BORO RICE PROCUREMENT IN BANGLADESH: IMPLICATIONS FOR POLICY

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BANGLADESH
IFPRI POLICY RESEARCH & STRATEGY SUPPORT PROGRAM

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ACRONYMS

APSU	Agricultural Policy Support Unit
BBS	Bangladesh Bureau of Statistics
BIHS	Bangladesh Integrated Household Survey
CPC	Centralized Procurement Center
CSD	Central storage depot
CMR	Custom milled rice
DAE	Department of Agricultural Extension
DAM	Department of Agricultural Marketing
DATA	Data Analysis and Technical Assistance
DC	District controller
DGF	Directorate General of Food
FAQ	Fair average quality
HIES	Household Income and Expenditure Survey
HYV	High yielding variety
IFPRI	International Food Policy Research Institute
IFPRP	Integrated Food Policy Research Program
KG	Kilogram
KII	Key informant interview
LSD	Local supply depot
MIS	Management information system
MSP	Minimum support price
MT	Metric ton
NID	National identification
PFDS	Public Food Distribution System
PRSSP	Policy Research and Strategy Support Program
QAIDS	Quadratic Almost Ideal Demand System
Rs	Indian rupee
SHG	Self-help group
Tk	Bangladeshi taka
UAO	Upazila agriculture officer
UFC	Upazila food controller
USAID	United States Agency for International Development
WQSC	Weight, quality, and stock certificate

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1 BACKGROUND AND MOTIVATION

"Boro" is the dry season irrigated rice crop planted from December to early February and harvested between April and June. In 2018/2019, the total production of rice in Bangladesh was 36,391,000 (36.4 million) metric tons (MT), of which boro rice accounted for 53.8 percent; aman rice, 38.6 percent; and aus rice, 7.6 percent.

In 2019, paddy prices in Bangladesh were depressed due to a bumper harvest of the boro rice crop. Average paddy price was Tk 17.42 per kg in January 2019 after the aman harvest, but declined by 22 percent to Tk 13.56 per kg in May 2019 (DAM 2020). Farmers complained that they did not receive price support from the Government when paddy prices did not cover their production costs.

In response to this situation, the USAID-funded Bangladesh Policy Research and Strategy Support Program (PRSSP) implemented by the International Food Policy Research Institute (IFPRI) actively engaged in policy dialogues, and the media extensively covered IFPRI's analysis and policy recommendations on this issue. On 20 May 2019, the IFPRI Country Representative presented policy options on how to improve farmers' situation, as related to the low paddy price issue, during a policy seminar at the Agricultural Policy Support Unit (APSU) of the Ministry of Agriculture, Government of the People's Republic of Bangladesh.

On 11 June 2019, the Ministry of Agriculture requested IFPRI-PRSSP to conduct a study jointly with APSU to assess the paddy price issue. IFPRI agreed to carry out the study.

The objectives of this study are to (1) assess to what extent boro farmers were able to sell their paddy to the Government at the announced procurement price; (2) evaluate the efficacy of the direct paddy procurement from farmers by the Government, in order to help farmers overcome low paddy prices in the future; and (3) examine ways to improve the foodgrain procurement system.

This report presents IFPRI's study findings and identifies policy options to address the study objectives.

2 BORO PADDY AND RICE PROCUREMENT IN 2019

2.1 The Procurement System

Public interventions in the foodgrain market have been quite substantial in Bangladesh. The government procures foodgrains (rice and wheat) from domestic and international markets, stores the procured foodgrains in public *godowns* (warehouses), and distributes them through different channels of the Public Food Distribution System (PFDS).

The method for purchasing paddy (unhusked rice) from farmers is described below:

- Field-level officials under the Department of Agricultural Extension (DAE) of the Ministry of Agriculture prepare lists of farmers who are eligible to sell paddy to the Directorate General of Food (DGF). These include farmers who have an agricultural input support card or *"Krishi* card*"* and meet other selection criteria. Eligible farmers are often selected via lottery because the number of farmers interested in selling paddy to the Government typically exceeds the number of farmers who can participate in the procurement process.
- Listed farmers bring their paddy to DGF's local supply depots (LSD).
- Selected farmers bring either their agricultural input support card or national identification (NID) when they sell paddy.
- DGF purchasing officers verify farmers' identification prior to purchasing paddy that meets paddy specifications (for example, percentage of moisture content, dead damaged grains, foreign materials, etc.).
- Paying officers issue payment orders based on weight, quality, and stock certificates (WQSCs). Payments are sent to farmers' accounts in designated banks.

DGF's method for purchasing rice from rice millers is described below:

- The DGF purchases rice from enlisted rice millers nationwide. Rice procurement allotment in districts and upazilas is based on paddy production, rice mill capacity, and the total target of rice procurement.
- The DGF's district and upazila controllers and rice millers establish an agreement for supplying rice to LSDs or central storage depots (CSDs), with terms and conditions stipulated in the agreement.
- The LSD or CSD officer in charge receives the rice as per DGF specifications. If the rice is of fair average quality (FAQ), the purchasing officer issues a WQSC to the paying officer, which states the rice quantity and total payment amount.
- The DGF paying officer verifies the rice stock in the respective LSDs/CSDs, signs the WQSCs, and issues the WQSCs to millers who supplied the rice. The millers receive payments in their designated banks.

2.2 Amounts of Boro Paddy and Rice Procured in 2019

On 25 April 2019, the DGF instructed the District Controllers of Food (DC Food) to procure 150,000 MT of paddy from farmers, and 1 million MT of parboiled rice and 150,000 MT of atap rice from rice millers before 31 August 2019.

The Government set the procurement prices as follows: Tk 26.00 per kilogram (kg) for paddy, Tk 36.00 per kg of parboiled rice, and Tk 35.00 per kg of atap rice.

On 13 June 2019, the DGF instructed DC Food to procure an additional 250,000 MT of paddy from farmers. The total rice-equivalent[1] target procurement quantity was 1,418,000 MT (1.42 million).

The total actual rice-equivalent procurement was 1,417,885 MT (1.42 million), of which rice procurement accounted for 81.1 percent and rice-equivalent paddy procurement accounted for 18.9 percent. Table 2.1 shows the targeted and actual amounts of boro paddy and rice procurement in 2019. The achieved procurements virtually fully met the targets.

Table 2.1 Boro paddy and rice procurement target and achievement in 2019

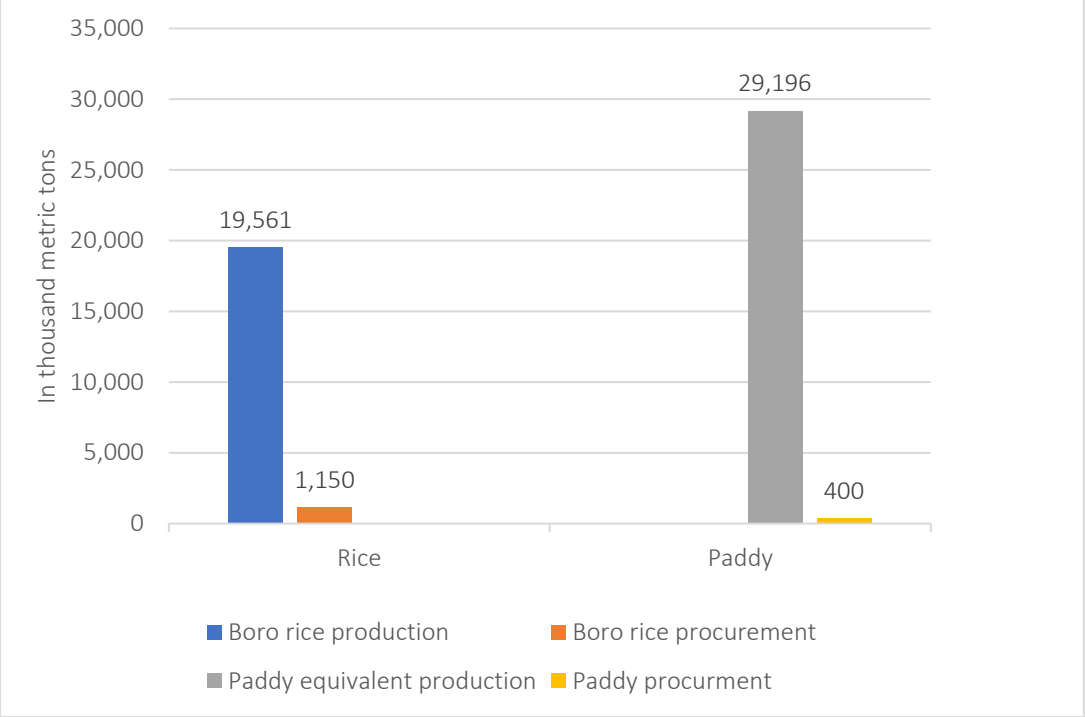
Commodity	Target	Achievement
	(metric tons)	
Paddy	400,000	399,862
Rice (parboiled)	1,000,000	999,987
Rice (atap)	150,000	149,990
Total rice-equivalent amount	1,418,000	1,417,885

Source: Management Information System (MIS), Directorate General of Food, Ministry of Food.

Figure 2.1 shows that, in 2019, rice procurement was 5.88 percent of total boro rice production, and paddy procurement was 1.37 percent of total paddy-equivalent boro rice production.

[1] The conversion factor from paddy to rice is 0.67 (67 percent).

Figure 2.1 Boro rice and paddy procurement and corresponding production in 2019



Source: Bangladesh Bureau of Statistics (BBS) for production data; Directorate General of Food (DGF) for procurement data.

3 DATA

Data for this study came from surveys of boro paddy farmers, rice millers, traders, and relevant government officials. Integrating these data provides a nuanced analysis of the boro paddy and rice market and the Government procurement system in Bangladesh. The Ministry of Agriculture, Government of the People's Republic of Bangladesh, authorized IFPRI to collect the required primary data for the study. In addition to primary data, IFPRI collected data from secondary sources, including the DGF, Bangladesh Bureau of Statistics (BBS) of the Ministry of Planning, and the Department of Agricultural Marketing (DAM) of the Ministry of Agriculture.

We also conducted a study in West Bengal, India, in late 2019 to examine its paddy and rice procurement system and identify alternative models of paddy procurement.

3.1 Sampling

3.1.1 Boro-producing households

The survey sample for this study was drawn from IFPRI's Bangladesh Integrated Household Survey (BIHS) conducted in 2019, which is statistically representative of national rural Bangladesh and the rural areas of the seven administrative divisions. The study sample includes all boro-producing households from the BIHS sample located in the 43 top-producing districts, which accounted for around 90 percent of the total boro rice and paddy procurement by the Government in 2019. A representative sample of 1,369 boro-producing farm households were interviewed.

3.1.2 Millers, traders, and government officials

We used IFPRI's Integrated Food Policy Research Program (IFPRP) 2018 database of rice millers and traders to sample from and interview 48 rice millers and 92 traders from 40 upazilas of Bogura, Dinajpur, Mymensingh, and Naogaon districts. We also interviewed upazila agriculture officers (UAOs) and upazila food controllers (UFCs) from the 40 upazilas.

3.2 Survey Design and Administration

In July 2019, IFPRI and APSU of the Ministry of Agriculture jointly consulted farmers, rice millers, traders, and government officials in Bogura and Naogaon districts about farming, marketing, and milling of boro paddy and the procurement system. This field visit informed the conceptualization of the study.

IFPRI contracted the survey firm Data Analysis and Technical Assistance (DATA) to provide experienced enumerators, contribute to reviewing and finalizing the survey instruments, and administer the surveys.

IFPRI and APSU jointly designed the survey questionnaires to interview farmers, rice millers, traders, and government officials. The farmers' questionnaire covered the production and sale of boro paddy, its marketing through different channels, and knowledge of and access to the government procurement system. The traders' and millers' questionnaires focused on the procurement and sale of paddy and rice by various types of traders and rice millers. The government officials' questionnaires focused on the government procurement system.

