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**Working Paper**

## Deployment Strategies for Golden Rice in Bangladesh: A Study on Affordability and Varietal Choice with the Target Beneficiaries

*Suggested Citation:* Rahman, Mohammad Chhiddikur; Rahaman, Md. Shajedur; Islam, Mohammad Ariful; Omar, Md. Imran; Siddique, Md. Abu Bakr (2021) : Deployment Strategies for Golden Rice in Bangladesh: A Study on Affordability and Varietal Choice with the Target Beneficiaries, Bangladesh Rice Research Institute, Gazipur, <https://doi.org/10.13140/RG.2.2.14318.33607>

This Version is available at:

<https://hdl.handle.net/10419/241994>

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**Deployment Strategies for Golden Rice in  
Bangladesh: A Study on Affordability and Varietal  
Choice with the Target Beneficiaries**



Agricultural Economics Division  
Bangladesh Rice Research Institute  
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# Deployment Strategies for Golden Rice in Bangladesh: A Study on Affordability and Varietal Choice with the Target Beneficiaries

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**Proposed Citation:** Rahman et al., 2021. Deployment Strategies for Golden Rice in Bangladesh: A Study on Affordability and Varietal Choice with the Target Beneficiaries. Working paper, Agricultural Economics Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh.

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## **Acknowledgment**

The authors are very much thankful to the International Rice Research Institute (IRRI), Philippines, for assigning the Agricultural Economics Division of the Bangladesh Rice Research Institute (BRRI) for conducting this research work. We are also grateful to Bill & Melinda Gates Foundation for the financial support. The authors recognize the dedication of the Scientists and staff of the Agricultural Economics Division, BRRI, and Data Enumerators for their arduous supports and cooperation while collecting data. We are especially thankful to Md. Saiful Islam, PSO, Agricultural Economics Division, BRRI for valuable technical supports. We are acknowledging the contribution of Md. Abdur Rouf Sarkar, SSO, Agricultural Economics Division, BRRI for his active support in the conceptualization of the project initially. The authors are also thankful to Dr. Humnath Bhandari, Country representative of IRRI for Bangladesh for his valuable suggestions to finalize the research work.

Very importantly, we are pleased to the BRRI authority for letting us do this research.

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## Executive summary

The sustainable development goals emphasized achieving food security and improved nutrition for all. As nothing is more important than health, all should have adequate basic nutrients to lead a healthy life. Vitamin A deficiency (VAD) is a major problem in large parts of the developing world. Apart from acute symptoms of eye problems, VAD also weakens the immune system, thus increasing the incidence and severity of infectious diseases. For adults, the implications can be serious too, especially for pregnant and lactating women. The most affected are the poor, whose diets are predominated by less nutritious staple foods on account of lacking purchasing power and limited awareness. ‘Golden Rice’ has been developed through genetic engineering at Swiss and German universities. It is a new type of rice that contains ‘beta-carotene’, which is converted into vitamin A inside the body as needed and gives the grain its golden color. It’s grown just like ordinary rice and aims to provide 30-50% of the estimated average requirement for vitamin A. It could improve the vitamin A status of deficient food consumers, especially women and children in developing countries. Some optimists praise it as the solution to overcome malnutrition and VAD. It already has received biosafety approval and released in the Philippines and hopes to release in Bangladesh soon. Prior to the release, the healthier rice team aimed to draw a deployment strategy of golden rice in Bangladesh. Therefore, this study has been conducted to assess the affordability and varietal choice of the targeted beneficiaries in the specific regions of Bangladesh. The targeted study areas of this project are three different districts of the country where the concentration of poor people (according to the Head Count Ratio (HCR)) is higher and the adoption rate of BRRI dhan29 is relatively more. Purposively selected Upazilas of Jamalpur (HCR: 52.5), Kurigram (HCR: 70.8), and Sylhet (HCR: 13), as well as slum area of Dhaka, have been surveyed to figure out the rice production, disposal, and consumption patterns of the targeted groups. The purpose of the study was to find out the attitudes of the rice value chain actors and consumers towards upcoming golden rice to draw the possible deployment strategies through an ex-ante assessment. The findings of the study reveal that the Kurigram district faced higher poverty compare to other sampled districts according to the estimated HCR, Poverty Gap Index (PGI), and Squared Poverty Gap Index (SPGI). The consumers in the Jamalpur district spend 38% of the households’ annual income as food expenditure, followed by Kurigram (29%) and Sylhet (26%). Whereas the consumers of the Dhaka slum areas devote 37% of the annual households’ income to



