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COOPERATIVE FARMING POTENTIAL FOR ESTABLISHING FOOD SECURITY WITHIN RURAL BANGLADESH

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Abstract

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Cooperative farming led by smallholder farmers might be the future of Bangladesh's agriculture. The paper examines rice-farming surveys from Kurigram Sadar, Bangladesh, and explores the potential of cooperative farming and mechanization. It reveals that a number of informal, community-supported cooperative practices are already in place, although rice farming is still labor intensive and inefficient. The paper argues that mechanization of key activities and institutionalization of cooperative farming may reverse the situation and improve food security. Kurigram Sadar rice farming is relevant to other parts of rural Bangladesh as well, as most of the country is employing similar agricultural practices.

Keywords: smallholder cooperatives, food security, rice farming, farm mechanization

INTRODUCTION

Individual farmers may realize mutual economic and even social benefits by pooling their limited resources through agricultural cooperatives (Bishop, 2012), themselves a 250 million member phenomenon with numerous successful examples reported worldwide (ICA, 2015; FAO, 2012; Agarwal, 2010; Kokaisl, 2013).

Agricultural cooperatives are typically classified into agricultural service cooperatives and agricultural production cooperatives (Cobia, 1989). Cooperatives tend to expand as markets fail to deliver goods and services at reasonable prices and adequate quality (Barrow *et al*., 2005). They empower their members, help them procure products and services for less then what they would individually and also facilitate their efforts in achieving greater profits (Barton, 2000). Through cooperation, members may share the profits, expenses and manage the risks of production according to their individual inputs (McLeod, 2006).

Bangladesh is an agriculture-dependent country, with almost a third of its population below the poverty line (WB, 2014). In this regard, cooperative movement has failed to materialize the crucial goal of reducing poverty (FAO, 2014; WB, 2014). Even so, the 13 million rice-growing households are still in a position to benefit through agricultural cooperatives in more than one way, including group procurement and selling as well as group utilization of agricultural land and equipment (BRRI, 2015; Wanyama, 2014).

The paper focuses on rice producers since rice occupies as much as 75 percent of agricultural land in Bangladesh, resulting in more than 35 million metric tons of rice every year (GAIN, 2013). Rice has gained popularity due to it being one of the cheapest sources of calories, protein and fat (Hossain *et al*., 2012), supplying the population with up to two-thirds of their calorie intake (BRRI, 2015).

Most rice-farming households in Bangladesh, however, rely on traditional methods of farming, resulting in reduced yields. Another issue is the large percentage of landlessness amongst rural households (51.61 % in Rangpur division) (NIPRT, 2013). Lastly, Islamic inheritance law acts as an encouragement, effectively sustaining land fragmentation and making it harder for many farmers to apply any form of mechanization to their lands (Bosworth *et al*., 1993).

In this paper, agricultural cooperatives are defined as a service and production cooperative, capable of pooling individual farmers' resources to purchase required inputs and also assist with marketing produced goods. The aim of the paper is to assess the cooperative farming practices and capacities of rural farmers within Kurigram Sadar, Kurigram district, using collected surveys from 232 households.

The paper starts by reporting on the characteristics of rice growing in Kurigram Sadar. It then proceeds by identifies potential for labor substitution through cooperative farming and finally provides estimates through a number of cooperative scenarios.

MATERIALS AND METHODS

Study area and data collection

Surveying was done in Kurigram Sadar upazila, a region consisting of 8 unions and 269 villages (BBS, 2012a). The upazila's 72,592 households, three quarters of them being rural, are spread over 276.45 km² (Islam *et al*., 2003). The region is infamous due to extreme levels of poverty, high level of illiteracy (BBS, 2014), large rice yield gaps (Sattar, 2010), and common land flooding, which all act as obstacles to farming and food security attempts.

Survey was administered via face-to-face interviews using a questionnaire with 41 questions, requiring on average half an hour to complete. Participants were offered no incentives in order to avoid potential bias, with anyone above the age of 18 considered a potential interviewee.