Farmers, traders, rice millers, and government officials were surveyed in October 2019. A follow-up telephone survey of farmers was carried out in January 2020.

4 RESULTS AND DISCUSSION

4.1 Salient Characteristics of Boro Farmers

Using national-level data from IFPRI's 2019 BIHS, this section presents broader contextual factors that shape the implications of boro paddy and rice procurement for farmers. These factors include farm-size classification, land tenure patterns, boro paddy varieties grown by farmers, and the cost of production of boro paddy.

4.1.1 Total number of boro rice farmers in Bangladesh

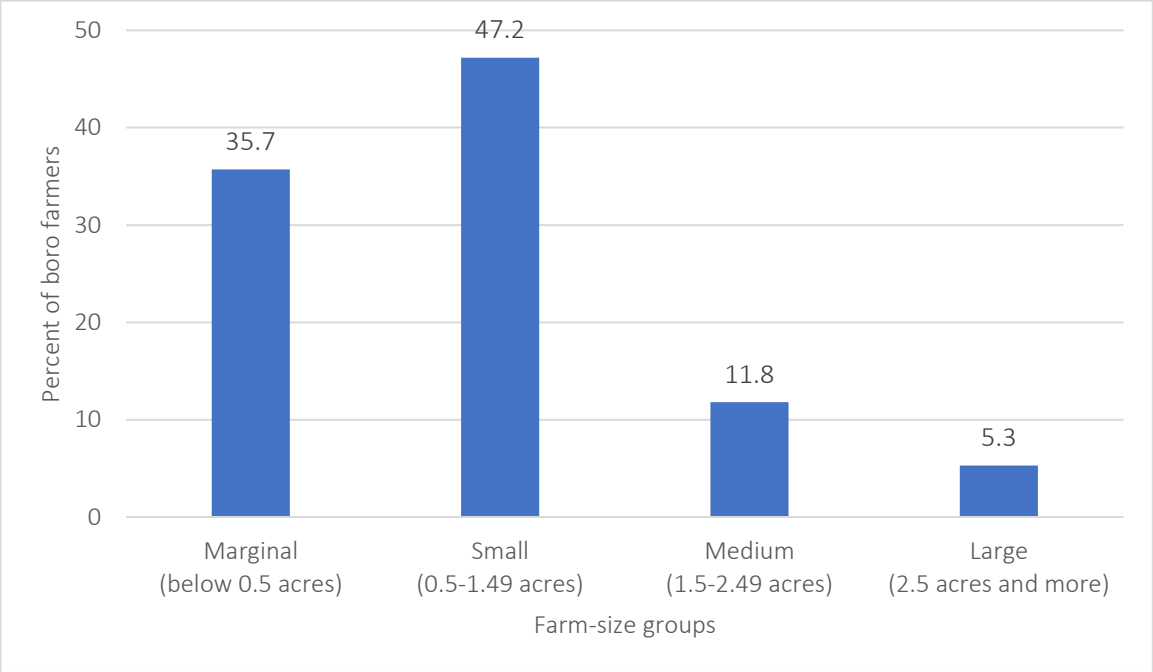
Since the BIHS is statistically representative of all rural households in Bangladesh, we can estimate the total number of farmers who cultivated boro paddy. Using population projection data from the World Bank, we estimated a total of 25.61 million rural households in Bangladesh in 2019. From the BIHS dataset, we calculated that 36.3 percent of all households cultivated boro rice. Therefore, the total number of boro rice farmers was around 9,287,000 (9.29 million) in 2019.

4.1.2 Farm-size groups of boro farmers

The analysis disaggregates all boro farmers into four operated farm-size groups: (1) marginal farmers (operating less than 0.5 acres of land); (2) small farmers (operating 0.5 to 1.49 acres of land); (3) medium farmers (operating 1.5 to 2.49 acres of land); and large farmers (operating 2.5 acres or more land). The four farm-size groups match the cut-off points of the six operated farm-size groups reported in 2010 Household Income and Expenditure Survey (HIES) report (BBS 2011) by aggregating the smallest two HIES farm-size groups under the marginal farm category and the largest two groups under the large farm category.

Figure 4.1 presents the distribution of operated land by each of the four farm-size groups of boro farmers in Bangladesh. Marginal and small farmers account for 82.9 percent of all boro farmers.

Figure 4.1 Distribution of operated land by farm-size groups of boro farmers in 2018

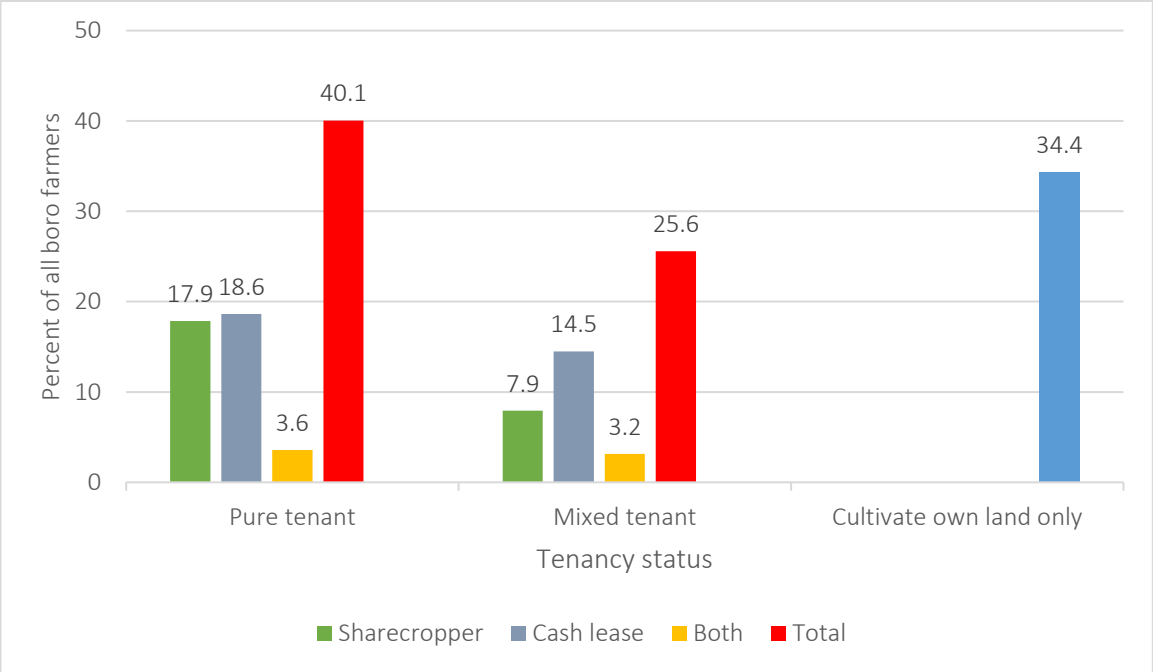


Source: IFPRI Bangladesh Integrated Household Survey, 2019.

4.1.3 Land tenure patterns

Figure 4.2 shows land tenure arrangements for boro farmers. In 2018, 40.1 percent of all boro farmers were pure tenants—that is, they did not own the land they cultivated. The dominant tenurial arrangement during boro season was cash-lease (33.1 percent of farmers), who were either pure tenants (18.6 percent) or cultivated their own land and cash-leased land (14.5 percent). About one-quarter (25.8 percent) of farmers were sharecroppers, meaning the produce is shared between the cultivator and the landowner in proportions agreed upon prior to cultivation. Approximately one-third (34.4 percent) of the boro farmers did not have any land-lease arrangements; they cultivated only their own land.

Figure 4.2 Land tenancy status of boro farmers in 2018

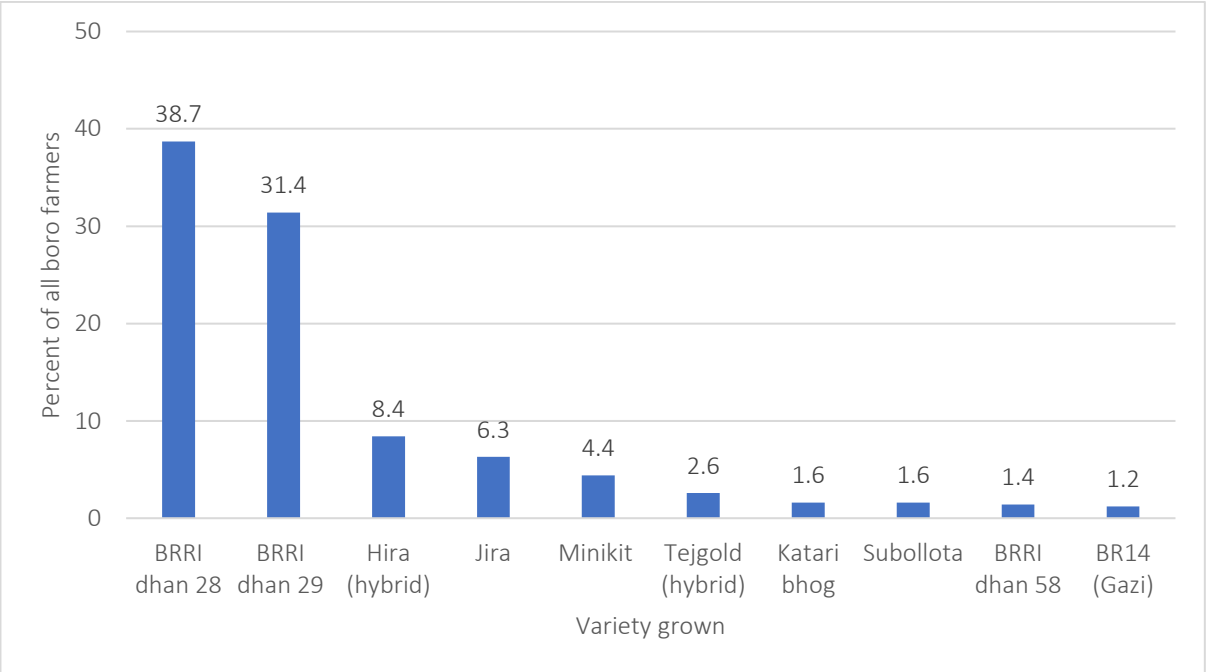


Source: IFPRI Bangladesh Integrated Household Survey, 2019.

4.1.4 Boro rice varieties grown

Figure 4.3 shows the percentages of farmers cultivating each of the 10 most popular boro paddy varieties in 2018, which account for 98 percent of all farmers. Despite the introduction of about 100 modern varieties over the past few decades, 70.1 percent of farmers grow only two varieties—*BRRI dhan 28* and *BRRI dhan 29*, both of which were released in 1994. A reason for the continued popularity of *BRRI dhan 28* is its shorter growth cycle (Ahmed, Hernandez, and Naher 2014). According to the 2019 BIHS, 17.1 percent of all boro farmers cultivated hybrid rice in 2018.

Figure 4.3 Top 10 boro rice varieties cultivated by farmers in 2018



Source: IFPRI Bangladesh Integrated Household Survey, 2019.

4.1.5 Costs of producing boro paddy

There are inherent conceptual problems with using the average cost of production to estimate farmers' returns (Timmer, Falcon, and Pearson 1983) (see Appendix A). Nevertheless, cost of production remains popular as a basis for determining paddy and rice procurement prices issued by the Government of Bangladesh.

