role in encouraging women's participation in service provision.

ACKNOWLEDGEMENTS

The authors would like to thank the following individuals for their contributions:

- Dr. Monjurul Alam, Dr. Chayan Saha in guiding the efforts to conduct the Gender Technology Assessments in Bangladesh
- Dr. Md. Hammadur Rahman, Md. Kamrul Hasan, and Md. Shadhin Ibn Ali Pathan in sharing their expertise, time and conducting the assessments in the field
- Shahana Begum, ASMIH-BD Gender Specialist for her support in developing the questionnaire
- Cristina Manfre, TechnoServe Gender Director for guiding the development of recommendations for this report
- And countless staff at Bangladesh Agricultural University, who helped organize logistics for trainings and the assessments

This report is made possible by the support of the American People provided to the Feed the Future Innovation Lab for Sustainable Intensification through the United States Agency for International Development (USAID). The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government. Program activities are funded by USAID under Cooperative Agreement No. AID-OAA-L-14-00006.

Contact: Maria Jones mjones10@illinois.edu ; Dr. Hammadur Rahman hammadbau@yahoo.com

REFERENCES

- Alam, M. and I. N. Khan. 2017. Agricultural Mechanization: Status, Challenges and Opportunities in Bangladesh, Mechanization for Sustainable Agricultural Intensification in SAARC Region, SAARC Agriculture Centre, page 41-70.
- BBS (2017). Statistical Pocketbook of Bangladesh. Bangladesh Bureau of Statistics. Ministry of Planning, Bangladesh.
- Bala B. K., M. A. Hoque, M. A. Hossain and S. Majumdar (2010). Post-harvest loss and technical efficiency of rice, wheat and maize production system: assessment and measures for strengthening food security. Final Report (CF # 6/08) submitted to the National Food Policy Capacity Strengthening Programme (NFPCSP), Ministry of Food and Disaster Management, Dhaka, Bangladesh.
- FAO. (2011). The State of Food and Agriculture. Women in Agriculture: Closing the Gap for Development. Rome: Food and Agriculture Organization of the United Nations.
- Gurung K., H. Bhandari, T. Paris, S. Mohanty (2013). Gender Dynamics in Changing Rice-Based Agricultural Systems in Bangladesh. Village Dynamics in South Asia (VDSA), Policy brief, IRRI.
- Hasan MNM, Hossain SM, Islam RM, Bari MA (2013). Trends in the Availability of Agricultural Land in Bangladesh. Soil Resource Development Institute (SERDI), Ministry of Agriculture, Bangladesh, Dhaka. Available from URL: <http://www.nfpcsp.org/agridrupal/sites/default/files/Trends-in-the-availability-of-agricultural-land-in-Bangladesh-SRDI-Supported-by-NFPCSP-FAO.pdf> (accessed 17.05.15.)
- M. K. Hasan, M. R. Ali, C. K. Saha, M. M. Alam and M. M. Hossain (2019). Assessment of Paddy Harvesting Practices in Southern Delta Region of Bangladesh. Progressive Agriculture. 30(1): 57-64.
- Hossain, M. A. M. A. Hoque, M. A. Wohab M. A. M. Miah and M. S. Hassan. (2015). Technical and Economic Performance of Combined Harvester in Farmers' Field. ISSN 0258-7122. Bangladesh J. Agril. Res. 40(2): 291-304, June 2015.
- International Food Policy Research Institute (IFPRI), 2016, "Bangladesh Integrated Household Survey (BIHS) 2015", <https://doi.org/10.7910/DVN/BXSYEL>, Harvard Dataverse, V3