Households selected for the interview were required to have at least 0.01 acres of land, effectively excluding landless households. The later were not considered in the study as they had only their labor to contribute to an agricultural cooperative. This is crucial since member homogeneity is the prerequisite for successful cooperation (Hansmann, 2000). Another criteria required of the households is that they have grown rice at least once during the last five years, assuring that they have the competencies and knowledge to answer the questions.

Individual villages within each of the eight unions of Kurigram Sadar were selected using simple random sampling method (Yates *et al*., 2008). An average village in Bangladesh has 232 households (Islam and Jamal, 2012), half of whom are landless (NIPRT, 2013). This helped narrow the number of potential households to 928. Systematic sampling was used in the field to assure that every other house within a village is selected. Should a household be unavailable, the surveyor would move on to the second house, following the every-other-house rule. This further narrowed the potential number of interviewees to about 464, assuring a sound base for research in case some households are unavailable to participate.

The study aimed at collecting at least 196 surveys, assuring the targeted 95 % confidence interval and 7 % margin of error of the sample. This goal was determined by the resources availability, geographical setting of the study area and the available transportation options. Survey was administered with the help of three assistants during the first half of November 2015, producing 232 surveys.

Lastly, the study acknowledges limitations such as relatively narrow sampling area, unavailability of all targeted households, sublime influence of family and friends during the interview and the truthfulness of respondents when answering questions.

Cooperative model

Three scenarios are used to demonstrate potential benefits of cooperative rice farming within Kurigram Sadar. The first scenario shows how much rice is being produced using present agricultural practices. A cooperative within a hypothetical village of 232 households is taken as an object of the study. Half of the residents are taken to be landless, with the other half structured based on the gathered survey data. The model focuses on rice-growing households who have expressed willingness to be part of an agricultural cooperative without any government intervention.

Such conditions are met by 171 surveyed households, suggesting that the actual number of cooperative-ready households within the hypothetical village is 86, with a total joint agricultural land of 211.54 acres. These figures are used as the base for the other two scenarios.

A separate situation where agricultural land of participating households is aggregated is presented in the second scenario. Farmers in this case are assumed to be working together, cooperatively farming the land and sharing potential profits and losses based on each farmer's contribution. The model for distribution relies on the sales value of each harvest, recorded costs and realized profits to determine each farmer's share. This is accomplished through division of individually contributed inputs with corresponding totals and then using the quotient to calculate the share.

Some of the benefits of land aggregation are reflected in a joint adoption of best practices, coordinated land preparation, rice planting and harvesting, with some of the more quantifiable areas shown in Tab. I. The idea behind the improvements is to reduce a portion of some of the most common losses caused by poor farming practices.

As part of this scenario, production estimate in case all farmers planted rice twice a year using current agricultural practices is presented as well. It focuses on raising cropping intensity to two crops per year (200 %), predicting substantial increases in production since the current cropping intensity for rice stands around 141 % and raises to 185 % when the rest of the crops are included.

I: *Areas with potential for improvement*

Area of improvement	% of potential improvement
Pest control (weeds, animal pests, pathogens and viruses)	37.4 %
Post-harvest practices (harvesting, drying, milling, storing)	13.2 %
Total	50.6 %

Note: The percentages present estimated losses caused by poor farming practices.
Source: Oerke, 2006; Mejia, 2003

Estimating rice production in this case combines recorded yields with country's most common cropping pattern (potato – Boro – Aman) (Enamul, 2001), while admitting that due to differences in land characteristics such wide application of the pattern may not be possible.

Third scenario substitutes chosen manual operations with respective mechanized equipment. Motorized equipment is contrasted with manual labor through a cost-benefit analysis for transplanting, weeding, and harvesting stages of rice farming. This scenario, unlike the previous, presents the improvements in monetary terms.