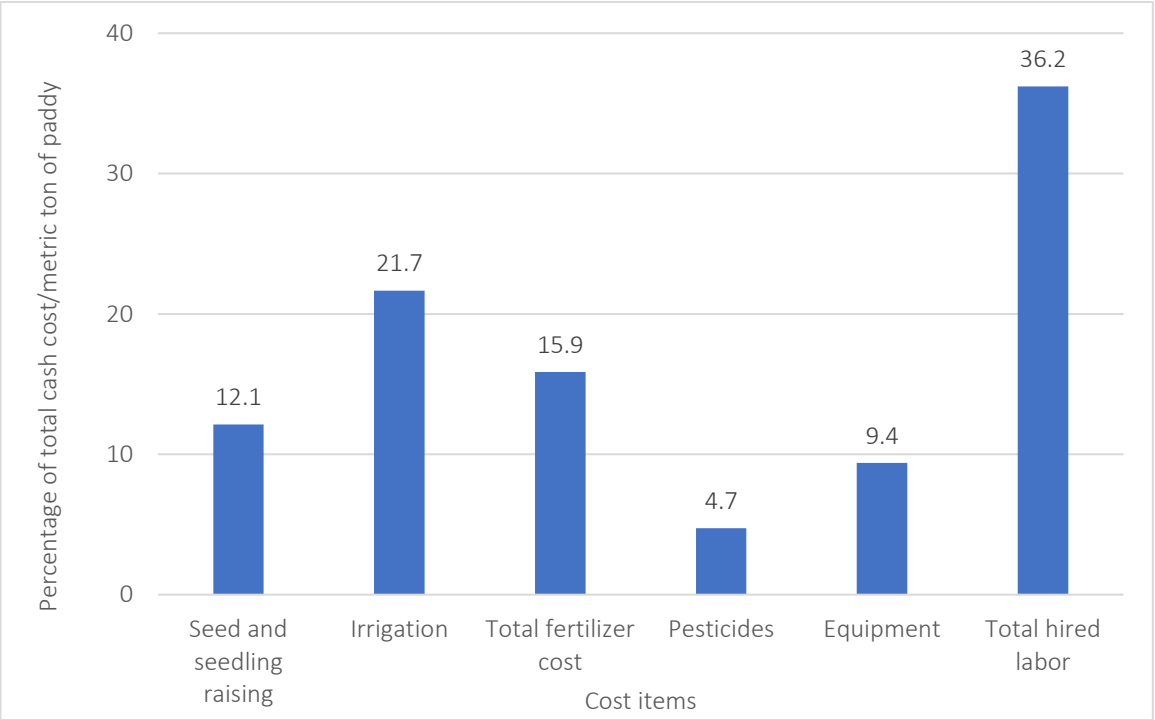
The BIHS collected detailed plot-level data on the use of various inputs and their prices for rice and other crops. The average prices are multiplied by respective input coefficients to calculate per-hectare costs of these inputs.

The total cost of boro paddy production per hectare is obtained by adding all input costs, including seed and seedling raising, irrigation, pesticides, bullock and mechanical power, hired and imputed family labor costs, and imputed land rent for both farmer-owned and rented-in land. Dividing the cost per hectare by paddy yield gives the cost per MT of paddy.

In 2018, the total full cost of production of boro paddy per hectare, including the imputed costs of family labor and land rent, was Tk 100,408, and the total cash cost (without imputed family labor cost and land rent) was Tk 64,862. The total full cost per MT of boro paddy was Tk 17,834 (Tk 17.83 per kg), and the total cash cost was Tk 11,520 per MT (Tk 11.52 per kg). The cost per MT is the relevant concept for the purpose of procurement pricing.

Figure 4.4 shows the shares of total cash cost for boro paddy production per MT in 2018. Hired labor costs represented more than one-third (36.2 percent) of the total cash cost of boro paddy per metric ton. A discussion on the calculation of cost of production and the detailed breakdown of costs of inputs per hectare and per metric ton for boro paddy cultivation are presented in Appendix A.

Figure 4.4 Shares of total cash cost for boro paddy production per metric ton in 2018



Source: IFPRI Bangladesh Integrated Household Survey, 2019.

4.2 Results from the Study Surveys

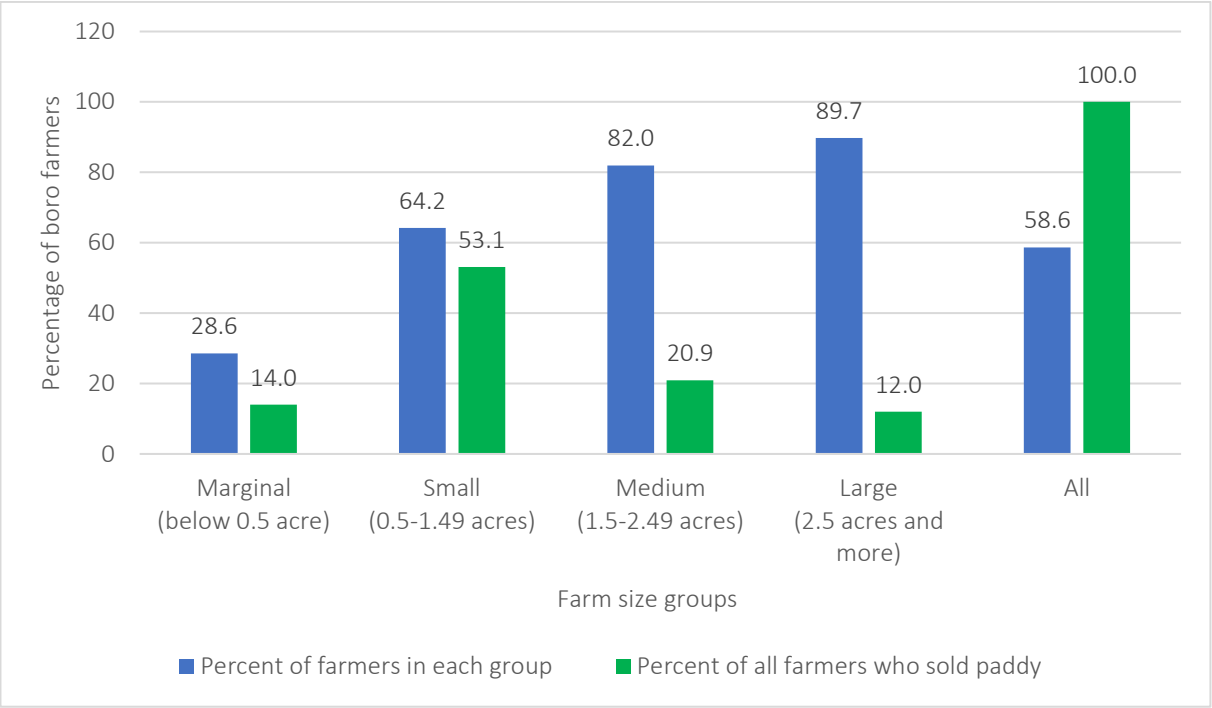
4.2.1 Farmer survey findings

This section presents the results from the primary data collected under this study. The major advantage of drawing the study sample of boro farmers from the 2019 BIHS sample is that we have information on the sample farm households with regards to their livelihoods, including education, employment, assets, food and nonfood consumption, nutrition, and very detailed plot-level data on agricultural production and practices for all crops, as well as livestock and fish farming.

4.2.1.1 Who sold boro paddy in 2019?

Figure 4.5 shows that, during the boro procurement season from April to August 2019, 58.6 percent of all boro farmers (5.44 million farmers out of 9.29 million boro farmers in 2019) sold boro paddy in the market. Marginal farmers made up 28.6 percent of all boro farmers, and 14 percent of all farmers who sold paddy. Marginal farmers are mostly subsistence farmers who produced mainly for home consumption, as their small size of operated land (less than half an acre) does not permit them to produce surplus paddy. By contrast, small farmers constituted about one-half (53.1 percent) of all farmers who sold paddy during the 2019 boro procurement season.

Figure 4.5 Percentage of boro farmers who sold paddy from April to August 2019



Source: IFPRI survey for boro procurement study, 2019.

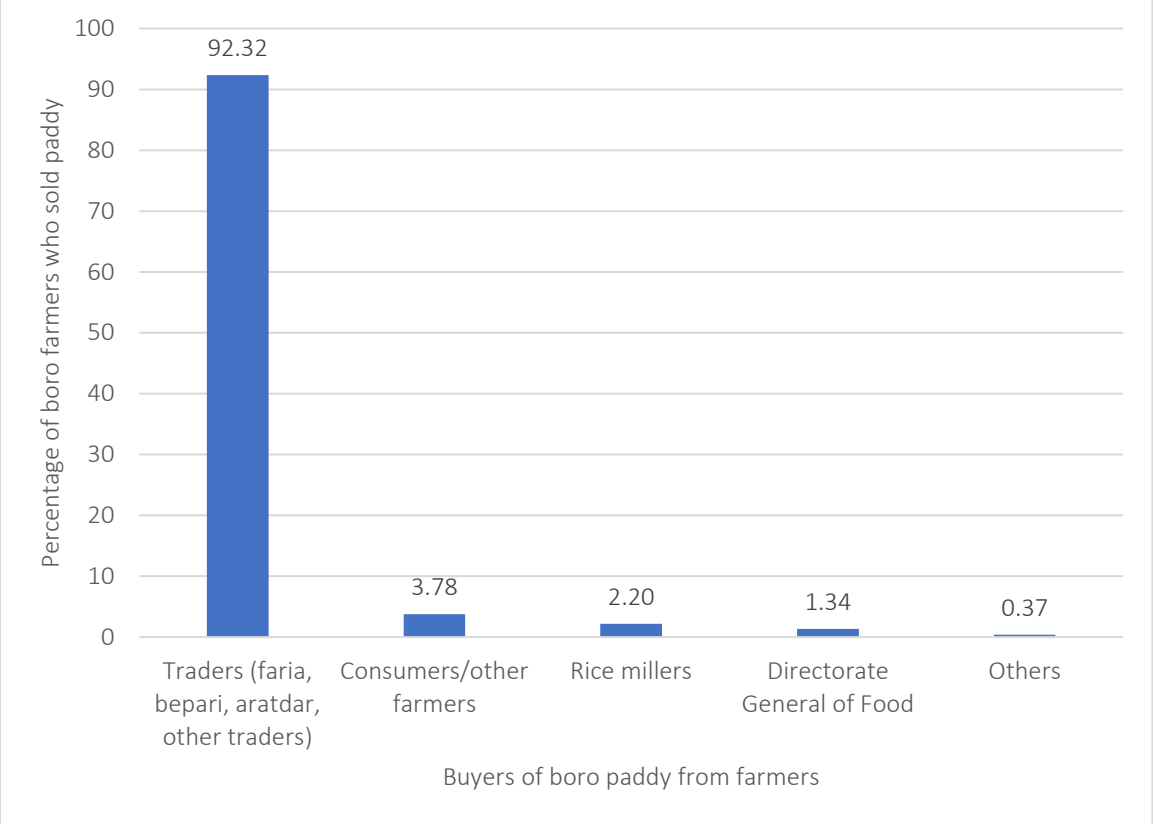
4.2.1.2 To whom did the farmers sell paddy?

Among those who sold boro paddy from April to August 2019, 1.34 percent of the farmers sold paddy to DGF purchasing officers. This means that about 73,000 farmers sold paddy in the boro procurement system in 2019.

Contextualizing this finding, rice procurement was 5.88 percent of total boro rice production, and paddy procurement was 1.37 percent of total paddy-equivalent boro rice production in the 2019 boro procurement season, according to official sources (see Figure 2.1).

Most farmers (92.3 percent) sold their boro paddy to various traders, including *faria*, *bepari*, *aratdar*, and other traders (Figure 4.6).