- Mahbub Hossain and Abdul Bayes (2010) *Rural Economy and Livelihoods*, A.H.L. Development Publishing House, Dhaka
- Mainuddin M and Kirby M (2015). National food security in Bangladesh to 2050. *Food Secure*. 7 (3), 633-646.
- Mandal, M. A. S. (2002). Agricultural machinery manufacturing and farm mechanization: a case of rural non-farm economic development in Bangladesh. In: Paper Presented at International Workshop on Fostering Rural Economic Development through Agriculture-based Enterprises and Services. November 19-22, GTZ-Haus, Berlin, Germany.
- Manfre, Cristina; Nordehn, Caitlin; Rubin, Deborah (2017) *Technology Assessment Toolkit*
- Monsoor, Taslima, 1998, "In Search for Security and Poverty Alleviation: Women's Inheritable Entitlements to Land, the Untapped Resources", *Journal of International Affairs*, Vol. 4, No. 2, BILIA, Dhaka
- Noby, M. M., M. K. Hasan, M. R. Ali, C. K. Saha, M. M. Alam and M. M. Hossain. 2018. Performance evaluation of modified BAU self-propelled reaper for paddy. *Journal of Bangladesh Agricultural University*, 16(2): 171-177.
- Pandey, Sushil, Derek Byerlee, David Dawe, Achim Doberman, Samarendu Mohanty, Scott Rozelle, and Bill Hardy, eds. 2010. *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*. Los Baños, Philippines: International Rice Research Institute
- Rahman, F., S. A. Shammi, M. T. Parvin, N. Akter, M. S. Khan, S. Haque (2016). Contribution of rural women to rice production activities in two different areas of Bangladesh. *Progressive Agriculture* 27 (2): 180-188.
- Rubin, Deborah; Ferdousi, Shammi; Parvin, Aklima; Rahaman, S.M. Tahsin; Rahman, Shuchita; Rahman, Waziha; and Redoy, Md. (2018) Qualitative research on women's empowerment and participation in agricultural value chains in Bangladesh. Bangladesh and Washington, DC: International Food Policy Research Institute (IFPRI). <http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/132875>.
- Sourav, Md. Raisul Islam (2015) Unjust Land Right of Women in Bangladesh. *International Research Journal of Interdisciplinary & Multidisciplinary Studies (IRJIMS)*. Volume-I, Issue III, Page No. 5-13 <https://pdfs.semanticscholar.org/63ad/d6452b8606eb9c397e0ebd5ab8332b68d80a.pdf>
- Theis, Sophie, Nasrin Sultana, and Timothy J Krupnik (2018) "Overcoming Gender Gaps in Rural Mechanization: Lessons from Reaper-Harvester Service Provision in Bangladesh." *Gender, Climate Change and Nutrition Integration Initiative (GCAN) Policy Note 8*; the Cereal Systems Initiative for South Asia (CSISA) Research Note 9. Dhaka, Bangladesh.
- Theis, Sophie; Krupnik, Timothy J; Sultana, Nasrin; Rahman, Syed-Ur; Seymour, Greg; Abedin, Naveen (2019) "Gender and Agricultural Mechanization: A mixed methods exploration of the impacts of multi-crop reaper-harvester service provision in Bangladesh." IFPRI Discussion Paper 01837.
- Ullah, Mohammad Shahid (2014) *Agriculture labourers of Bangladesh: Entrapped in unviable production relations*. Bangladesh Labor Foundation <http://www.blf-bd.org/wp-content/uploads/2017/03/Agriculture-labourers-of-Bangladesh.pdf>
- USAID (2010) *Land Links Bangladesh*. <https://land-links.org/country-profile/bangladesh/#land>
- World Bank (2016) *Bangladesh: Growing the Economy through Advances in Agriculture*. October 9, 2016. www.worldbank.org/.../bangladesh-growing-economy-through-advances-in-agriculture.
- World Bank (2016) *Country Partnership Framework for Bangladesh FY 2016 – 2020*. September 12, 2016. https://issuu.com/world.bank.publications/docs/cpf_report_outline_created_small_si
- World Bank (2019) *Bangladesh Country Overview: Results*. Retrieved June 12, 2019 <https://www.worldbank.org/en/country/bangladesh/overview#3>
- Zhang, X., S. Rashid, K. Ahmad, A. Ahmed. 2014. Escalation of real wages in Bangladesh: is it the beginning of structural transformation? *World Dev.* 64, 273-285.