RESULTS AND DISCUSSION

Agricultural practices of Kurigram Sadar rice farmers

Results are laid down starting with demographic, ownership, income, spending and savings data. Data on production, processing and use of agricultural produce is shown next. Cooperative farming inclinations are presented at the end. All results are within the 95 % confidence interval and 7.49 % margin of error, with 171 samples used.

Average household size within the surveyed group was 5.47, significantly higher than the national average of 4.36 (BBS, 2012b). Most popular occupations of household members revolved around agriculture (99 %), followed by the service sector (41 %) and schooling (62 %).

The high percentage of service workers revolves mostly around positions such as a rickshaw driver, small retailer or a local artisan. Presently, only one percent of household members are working in an industry, revealing potential for diversification and a shift in that direction.

As much as 97 percent of households own houses they live in, together with some 1.23 acres of land (on average). Unfortunately, land ownership inequality within the region reveals that the top 20 percent of households own as much land as land the remaining 80 percent, with land policies including land ceilings unsuccessful and easily circumvented by the more powerful households (Rahman and Manprasert, 2006). The situation of high landlessness and disturbed land ownership inequality is only one of the three obstructions to cooperative farming. The remaining two include land fragmentation institutionalized by the Islamic inheritance law and the prevalence of traditional farming methods.

Farmers use the land primarily for agricultural purposes (99 %), with 12 percent of households reporting using the land for fisheries as well. The average distance of agricultural land from the house is less than a kilometer, however, eight in ten households have their land fragmented with an average of five parcels per household.

Similar conclusions may be reached for the 40 percent of households who reported owning equipment. Majority of this machinery, however, refers to simple tools such as sprayers or rarely irrigation equipment. Overall, out of 232 households, only five have mentioned owning a cultivator and only a single household said they owned a tractor.

When it comes to income and spending, the rural households seem to be slightly poorer compared to the national average (BBS, 2010). Moreover, as much as 56 percent of households are indebted, with insignificant ability to save (on average $7.9 per month).

As much as 89 percent of households grow rice at least once per year. Bangladesh has three rice-growing seasons, Aus, Aman and Boro. While Aman is the largest harvest measured by the amount of land used to cultivate rice and the number of farmers growing it (66 %), Boro is the largest harvest by the amount of rice harvested (grown by 53 % of households). Aus season once used to be the second largest harvest, however, it was gradually replaced by Boro during the past couple of decades (Heitzman and Worden, 1989).

Average Aus rice yield within the surveyed area was 2,086 kg per acre, for Aman it was only 1,411 kg per acre, while for Boro it was a record 2,114 kg per acre (1 acre = 4046.86 m^2). Recorded yields are surprisingly higher that the national averages (829 kg per acre for Aus, 930 for Aman and 1,596 for Boro) (BBS, 2015) although Food and Agriculture Organization offers a more reasonable number of 1,788 kg per acre (FAO, 2015).

Such high yields may be partially explained through relatively high adoption rates of high yielding varieties (HYVs) (48 % of households), quite liberal use of fertilizers (98 %), and pesticides, herbicides and fungicides (PHFs) (92 %).

Tab. II summarizes all of the recorded farming operations along with the method of how they are performed. As may be noted, majority of operations are performed manually, with very few exceptions that would otherwise be impossible or extremely hard to perform manually.

II: *Farming operations performed manually and using equipment (% of households)*

Nº	Operation	Done manually	Done using animal power	Done using equipment
1	Land preparation	20 %	14 %	66 %
2	Planting	99 %		1 %
3	Fertilizer application	98 %		0 %
4	PGF application	11 %		81 %
5	Weeding	93 %		7 %
6	Harvesting	98 %		3 %
7	Transportation	92 %	3 %	6 %
8	Threshing	83 %		19 %
9	Milling	0 %		100 %

Note: Totals could go beyond 100 % since households often combine manual work with the use of equipment. Source: own work

Land preparation, for instance, is done mostly using equipment, which may lead to a wrong conclusion that many farmers own cultivator and tractors. The reality of it is that just fewer than 3 percent of households own cultivators and tractors, leaving the rest to borrow or hire equipment from the more well off households, delaying their planting activities in the process.