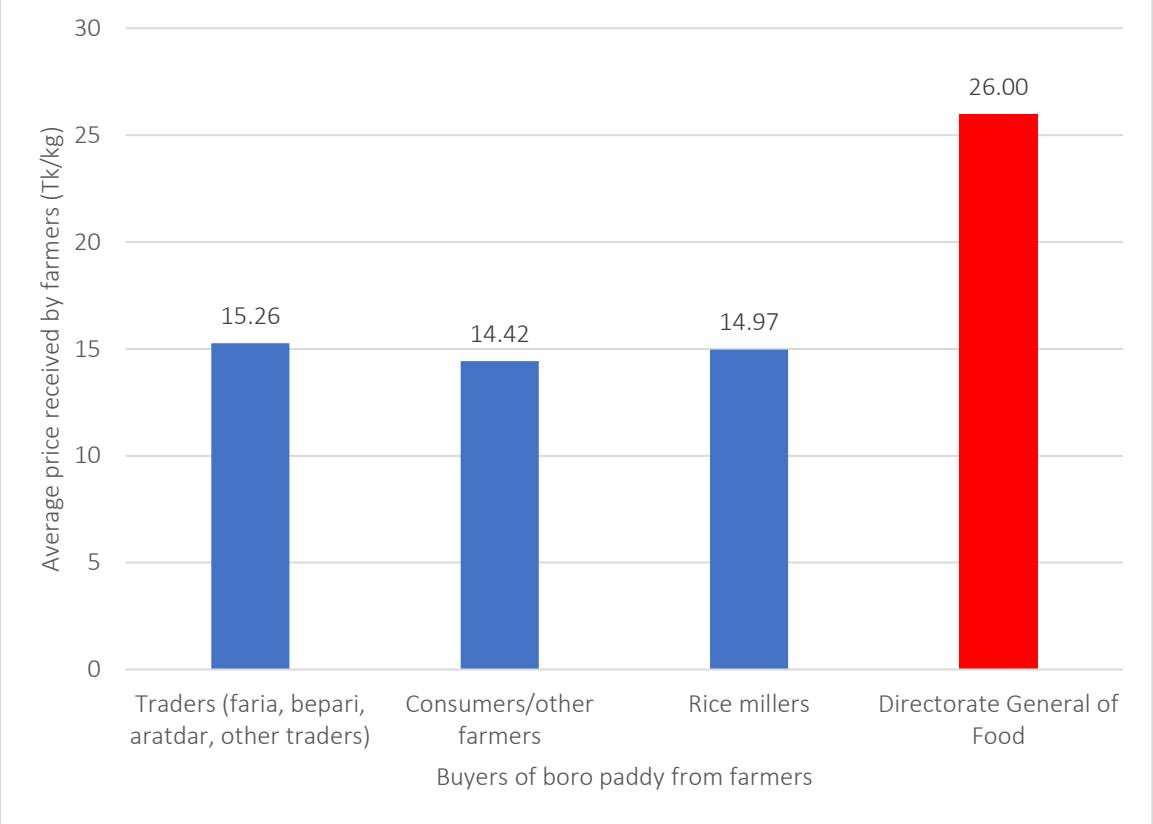
Figure 4.6 Percentage of farmers selling boro paddy to various buyers



Source: IFPRI survey for boro procurement study, 2019.

Figure 4.7 shows the average price of paddy (Tk per kg) received by farmers from various buyers during the 2019 boro procurement season. Farmers who sold their boro paddy to the DGF received Tk 26 per kg; however, farmers who did not sell their paddy to the Government received between Tk 14 and Tk 15 per kg.

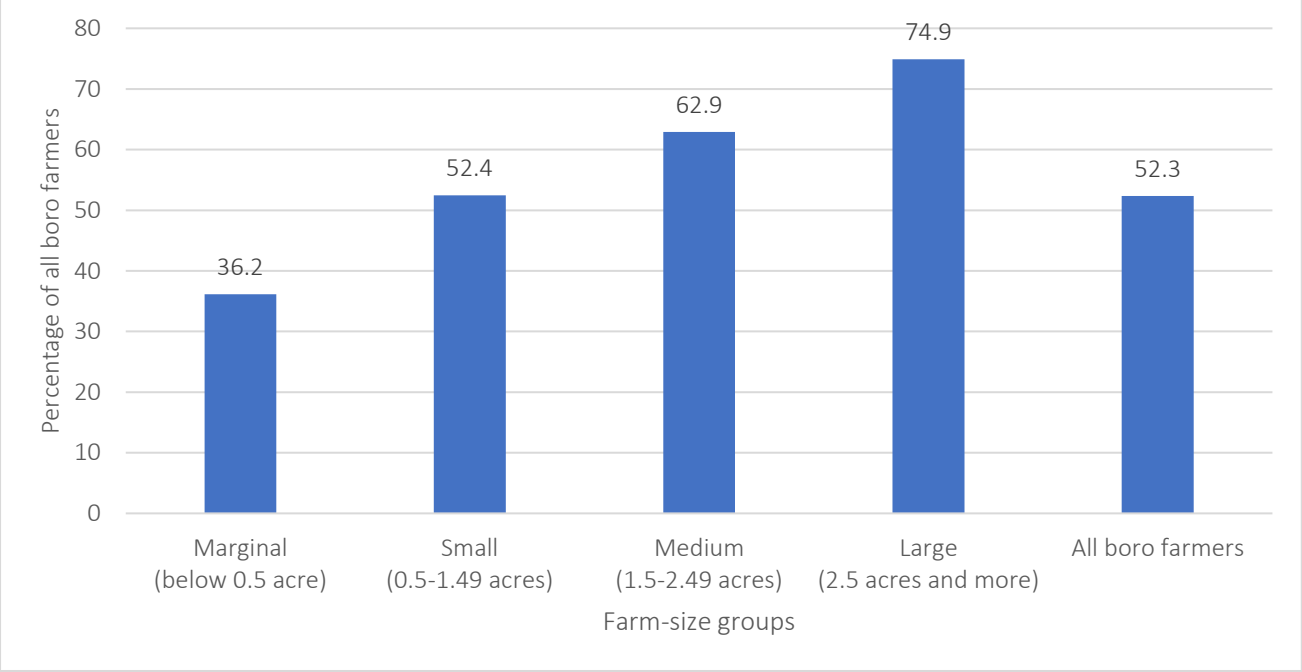
Figure 4.7 Average price of paddy received by farmers from various buyers from April to August 2019



Source: IFPRI survey for boro procurement study, 2019.

According to the DGF's guidelines, farmers who have an agricultural input support card (*Krishi* card) are eligible to sell paddy to the DGF at the procurement price of paddy (Tk 26 per kg). Figure 4.8 shows that 52.3 percent of boro farmers in the survey sample had an agricultural input support card in 2019. The ***percentage*** distribution of the agricultural input support card appears regressive—36 percent of the marginal farmers had agricultural input support cards compared with 75 percent of large farmers.

Figure 4.8 Percentage of boro farmers who have an agricultural input support card by farm-size groups

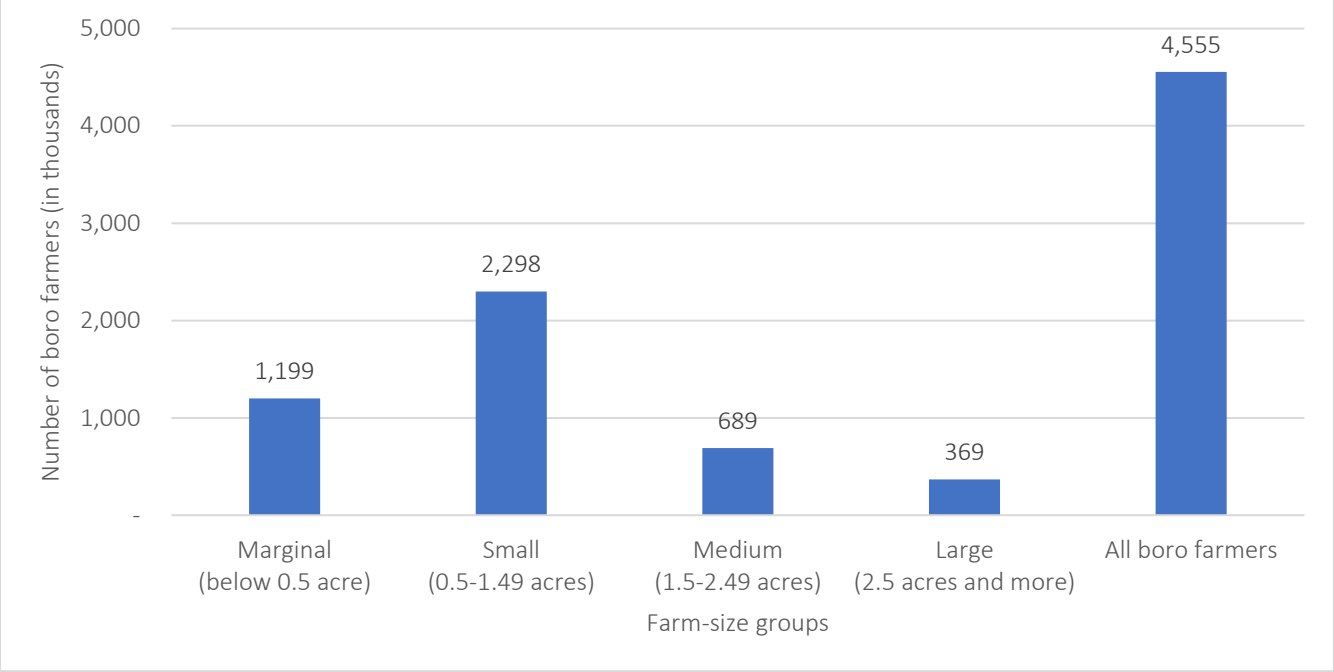


Source: IFPRI survey for boro procurement study, 2019.

However, when we examine the estimated ***number*** of farmers having agricultural input support cards, we see a ***progressive*** pattern of distribution across farm-size groups (Figure 4.9). In 2019, 4,555,000 (4.56 million) boro farmers were estimated to have an agricultural input support card;[2] of them, 26.3 percent were marginal farmers, 50.5 percent were small farmers, 15.1 percent were medium farmers, and 8.1 percent were large farmers.

[2] We multiply the estimated total number of boro farmers in 2019—9,287,000 (9.29 million)—by the proportions of boro farmers in each farm-size group shown in Figure 4.1 to obtain the number of farmers by farm-size groups. Then, the proportions of farmers having agricultural input support cards are used to obtain the numbers.

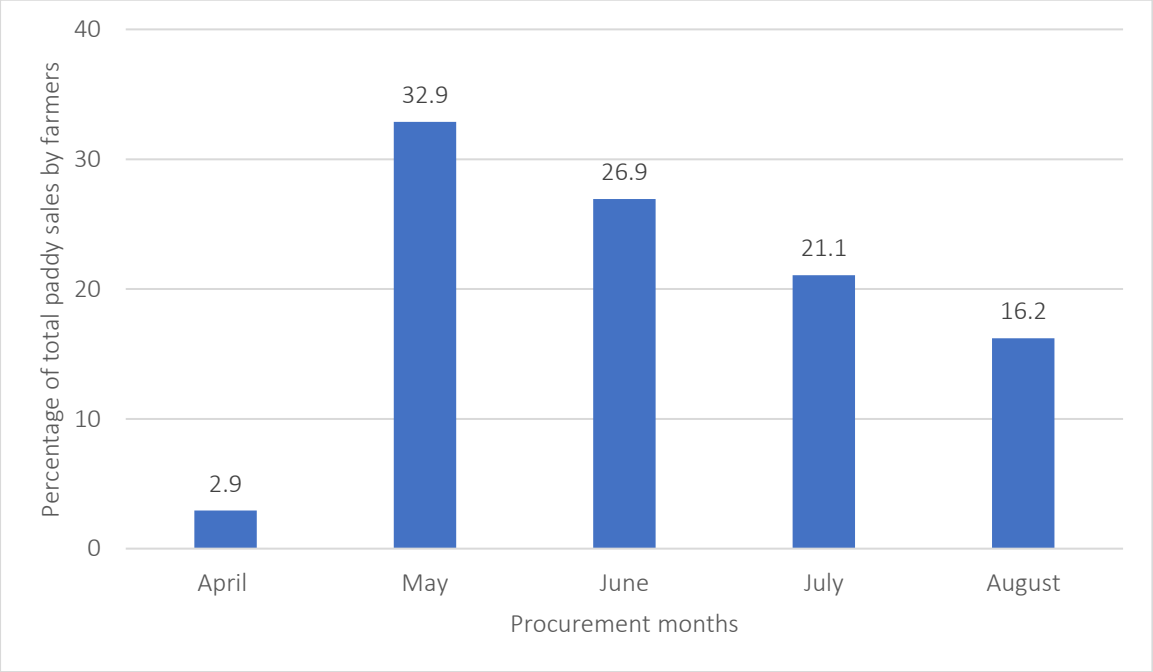
Figure 4.9 Number of boro farmers who have agricultural input support cards by farm-size groups



Source: IFPRI survey for boro procurement study, 2019.

Figure 4.10 shows the pattern of monthly paddy sales as share of total sales by farmers from April to August 2019, which was the procurement period. Sales peaked in May when farmers made one-third (32.9 percent) of their total paddy sales for the 2019 boro procurement season.

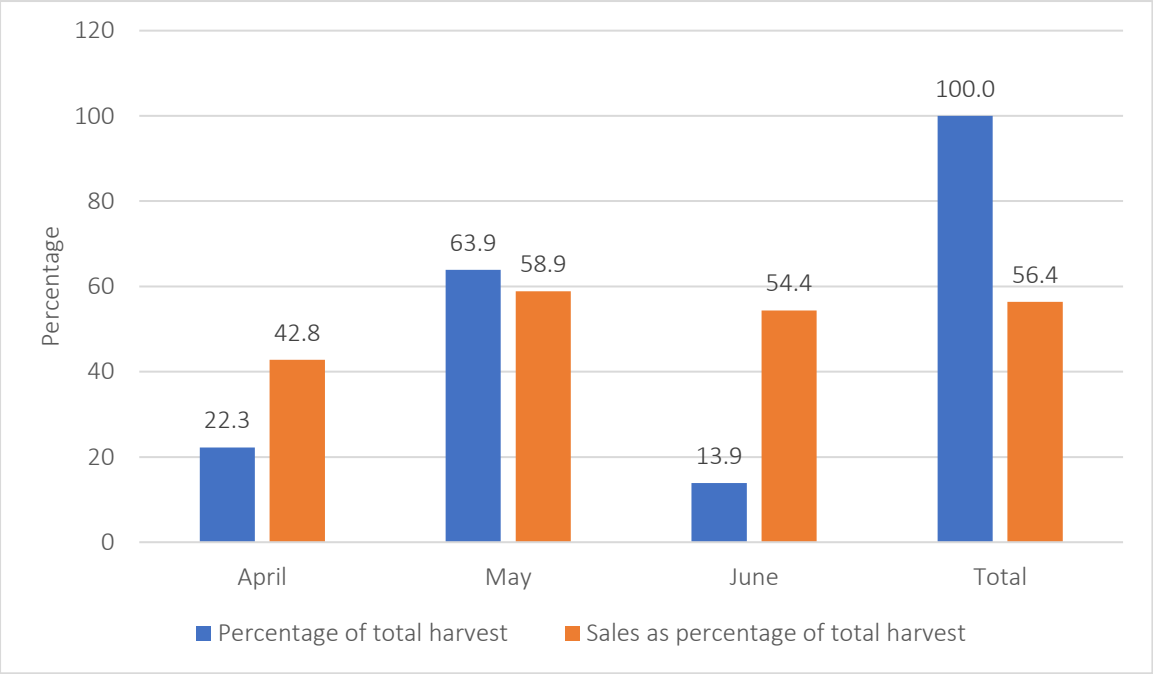
Figure 4.10 Monthly paddy sales as percentage of total sales by farmers from April to August 2019



Source: IFPRI survey for boro procurement study, 2019.

In 2019, the boro paddy harvest started in April and ended in June. Figure 4.11 shows that about 59 percent of the total amount of boro paddy produced by farmers was harvested in May. Figure 4.11 also shows total monthly paddy sales by farmers as percentage of their total monthly harvested amount, which is termed marketed surplus. The total marketed surplus of boro paddy was 56.4 percent of total harvest during the 2019 boro procurement season.

Figure 4.11 Monthly paddy harvest and paddy sales, as percentage of total harvest from April to June 2019



Source: IFPRI survey for boro procurement study, 2019.

Other key findings from the survey of farmers are summarized below:

- The average length of time from paddy harvesting and threshing to the first sale was 32 days, mostly used for cleaning and drying paddy.
- The main reasons for selling paddy within 30 days after harvest are repayment of loan (38.2 percent), household expenses (27.9 percent), emergency expenses (15.8 percent), lack of storage (8.1 percent), and paying off land rent (4.3 percent).
- 71.2 percent of farmers knew about 2019 boro procurement announced by the Government. Farmers' sources of information included the following: other farmers (57.3 percent), newspaper/TV/radio (22.9 percent), union council (8.6 percent), Department of Agricultural Extension (5.0 percent), DG Food (0.8 percent), and other sources (5.4 percent).
- 55.8 percent of farmers knew the announced price of paddy procurement.

4.2.2 Trader survey findings

Key findings from the survey of traders are summarized below:

- Among 92 traders interviewed, 59.7 percent purchased paddy, 29.4 percent purchased rice, and 10.9 percent purchased both paddy and rice during the 2019 boro procurement season.

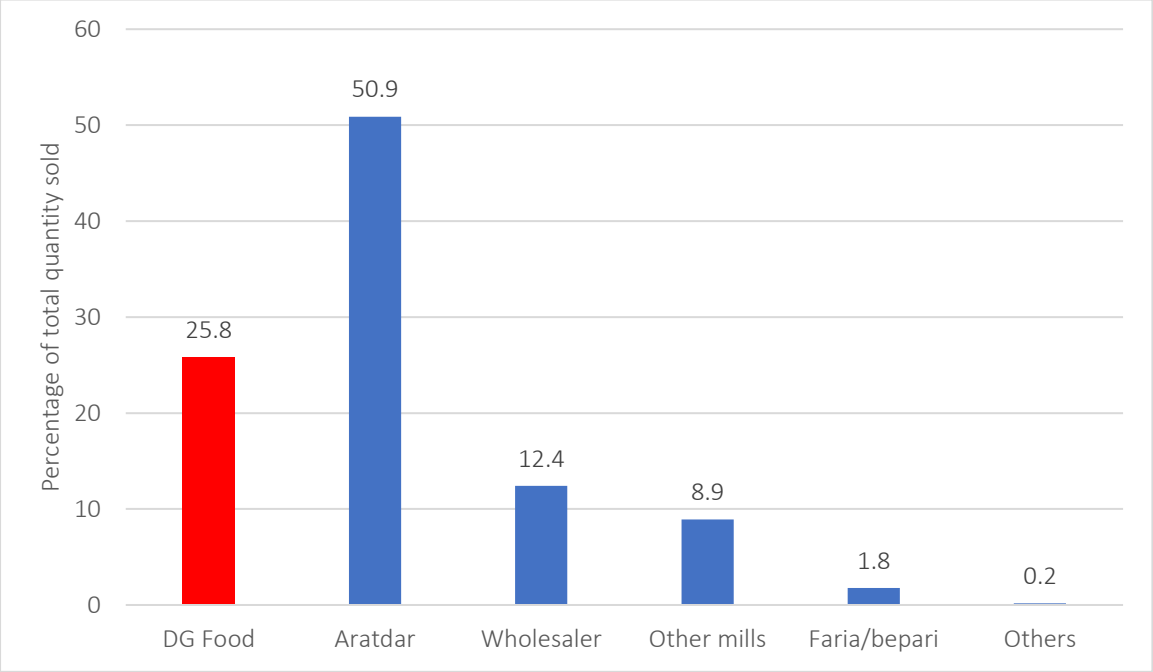
- Of the total purchased quantity of paddy, 76.3 percent was high yielding variety (HYV) boro paddy and 23.7 percent was hybrid boro paddy on average.
- 80.4 percent of the traders sold paddy to rice millers, 13.1 percent sold to other *beparis* and *farias*, 3.7 percent sold to *aratdars*, and 2.8 percent sold to others.
- Traders sold paddy at the average price of Tk 16.80 per kg to *aratdars* and other traders, and Tk 17.29 per kg to rice millers.
- On average, traders sold rice at Tk 36.07 per kg to *aratdars* and other traders and Tk 40.99 to consumers.

4.2.3 Rice miller survey findings

IFPRI's survey interviewed 48 enlisted rice millers, including automatic (58.3 percent), semi-automatic (18.8 percent), and husking (22.9 percent) rice millers who sold boro rice to the DGF during the 2019 boro procurement season.

Figure 4.12 shows the shares by buyer of the total amount of boro rice sales by rice millers from April to August 2019. They sold about one-quarter (25.8 percent) of their total sales of milled rice to the DGF. *Aratdars* were the biggest buyer, purchasing one-half (50.9 percent) of the total rice sold during the 2019 procurement season.

Figure 4.12 Percentage of total amount of rice sold to various buyers from April to August 2019



Source: IFPRI survey for boro procurement study, 2019.

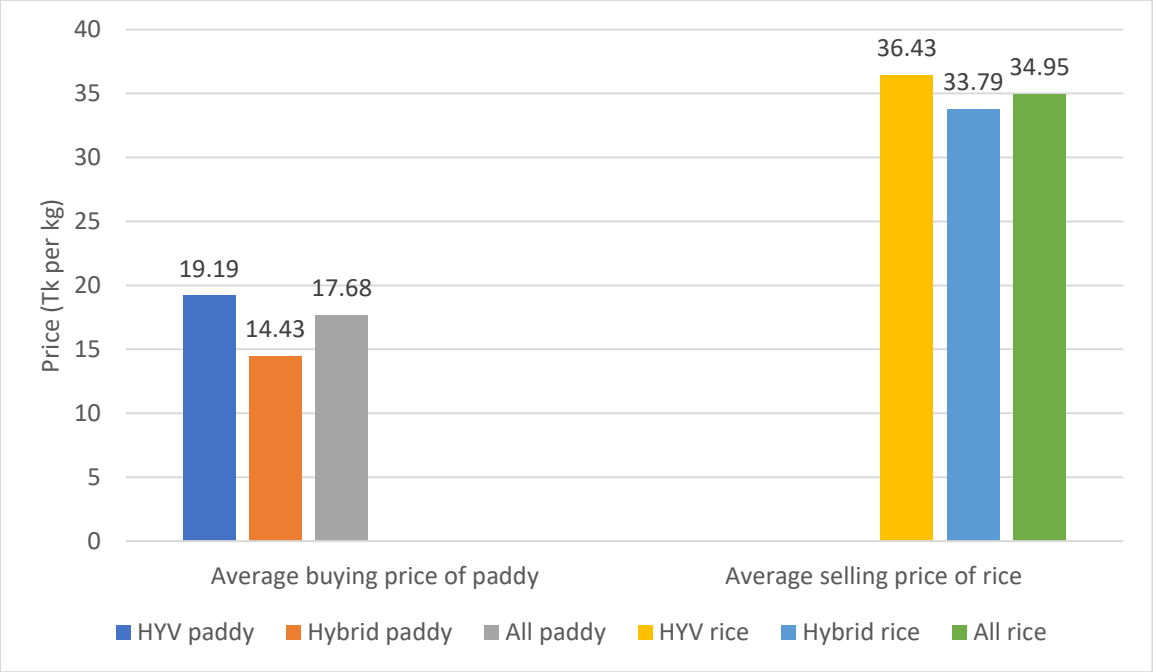
4.2.3.1 Rice millers mostly sold hybrid rice to the Government

On average, 94.3 percent of all rice sold to the DGF by rice millers was hybrid rice. A key driver is the relative lower cost of hybrid boro paddy compared with HYV boro paddy. The survey reveals that rice millers purchased HYV boro paddy for Tk 19.19 per kg and hybrid paddy for Tk 14.43 per kg (that is, the millers paid 24.8 percent less for hybrid paddy), but they sold both types of rice to the DGF at the procurement price of Tk 36.00 per kg. Therefore, the millers had a large incentive to buy hybrid

paddy for milling and to sell hybrid rice to the DGF, which substantially increased their profit margin. A study on hybrid rice in Bangladesh and India suggests that the price of hybrid rice is lower because of its poor cooking quality, which makes it less attractive to consumers (Spielman et al. 2017).

Figure 4.13 shows the average buying prices of paddy and selling prices of milled rice to *aratdars*, wholesalers, and others. The average selling price of hybrid rice was 7.2 percent lower than HYV rice. In 2019, hybrid rice accounted for 17.7 percent of total boro production of 19.56 million MT (BBS 2019).