Cooperative farming in this case may potentially reduce the wait time for participating households through cooperative land preparation, planting, weeding, harvesting, and other operations. Such strategy would also reduce any inefficiency in using the equipment and contribute to productivity.

Sowing and planting, however, are performed by hand. In doing so, farmers typically chose between direct seeding method (seeds are planted directly in the field) and transplanting (seedlings are raised in seedbeds before being planted in the field). Which method of planting farmers end up selecting will depend on a number of factors such as location of the land, soil characteristics, and the risk of flooding.

Transplanting however seems to work best in Kurigram Sadar as 93 percent of households opt for this method of rice planting. The method brings many benefits with it as it requires half as less seeds as direct seeding and is also a proven form of weed control. It is, however, more labor intensive, the prepared seedbeds take up to 10 percent of the land area, and the actual rice usually takes longer to adept after transplanting (IRRI, 2015).

Once planted, rice requires a lot of water to grow. As much as 90 percent of households rely on shallow tube wells to provide water for their crops. Most of the wells run on diesel, a rather costly alternative. Irrigation costs make up to a third of variable costs in rice farming in Bangladesh. In Thailand, it is eight while in Viet Nam only six percent (Farid *et al.*, 2006). Managing water sources cooperatively may be a solution, especially if it could reduce dependency on arsenic-contaminated underground water.

Remaining operation such as weeding harvesting, transportation and threshing are performed manually, too. Substituting labor with mechanized equipment would not only increase productivity but would also lead to reduced costs. Moreover, equipment such as a cultivator has more than one use due to its detachable engine, allowing it to be used as a water pump, rice thresher, mill or a transport vehicle.

Harvested rice requires quick drying in order to bring down the moisture content in rice (typically to 12 %). Sun drying is most widely used method because of its low cost compared to mechanical drying (100 % of households sun-dry their rice). Milling and storage are operations closely connected with the previous phase. Unlike the other labor-intensive operations, rice is actually milled completely using equipment (100 % of households). At the end of the rice-growing process, rice is stored in bulk storages (61 % of households) or in jute or plastic bags (47 %).

Sixty-three percent of produced rice is then consumed within the household, while remaining amounts are sold. Profits made on the sale are typically used to cover costs of hired labor as 83 percent of households hire help at least once during the season. Another portion is saved for unexpected events such as floods (experienced by 84 % of households).

Quantifying the benefits of cooperative farming

When benefits and requirement of cooperative farming were explained to surveyed households, a surprising 81 percent expressed their interest in participating. The number grew to 91 percent in case government supervised cooperative farming. Equally important were the 74 percent of households that believed that their neighbors would participate, too.

However, the most peculiar finding is the percentage of households already cooperating with each other (81 %). This was also confirmed first hand since the study was realized in the middle of the Aman season harvest. Groups of men would gather to harvest, manually transport, thresh and spread the rice on the floor to sun-dry. A good part

III: *Aus, Aman and Boro rice production using current practices (acre, kg/acre and kg)*

Rice season	Farmers growing rice	Amount of land	Yield	Production
Aus	24	23.54	2,086	49,104
Aman	124	157.65	1,411	222,444
Boro	93	120.77	2,114	255,308
Total	241	301.96		526,856

Note: Number of farmers exceeds the total number (171) as some grow rice more than once per year.
Source: own work

IV: *Potential improvements resulting from cooperative farming (% and kg)*

Area of improvement	Rice season	% of improvement	Production increase
Pest control	Aus	9.35 %	4,591
	Aman		20,799
	Boro		23,871
Post-harvest practices	Aus	3.30 %	1,620
	Aman		7,341
	Boro		8,425
Total		12.65 %	66,647

Note: It is assumed that only a quarter of estimated losses are reduced through collective farming.
Source: own work; Oerke, 2006; Mejia, 2003

V: *Production of Aman and Boro rice under 200 % cropping intensity (kg)*

Rice season	Farmers growing rice	Amount of land	Yield	Production
Aman	171	211.54	1,411	298,483
Boro	171	211.54	2,114	447,196
Total	342	301.96		745,679

Source: own work

of the helping staff were extended family members or friends.