Figure 4.13 Buying prices of paddy and selling prices of rice by rice millers



Source: IFPRI survey for boro procurement study, 2019.

4.2.4 Government officials' observations

IFPRI's survey of 40 upazila agriculture officers (UAOs) generated these observations on the paddy procurement system:

- Most farmers have an agricultural input support card (85.6 percent), varying between 32 percent and 100 percent across upazilas.
- UAOs reported that compiling the farmers' list for procurement was primarily based on land area, production quantity, predicted sale quantity, and lottery. Moreover, there were reports of farmers being selected based on an influential person's recommendation.
- Half of UAOs disagreed that farmers faced obstacles selling paddy, 37.5 percent believed that farmers did face challenges, and 12.5 percent were agnostic.
- 17.5 percent of UAOs reported that some farmers used another farmer's agricultural input support card to sell paddy to the DGF.

IFPRI's survey of 40 upazila food controllers (UFCs) gleaned the following insights on the paddy procurement system:

- On average, 18.9 percent of the total number of farmers enlisted by UAOs were selected for paddy procurement.
- The average maximum amount of paddy sold to the Government using an agricultural input support card was 1.85 MT. This varied widely, with 52.5 percent of UFCs reporting that farmers sold up to 1 MT of paddy and 37.5 percent of UFCs indicating that farmers sold up to 3 MT of paddy.
- The minimum amount of paddy that farmers could sell to the Government differed across upazilas. Specifically, 40 percent of UFCs stated that the minimum amount of paddy that could be procured was 0.120 MT in their upazilas, whereas 37.5 percent of UFCs reported that the minimum amount of paddy that could be procured was 1 MT of paddy in their respective upazilas. The average minimum amount of paddy procured across the surveyed upazilas was 0.534 MT.
- All paddy sold to the government was verified as having 14 percent moisture content using a moisture meter. On average, only 43.6 percent of farmers brought paddy to be sold that met the required moisture content.
- The average upazila-level target amount for the first procurement announcement on 25 April 2019 was 546.65 MT. With the second procurement announcement, which was made on 13 June 2019, the average target amount increased to 895.98 MT.
- 50.5 percent of paddy procured was HYV and 49.5 percent was hybrid.

4.3 Estimated Effects of Procurement on Market Price

What is the expected impact of paddy procurement on the market price of paddy? We used a mathematical demand-supply model to estimate the impacts under different scenarios. Appendix B provides a description of the model and parameters used for the estimations.

The price of a commodity is determined by the interaction of its demand and supply in the market. We have estimated that the actual procurement of 399,862 MT of boro paddy in 2019 increased the market price of paddy by 7.6 percent, from Tk 15.41 to 16.56 Tk/kg.

The total rice equivalent procurement in 2018/2019 was 1.42 million MT(2.12 million MT paddy equivalent), equal to 7.25 percent of total production for the year. If the Government had procured the entire quantity of in term of paddy, then the market price of paddy would have been Tk 22.36 per kg, (45 percent higher than the actual average market price of Tk 15.41 per kg).

What quantity of paddy procurement could raise the market price to the stated procurement price of Tk 26.00 per kg? Our estimates suggest that the procurement quantity of 3,074,000 (3.07 million) MT of paddy is needed to increase the market price of paddy to Tk 26.00 per kg. This amount accounts for 18.7 percent of market supply of paddy (that is, farmers' marketed surplus), or 10.5 percent of total paddy-equivalent boro production in 2018/2019.

5 PADDY PROCUREMENT IN WEST BENGAL, INDIA

In 2019, IFPRI-PRSSP commissioned a study in the Indian state of West Bengal to understand how paddy is procured directly from farmers. The study included farmer surveys and key informant interviews (KII) with government officials, self-help groups and cooperatives, and paddy/rice traders and transporters who procure paddy directly from farmers (Jana and Barun 2019).

How expansive is the procurement system in terms of farmers' participation and amount of paddy procured by the State Government?

Since 2016/2017, the West Bengal State Government has implemented an electronic paddy procurement (e-procurement) system.[3] Between 2017/2018 and 2019/2020, farmers' participation in the e-procurement system has increased five-fold, from 465,000 to 2.36 million farmers.[4] Overall, West Bengal's paddy procurement was 22 percent and 24 percent of total production in 2017/2018 and 2018/2019, respectively. Although the Government purchases aman and boro paddy at the same announced price, the vast majority of paddy procured by the Government is aman. In total, the amount of aman paddy procured by the Government is more than double that of boro paddy (8,649 quintal versus 4,232.4 quintal, or 864.9 MT versus 423.2 MT).

How is paddy procured from farmers by the State Government?

Paddy is procured from farmers primarily through two approaches. Under the first approach, farmers bring paddy to centralized procurement centers (CPCs), or *Kishan Mandis*, and receive a Rs. 20 per quintal transport allowance (Tk 226.30[5] per MT). Here, the Food and Supplies Department assigns one purchase officer and one disbursement officer who purchase paddy from farmers and record these sales in the e-procurement system. Farmers' payments are made via account payee checks under the *Dhan Din Cheque Nin* program on the same day of receipt of paddy from farmers.

Under the second approach, registered farmers' cooperatives,[6] self-help groups (SHG), or producers' organizations, which have applied, been screened, and are registered with the District Food and Civil Supply Department, announce the paddy procurement date in advance in the locality and procure paddy from registered farmers. The cooperatives then deliver the paddy to state government-designated custom milled rice (CMR) agencies, which have agreements with select rice mills. A designated government official (that is, block extension officer/cooperative inspector) certifies receipt of the paddy and sends the certificate of delivery to the CMR agency, and farmers receive an acknowledgement of sale on the back of the Farmers' Registration Certificate to be issued by the respective CMR agency. Rice millers are provided a transport allowance of Rs. 18.38 per quintal (Tk 208.00 per MT) for delivering paddy from the CMR agency to the government-designated rice mill. Farmers' cooperatives update the sales information on the e-procurement system and notify all registered members about sales via SMS. The State Government pays farmers' cooperatives, SHGs,

[3] West Bengal's e-paddy procurement system was first piloted in 2015/2016.
[4] The number of registered farmers in West Bengal's e-procurement system in 2019/2020 is reported as of December 14, 2019.
[5] The exchange rate used is 1 Indian Rupee (Rs.) to 1.13 Bangladeshi Taka (Tk), effective 30 April, 2020.
[6] Farmers' cooperatives and SHGs are crucial players in West Bengal's paddy procurement system. The West Bengal State Government promotes the formation of farmers' cooperatives and self-help groups, but is otherwise not involved in their management and operation.

and producers' organizations Rs. 31.25 per quintal of paddy procured as commission (Tk 353.70 per MT).

In 2019/2020, out of the state government's 5.2 million MT target for paddy procurement, the selected state government-designated custom milled rice (CMR) agencies procured the most paddy (46 percent), followed by the State Government-run CPCs (42 percent) and the Food Corporation of India (that is, the Central Government) (12 percent).

What benefits and challenges were identified by farmers who participated in the procurement system?

IFPRI-PRSSP surveyed 205 farmers in Dakshin Dinajpur and Nadia Districts to assess their satisfaction with participating in the e-procurement system. Of the surveyed farmers, 96 percent were satisfied with the higher price received, and all farmers received the announced price of Rs. 1,750 per quintal in 2018/2019 (Tk 19,805.50 per MT). Since 2006/2007, the minimum support price (MSP) in West Bengal has gradually increased, with an announced price of Rs. 1,750 per quintal in 2018/2019 and Rs. 1,815 per quintal (Tk 20,541.10 per MT) in 2019/2020. Nevertheless, farmers who participated in the paddy procurement system also reported difficulties related to three key areas: (1) collection (weight rebate: 66 percent; limited quantity: 33 percent); (2) logistics (distance to center: 24 percent; long time waiting: 15 percent), and (3) payment (paying extra charges: 30 percent;[7] payment problems: 24 percent; check cashing: 15 percent).

In recent years, the West Bengal Government has revised its paddy purchase limits per farmer. In 2015/2016 and 2016/2017, there were no upper limits on paddy purchases. However, in 2017/2018, the yearly maximum purchase per farmer was restricted to 180 quintal (18 MT), which was halved to 90 quintal (9 MT) in 2018/2019, and further reduced in 2019/2020 to 45 quintal (4.5 MT). The purpose of reducing the maximum yearly limit per farmer is to enhance participation among smallholder farmers.

How are rice millers engaged in the procurement system?

For every 100 MT of paddy received, rice millers supply 67 MT of milled rice to the State Government. During the 2018/2019 kharif marketing season, the Government paid enlisted rice millers Rs. 2,877.72 per quintal for raw rice and Rs. 2,825.54 per quintal for parboiled rice (Tk 32,568.30 and Tk 31,977.80 per MT, respectively), which covers all incidental costs and includes a paddy-drying allowance equivalent to 1 percent of MSP, which has been implemented since 1998.

Overall, West Bengal's paddy procurement model may provide options for Bangladesh's paddy procurement system.

[7] The data show that farmers who participated in the Government's e-procurement system pay, on average, an extra Rs. 14-15 per quintal of paddy (Tk 158.40-169.80 per MT) related to loading, packing, storage, and illegal payoffs whereas farmers who sell to private traders pay, on average, Rs. 1-2 per quintal of paddy (Tk 11.30-22.60 per MT).

6 SUMMARY AND POLICY CONCLUSIONS

6.1 Summary

During the 2019 boro season in Bangladesh, farmers were adversely affected by low paddy prices. This situation prompted the Ministry of Agriculture to commission IFPRI to conduct a study on the Government of Bangladesh's boro paddy procurement. In 2018/2019, the total production of rice in Bangladesh was 36.4 million metric tons, of which boro rice accounted for 53.8 percent. The total actual rice-equivalent procurement by the Government was 1.42 million MT, equal to 7.25 percent of production. Rice procurement from millers accounted for 81.1 percent of total procurement. The remaining 18.9 percent of procurement was purchased in the form of paddy from farmers.

Who was negatively impacted by last boro season's low paddy prices? The results indicate that some farmers were more affected than others. Smallholder farmers (47 percent of all boro farmers, operating 0.5 to 1.49 acres of land) were relatively more affected by low paddy prices than other farmer groups because they sold about half of the total volume of boro paddy sold from April to August 2019. Cash-lease tenant farmers (33 percent of all farmers) also suffered considerably when paddy prices dipped because they had to pay land rent in cash to landowners. Conversely, sharecroppers (26 percent of all farmers), who paid rent as a share of their paddy production, and marginal farmers (36 percent of all farmers, operating less than 0.5 acres of land), who mostly cultivated boro paddy for home consumption, were more insulated from the impacts of low paddy prices.

Who benefited most from the procurement process? Rice millers benefited most. They made a large profit, primarily from purchasing hybrid paddy from traders—which was 24.8 percent cheaper than HYV paddy—and then processing and selling hybrid rice to the Government at the Tk 36 per kg procurement price. Even though hybrid rice accounted for 18 percent of total boro production in 2018/2019 (BBS 2019), it represented 94 percent of rice millers' total volume of rice sales to the Government.

Among all farmers who sold paddy during the 2019 procurement season, only 1.34 percent sold to the Government. This is expected given that the total paddy procurement was 399,862 MT, which was 1.37 percent of total paddy-equivalent boro rice production in the 2019 boro procurement season.

Since farmers sell *paddy* during the harvest season, the procurement price is expected to benefit farmers when the Government purchases paddy directly from farmers. On the other hand, a large volume of rice procurement may increase the retail price of rice in the market, which can negatively impact consumers who must buy rice, particularly the urban poor.

Therefore, the Government's key challenge is how to provide price support to farmers and maintain a retail price that is affordable to low-income consumers.

What are the likely effects on market price of paddy from procurement? Using a mathematical demand-supply model, we found:

- The procurement of 399,862 MT of boro paddy in 2019 likely increased the market price of paddy by 7.6 percent compared with a scenario of zero procurement.
- The paddy-equivalent total procurement was 2.12 million MT in 2019. If the Government procured the entire quantity in terms of paddy instead of majority rice, the market price of

paddy may have been around 45 percent higher compared with a zero-procurement scenario.

- To raise the market price of paddy to the level of the procurement price of Tk 26 per kg, the procured quantity would need to be 3.1 million MT of paddy, which accounts for 18.7 percent of market supply of paddy (that is, farmers' marketed surplus), or 10.5 percent of total paddy-equivalent boro production in 2019.

6.2 Policy Conclusions

Three policy options arise from this study. We present these policy options and evaluate them based on their feasibility and limitations:

Policy Option #1: Purchase the entire procurement quantity as paddy to benefit the farmers. If this were implemented during the 2019 boro harvest season, it would have raised the market price of paddy by around 45 percent. Although this would still be below the procurement price of Tk 26 per kg, this would have been a significant improvement from the actual market price of paddy in 2019.

How can this be implemented? The proposed method is described below:

- Farmers would bring their paddy to the local supply depot (LSD) to sell it to the Directorate General of Food (DGF). Because boro harvest is during the rainy season, farmers' paddy usually has high moisture content. However, it is difficult for farmers to dry paddy and then sell it to the Government at the maximum allowable moisture content of 14 percent. Therefore, the procurement price would be adjusted based on the moisture content of farmers' paddy (that is, those who would supply paddy at 14 percent moisture content could receive the announced procurement price and those selling paddy with higher moisture content would receive a relatively lower price from the Government, which would need to be determined using conversion factors).
- The Government could set a lower limit of 200 kg and an upper limit to 2 MT of paddy per farmer for procurement to increase participation of smallholder farmers in the procurement system. Payment could be made to farmers using the existing paddy procurement system.
- The Government-designated rice millers would transport the procured paddy from LSDs to rice mills. The millers should transport paddy with higher than 14 percent moisture content within a day to avoid damage of paddy with excess moisture.
- Paddy-to-rice crushing ratio with 14 percent moisture should be 0.67 (that is, 67 MT of milled rice for every 100 MT of paddy) as per present rules. The crushing ratio for paddy with higher moisture content should be determined using conversion factors.
- Rice millers would receive payment to cover carrying cost for moving paddy from the LSD to mills and a milling charge.

This policy option would benefit farmers who participate and do not participate in the procurement system: farmers who sell their paddy directly through the procurement system would get the procurement price, whereas farmers who do not participate would benefit from the resulting higher market price of paddy during the harvest season. The critical factor for influencing paddy price is the volume of procurement.

Limitation: This option would require revamping the procurement system.

Policy Option #2: Raise the market price of paddy to the procurement price of Tk 26 per kg by substantially increasing the Government procured quantity to around 3 million MT of paddy and procuring directly from farmers. This would follow the same implementation process as described under policy option #1.

Limitations:

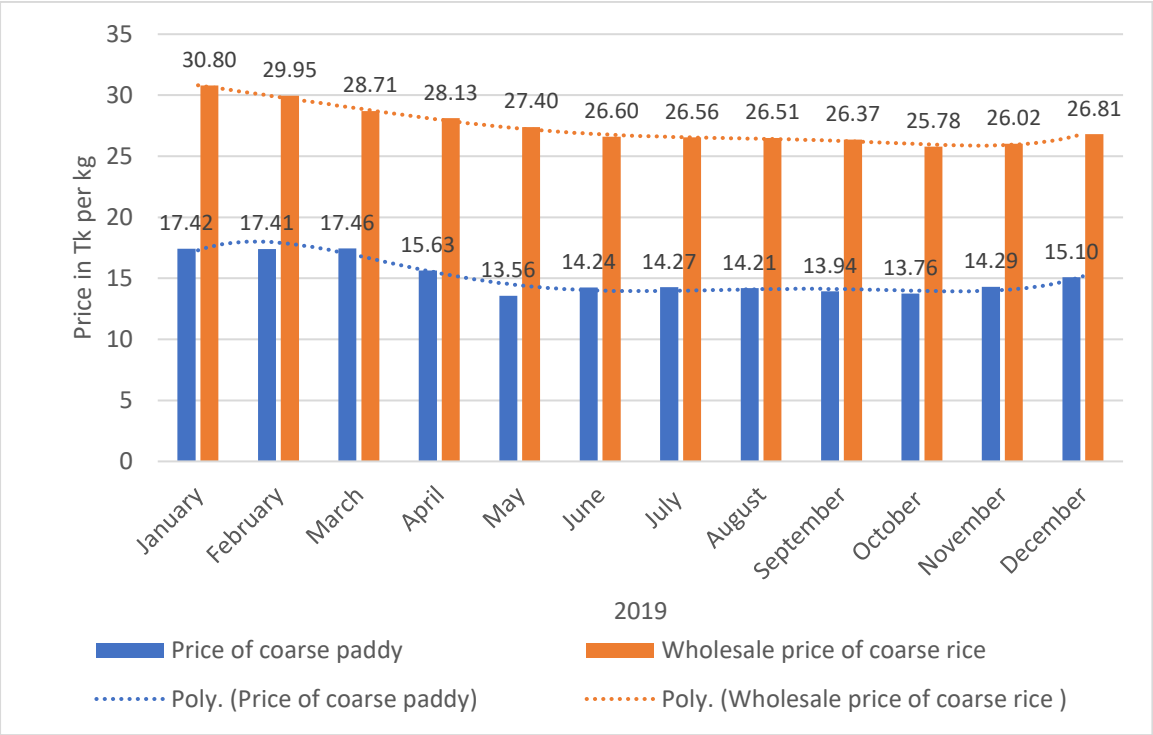
1. The Government's current functional foodgrain storage capacity (1.93 million MT) is insufficient to store this larger volume of rice-equivalent paddy (3.1 million MT of paddy, or 2.1 million MT rice equivalent). Although the Ministry of Food's Modern Food Storage Facilities Project is increasing the national storage capacity by 535,500 MT and is expected to increase the shelf life of rice stock from seven months to three years with the construction of modern steel silos, this expansion will still fall short of the storage required if this option is implemented.
2. Even with a longer shelf life of storage capacity, the rice stock still needs to be rotated. The main outlet of the Public Food Distribution System (PFDS) is social safety net programs; however, safety nets are increasingly transitioning from food- to cash-based programs to achieve higher efficiency. This means that there are fewer options for rotating the rice stock, which is needed to maintain the foodgrain quality and reduce waste.

Policy Option #3: Procure rice through open tender. If appropriately designed, this option would shift the responsibilities of milling, handling, and transportation from the DG Food to private traders. Various factors must be incorporated into the design of open tender procurement to achieve the potential cost-effectiveness of this mechanism, including packaging, delivery points, pricing guidelines, quantity and quality control through inspection, time schedule, and mode of payment (Ahmed, Chowdhury, and Ahmed 1993).

Limitations: This option may not fulfill the objective of providing price support to the farmers during the boro harvest season because the Government would have to purchase *rice* from the traders through tender, not *paddy* from the farmers. Paddy and rice are different commodities; while their markets mostly overlap, they sometimes differ, particularly during harvest season. Although rice and paddy prices are known to be fairly integrated in Bangladesh, prices in the rice market do not completely pass through to the paddy market prices in the short run.

Figure 6.1 indicates that actual paddy and rice prices did not move together closely during the critical months of boro harvest from April to June 2019. Although month-to-month paddy prices fluctuated during the harvest season, rice prices remained relatively stable. Figure 6.1 also shows that rice price declined by 3.1 percent between May and July 2019 despite 1.15 million MT of boro rice was procured during the procurement season. By contrast, paddy price increased by 5.2 percent between May and July 2019, even though the quantity of paddy procured was 0.40 million MT during the 2019 procurement season.

Figure 6.1 Monthly average prices of paddy and rice in 2019



Source: Department of Agricultural Marketing (DAM), Ministry of Agriculture.

We have provided three policy options for modifying Bangladesh's paddy and rice procurement system. Choosing among these depends on the main objective of procurement—that is, whether it is to provide price support to farmers or to replenish the PFDS stock. Although both issues are of utmost importance, achieving multiple objectives requires multiple instruments. The procurement program is a single policy instrument that cannot be used effectively to address both providing price support to farmers during the harvest season *and* building up PFDS stock. Thus, if the primary objective is to support farmers, then the Government may consider policy options #1 or #2; however, if the main objective is to maintain adequate public stock, then policy option #3 may be considered.

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APPENDIX A

Costs and Profitability of Producing Boro Paddy

Conceptual Issues

In Bangladesh, there is a general tendency to compare the harvest price with the average production cost to evaluate farmers' profitability, even though there are inherent conceptual problems with using the average cost of production to estimate farmers' returns. It is the cost of production at the margin—not the average cost—that is relevant in using production cost to measure farmers' profitability, if such guidance is necessary. The remarks of Timmer, Falcon, and Pearson (1983) may be noted in this context:

> The supply curve for a farm crop is directly related to its marginal cost curve, that is, the additional cost of producing additional units of output. The point at which a rational farmer chooses to be on the cost curve (or the supply function) depends not only on the price of inputs but also on the absolute and relative prices of the various crop outputs. Even for a single crop on a given farm, the cost of production is a fiction; there is only a schedule of costs and outputs. These schedules vary by farm and by agroclimatic zone. Both conceptually and empirically, therefore, the search for a single cost of production is fruitless, despite the tendency of government procurement agencies and price control boards to justify their prices on just such a basis. Various estimates over a wide range can all be correct even if the numbers are generated from reliable farm surveys. There cannot be one right answer even with perfect measurements (Timmer, Falcon, and Pearson 1983).

Nevertheless, the use of average cost of production remains popular as a basis for determining paddy and rice procurement prices issued by the Government of Bangladesh.

Estimating Paddy Production Costs and Returns

The method of estimating paddy production costs and returns is as follows:

- IFPRI's Bangladesh Integrated Household Survey (BIHS) collected detailed plot-level data on the use of various inputs and prices of these inputs. The average prices are multiplied by respective input coefficients to calculate per-hectare costs of these inputs. The costs of irrigation, seedling raising, pesticide use, and mechanical power per plot are obtained directly from BIHS and converted into per-hectare costs.
- Most farmers in Bangladesh rely heavily on family labor for crop cultivation. If family members cannot find jobs, or if family labor will not be offered to the market when the crop in question is not produced, then the opportunity cost of family labor may be near zero. However, when labor must be hired to supplement family labor, the use of market wage rate to value family labor may be appropriate. The BIHS collected information on the use of both hired and family labor per plot in hours for various production activities. Labor wages vary at different stages of crop cultivation (such as during land preparation, planting, weeding, and harvesting time). Hired and family labor coefficients for different activities are multiplied by respective wages for these activities to obtain hired and family labor costs.
- The inclusion of land rent in the cost of production calculations involves both conceptual and empirical issues. Land rent should reflect the true opportunity cost of the land for production of any particular crop. The opportunity cost of land is the net value of production forgone when the land is engaged in its next-best alternative use. The opportunity cost of land will vary between

crop seasons, and between agroclimatic zones within the same season. Empirically, it is very difficult, if not impossible, to calculate the true opportunity cost of land for production of any particular crop. Also, as the supply of land is fixed, land rent is determined by demand and, therefore, is affected by product price. If the harvest price of the crop in question is expected to be higher than the previous year's price, land rental is likely to be higher as well for cultivation of that crop.

Recognizing these caveats, average land rents are calculated in this exercise from BIHS data. Although BIHS collected both renting-out and renting-in prices for land, the renting-out price is used for calculating land rent, which determines the opportunity cost of land, not the renting-in price.

- The total cost per hectare is obtained by adding input costs, costs of irrigation, seedling raising, pesticide use, and mechanical power; hired and family labor costs; and imputed land rent for both farmer-owned and rented-in land. Dividing the cost per hectare by paddy yield gives cost per metric ton of paddy. On the revenue side, the total paddy production per hectare is multiplied by farmers' selling price of paddy to calculate gross revenue or return per hectare. Dividing the gross revenue per hectare by paddy yield gives the gross revenue per metric ton of paddy. Subtracting the cost of production from gross revenue gives the net profit of producing paddy.