When asked about the obstacles for collective farming within their village, 49 percent named land ownership issues as the most important one, with financial situation at the second position (46 %). As for the requirements to participate in cooperative farming, government support in the form of new equipment, loans, seeds and fertilizers was a priority for majority.

Such findings give hope that cooperative movement may be revived in Bangladesh and could play the part in establishing food security and alleviating poverty. Moreover, this setup creates opportunities for rice farmers to take advantage of cooperative farming in the near future. Chosen aspects of these benefits are quantified and presented in the following three scenarios.

Tab. III gives an overview of current production levels of Kurigram Sadar rice growers under the assumption that they produce independently of each other.

Tab. IV shows selected areas of improvement under good cooperative management. It reveals the potential to increase production by 12.6 percent should estimated losses be cut by a quarter.

The extension to this scenario isolates cropping intensity benefit, offering an estimate for rice production in case all farmers managed to grow rice during two most popular seasons, Aman and Boro (Tab. V). Although this scenario shows a promising 41.5 percent increase compared to current production levels, it is imperative to consider the inability of all of the land to grow rice twice per year, mostly due to flooding. Nevertheless, it shows a promise if rice producers managed to organize themselves through a cooperative and increase the cropping intensity at least to a point.

The third and final scenario shows an alternative way collective farming could benefit rice producers by presenting a cost-benefit analysis of selected operations performed using motorized equipment and manual labor (Tab. VI). It reveals cost reductions of 85 percent in case of transplanting to as high as 92 percent in case of weeding. The analyses for other activities such as land preparation, threshing and transportation, shows similar ranges of saving, further extending the benefits.

In addition, substitution labor with mechanized equipment would reduce the yearly person-day requirements from the high of 14,126 to just 333, freeing the people to take on employment within the service or industry sectors. Such strategy, however, makes sense from financial point of view only should alternative employment options be available. Otherwise, cooperative members may find themselves burdened with loans and costly maintenance, eventually being forced to revert to labor-intensive practices.

VI: *Cost-benefit analysis for selected operations (USD)*

Cost structure	Transplanting	Weeding	Harvesting
Amortized equipment	$479	$220	$289
Repair costs	$80	$110	$144
Fuel costs	$283	$1,513	$1,269
Labour costs	$220	$333	$350
Total for equipment based production	$1,026	$2,176	$2,052
Amortized value of used equipment			$5,020
Repair costs			
Fuel costs			
Labour costs	$6,960	$27,838	$3,486
Total for labour based production	$6,960	$27,838	$3,536
Savings	$5,934	$25,662	$1,484

Source: own work; BBS, 2015

CONCLUSION

Food security in Bangladesh is presently a battle fought by the government, numerous non-governmental organization and foreign aid agencies. Cooperative farming may contribute significantly to the outcome by providing rural households with a tool to procure inputs more cheaply, farm more productively and market the goods more expensively. The promising 12.6 percent increase in rice production due to reduction in losses and the estimated 41.5 percent increase resulting from intensified cropping intensity, makes cooperative faming a prime tool for poverty alleviation in rural Bangladesh. An important aspect of cooperative farming are the potential savings due to mechanization of traditional, labor-intensive operations. The cost reductions of up to 92 percent suggest the need for replacing majority of manually performed operation in rice growing. The prospects and opportunities seem endless as the overwhelming majority of households presently rely on traditional farming methods although willing to partake in cooperative farming and take advantage of the benefits. Cooperative farming, however, may contribute to growing unemployment as more farmers become redundant in daily farm activities. Moreover, landless households are left out as they have nothing but their labor to contribute. The role of government is therefore a key factor to reviving cooperative movement in Bangladesh and making sure that additional labor and landless households are properly taken care of.

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