Results

Table A1 presents the detailed breakdown of costs of inputs per hectare for irrigated boro paddy cultivation in 2018. In 2018, the total full cost of production of boro paddy per hectare, including the imputed costs of family labor and land rent was Tk 100,408, and the total cash cost (without imputed family labor cost and land rent) was Tk 64,862. The total full cost per metric ton of boro paddy was Tk 17,834, and the total cash cost was Tk 11,520 per metric ton (Tk 11.52 per kg). The cost per metric ton is the relevant concept for the purpose of procurement pricing.

Table A1 presents costs of inputs as percentages of cash costs per hectare for irrigated boro paddy cultivation. Hired labor cost has the biggest share (36.2 percent), followed by irrigation (21.7 percent).

The cost of producing a ton of paddy is the relevant concept for the purpose of pricing, rather than cost of production per hectare. Cost per ton can be viewed in terms of a break-even point, indicating the price that farmers must receive for their crop in order to cover their costs. Did the government's paddy procurement price cover the average cost of paddy production in 2018? The government's domestic procurement price of paddy was Tk 26 per kg (Tk 26,000 per MT) in 2018 for the boro season. The information provided in Table A1 indicates that the procurement price covered the full cost (including the imputed values of land rent and family labor) of Tk 17.83 per kg of boro paddy cultivation for those farmers who sold paddy in the procurement system in 2018.

Figure 4.2 of this report on land tenure patterns reveals that about 40 percent of the boro farmers in Bangladesh do not own any cultivable land. Did the government procurement price cover the cost of production of farmers who are pure tenants and, therefore, must pay rent for the land they cultivate (either in cash or in terms of crop share)? Considering the imputed value of land rent but not the imputed value of family labor in cost calculations, the costs per ton of producing boro paddy was Tk 14,776 (Tk 14.77 per kg). Thus, if pure tenant farmers could sell paddy in the paddy procurement system in 2018, then the paddy procurement price (Tk 26.00 per kg) covered the cost of production

(including imputed land rent but not family labor) for pure-tenant farmers who cultivated boro paddy.

Table A1 also presents the costs and profitability (gross margin) of cultivating irrigated boro paddy per unit of land (hectare) and per unit of output (metric ton). Costs and profitability are reported on full cost and cash cost bases. Net profit is calculated by subtracting the full cost (including imputed costs of family labor and land rent) from the value of paddy (paddy output multiplied by farmers' selling price of paddy). Gross profit equals the value of paddy minus the cash cost (excluding imputed costs of family labor and land rent). On a cash cost basis (that is, when imputed values of land rent and family labor are not considered in cost calculations), the rate of gross profit per ton is 59.0 percent of total cash cost for boro. However, when the imputed values of land rent and family labor are considered in the cost calculations, then boro cultivation registers a much smaller net profit margin—only 2.7 percent of the full cost.

Table A1: Cost of production and gross margin of Boro rice paddy harvested in 2018

Description of costs	Cost per hectare	Cost per ton	Share of total cash cost
	(taka)		(percent)
Total full cost	100,408	17,834	
Cash cost	64,862	11,520	
Value of crop	103,139	18,319	
Gross margin or profit (cash cost basis)	38,277	6,798	
Cash costs			
Seed and seedling	7,863	1,397	12.12
Irrigation	14,052	2,496	21.66
Total fertilizer cost	10,296	1,829	15.87
Urea	3,904	693	6.02
TSP	2,823	501	4.35
SSP	12	2	0.02
DAP	1,562	277	2.41
MAP	87	15	0.13
MP	1,416	252	2.18
Zinc	305	54	0.47
Other chemical fertilizers	187	33	0.29
Pesticides/insecticides	3,072	546	4.74
Bullock and other equipment	6,086	1,081	9.38
Bullock	124	22	0.19
Power tiller	5,837	1,037	9.00
Harvesting equipment	43	8	0.07
Other equipment	82	14	0.13
Total hired labor	23,494	4,173	36.22
Land preparation	570	101	0.88
Transplanting	7,588	1,348	11.70
Weeding	3,504	622	5.40
Harvesting	11,714	2,081	18.06
Other hired labor	118	21	0.18
Imputed costs (non-cash)			
Total family labor	16,285	2,892	
Land preparation	2,039	362	
Transplanting	3,273	581	
Weeding	4,099	728	
Harvesting	4,121	732	
Other family labor	2,753	489	
Compost and manures	927	165	
Land rent	18,334	3,256	

Source: IFPRI Bangladesh Integrated Household Survey, 2019.

APPENDIX B

An Analytical Model for Estimating the Effects of a Demand Shift on Boro Paddy Price

The model is within the Marshallian framework of partial equilibrium analysis and based on an analytical framework that considers the fact that a share of total boro rice production in Bangladesh is consumed by producers themselves (Ahmed and Sampath 1992). The model is based on the assumption that the market for food crops produced by numerous small growers and sold to a mass of consumers is competitive. This implies that the crop prices are set by demand and supply in the domestic market. The analytical model is graphically illustrated in Figure B1 and the mathematical formulation of the model is below.

We undertake this analysis for the boro paddy market. In Figure B1, the vertical line D_hH represents the paddy demand curve of producers for home consumption. This demand curve is drawn as insensitive to changes in paddy price. The vertical demand curve for producers' home consumption represents the amount of rice consumed by the surplus farmers and the total quantity produced by the deficit farmers. The horizontal distance between the demand curve for farmers' home consumption (D_hH) and the market demand curve (D_mD_0) measures the quantity of the "gross marketed surplus" supplied by the surplus boro paddy producers.

The Government of Bangladesh is a potential large buyer of boro paddy and rice through its rice procurement system. The demand curve for boro paddy D_mD_0 represents the aggregate demand for boro paddy from domestic production. While the market equilibrium before the demand shift of paddy is at *A*, the market equilibrium is established at *B* after the rightward shift in the aggregate demand curve from D_mD_0 to D_mD_1.

To quantify the impact of the demand shift for paddy, a mathematical treatment of the above relationship is developed. Assuming a constant price elasticity of demand, the market demand function can be represented as

(1) $$q = ap^{-\varepsilon},$$

where *p* and *q* are the price and quantity demanded of paddy, respectively. The constant *a* includes demand shifters, and ε is the price elasticity of demand.

A constant elasticity supply function for paddy can be expressed as

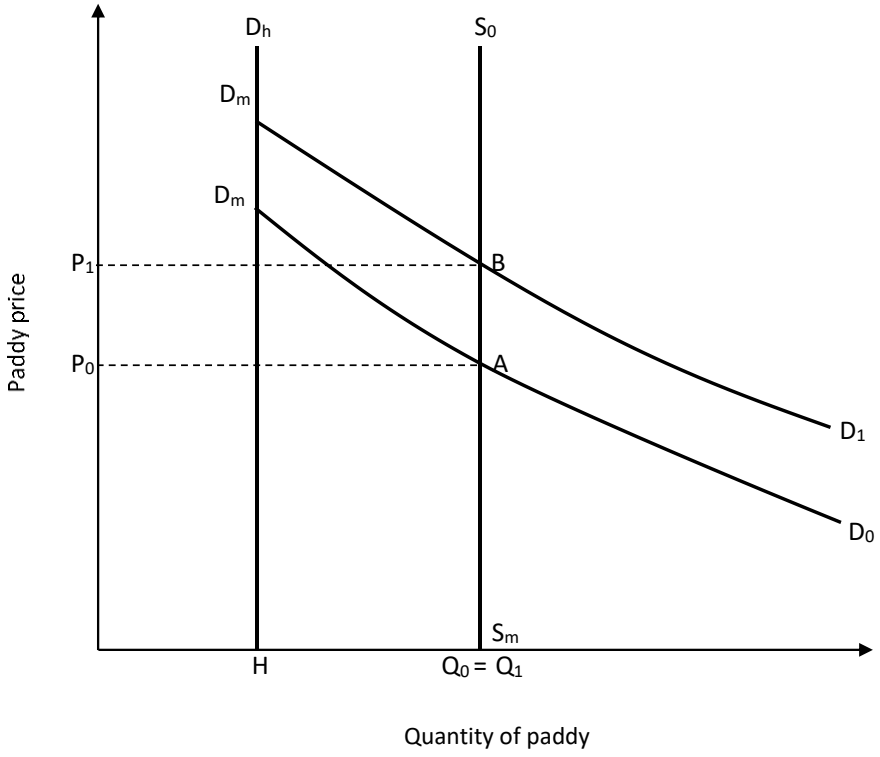
(2) $$q = bp^{\beta},$$

where *p* and *q* are the price and the quantity supplied, *b* includes supply shifters, and β is the price elasticity of supply.

Assuming an *m* shift in demand schedule, the new demand function can be expressed as

(3) $$q = a(1+m)p^{-\varepsilon}.$$

Figure B1 Effects of a shift in paddy demand on market price of boro paddy



If the supply of paddy results in a *k* shift in paddy supply schedule, then the new supply function can be expressed as

(4) $$q = b(1+k)p^{\beta}$$

The two equilibrium prices of paddy (P_0 and P_1), without the demand shift and with the demand shift, respectively, can be derived by equating equations (1) and (2) and (3) and (4) and solving them for P_0 and P_1. Thus,

(5) $$P_0 = \left(\frac{a}{b}\right)^{1/(\beta+\varepsilon)}$$, and

(6) $$P_1 = P_0\left(\frac{1+m}{1+k}\right)^{1/(\beta+\varepsilon)}$$.

Similarly, we can obtain the equilibrium quantities of paddy (Q_o and Q_1) with the supply shift as

(7) $$Q_0 = a^{\beta/(\beta+\varepsilon)}b^{\varepsilon/(\beta+\varepsilon)}$$, and

(8) $$Q_1 = Q_0(1+m)^{\beta/(\beta+\varepsilon)}(1+k)^{\varepsilon/(\beta+\varepsilon)}$$.

with subscripts 0 and 1 indicating the situations without and with the demand and supply shifts, respectively.

Assumptions and parameters used for the present exercise:

- For estimating the value of the demand shift parameter (*m*), we used the actual paddy procurement quantity of 399,862 MT of paddy by the Directorate General of Food (DGF) under the Ministry of Food.
- For estimating the impact of paddy procurement on the market price of paddy, we assume no shift in the supply of paddy; therefore, the value for *k* is set at 0.
- We used the 2019 marketed surplus of 16,350,000 MT (16.35 million) of paddy equivalent rice as the baseline quantity (Q_0).
- We used the paddy price of Tk 15.41 per kg prevailing in April 2019, as the base price.
- We used -0.327 as the value of price elasticity of demand for rice. We estimated the demand price elasticity from the 2011/2012 and 2015 rounds of BIHS panel data using the Quadratic Almost Ideal Demand System (QAIDS) model.[8]
- Since domestic production of paddy will not change in response to the procurement price before next year, we set the value of zero for the price elasticity of supply. Therefore, in Figure B1, the supply curve of paddy, S_mS_0 ,is constructed as a vertical supply curve, where the quantity of paddy supply remains constant ($Q_0 = Q_1$).
- The change in equilibrium price of paddy in from P_0 to P_1 results only from the shift in demand, as shown in Figure B1.

Section 4.3 of this report presents the results of the analysis. The estimates suggest that in order to raise market price of paddy to Tk 26.00 per kg, the procurement quantity needs to be 3,074,000 (3.07 million). This amount accounts for 18.7 percent of market supply of paddy (that is, farmers' marketed surplus), or 10.5 percent of total paddy-equivalent boro production in 2019.

[8] This QUAIDS model is the only demand system analysis in Bangladesh that used panel data, following the same households who faced changes in price from 2011/2012 to 2015. Other demand system analyses in Bangladesh used cross-section data, where the variation in commodity prices reflects only spatial price variation.