food. It should mention that about 13% of the expenditure spent for rice. The Household Dietary Diversity Score (HDDS) implies that more than 80% of the households contain medium HDDS (5-8). Where 13% of households of the Dhaka slum area and 12% of households of the Kurigram district contain low HDDS (less than 5). Only a minimum number of the sampled households had high (more than 8) HDDS, implying that only a few of the sampled households have the opportunity to consume a balanced diet. About one-third of the sampled consumers in the study areas have to purchase rice from the market year-round. Where 42% of them purchase rice partially (for a few months). Among the rice-growing farmers, 67% have to purchase rice from the market partially. The rest of the farmers do not need to purchase, even they sell paddy to the market. One of the major problems faced by the farmers in rice cultivation is the lack of quality seeds. The farmers of the study areas are accumulating more land (adoption rate 26%) for cultivating BRRI dhan29 than the national adoption rate (25%). However, the retailers in the study areas are providing only 32% of the total rice consumed. A significant proportion of the consumers in the rural level purchase paddy and milled it into rice for their consumption. The consumers are purchasing about 18% rice by the brand name 'Minikit'. The other popular brand names in the market are BR28, BR29, Nazir, Nizarshil, Katari, etc. Therefore, it is clear that different varieties of paddy are milled over the brand names. The paddy traders in the local markets purchase paddy from the farmers, *farias*, and *beparies*. They usually mixed similar types of paddy grains irrespective of the varieties and supply to the millers. The millers process the collected paddy according to the demand of the market. They shape the rice according to the popular brand name to attract consumers. Most of the millers are not much concerned about the nutrients and quality change due to the over-polishing of rice grain. Some of the millers know about it but do not bother at all. The rice traders are mainly consumer-oriented, and they traded the most popular branded rice. Almost all the traders and millers in Bangladesh rice sectors are members of traders and millers' organizations and they hold market power to fix the price of their product with the collusion of the fellow trades.

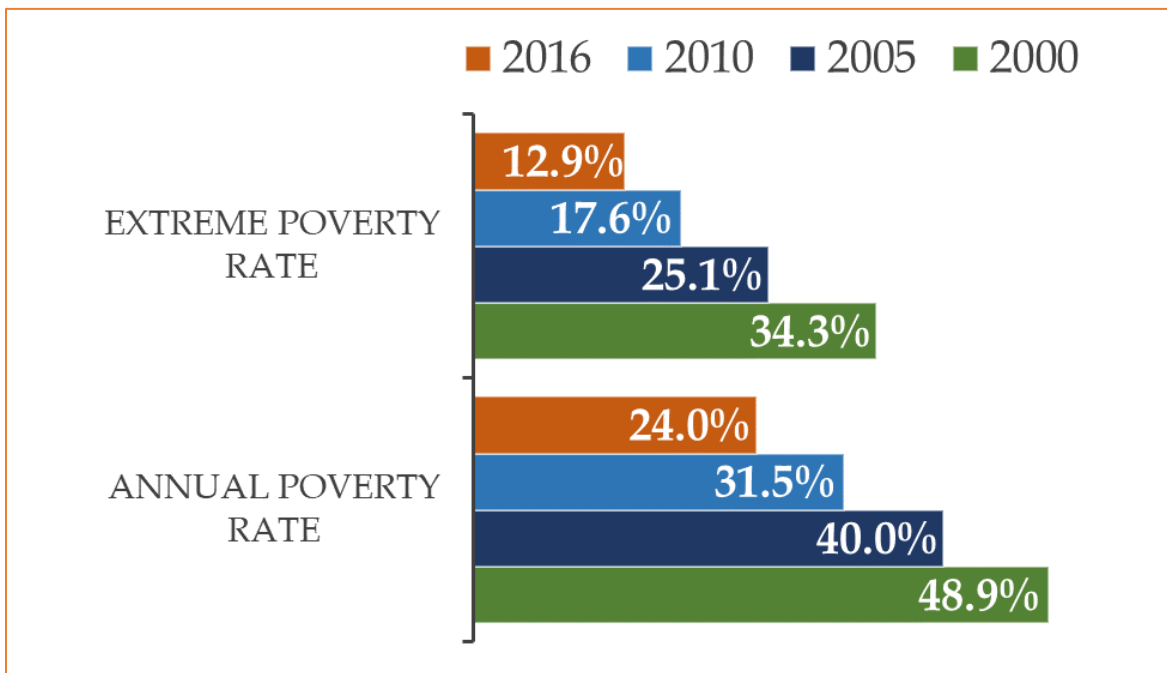
None of the consumers, farmers, and other value chain actors in the study area heard the name 'Golden Rice' before the survey. More than 90% of the sampled respondents do not know about the importance of nutrients. About 37% of the respondents know that vitamin A deficiency is the cause of 'night blindness'. Initially, the respondents show a negative attitude towards the yellow grain of the upcoming GR. However, their attitude turns positive after hearing the importance of

vitamin A and the grain color is the cause of beta-carotene. According to the consumers, the yellow color of the cooked rice is not a major problem if the importance of vitamin A is spread through awareness building. However, the consumers impose a condition that the taste and price of the GR should not be very much different from BRR1 dhan29 or BRR1 dhan28. The mass media and special awareness-creating programs can play a vital role in this regard. The government can include GR in the social safety net programs (such as VGF, OMS, FFW, rationing, etc.). The producers demanded that the yield and market price should be ensured to make the rice production profitable. The traders expressed their opinion to create the market demand of the golden rice so that they should not face any risk of selling. The seed growers will follow the market demand for GR to produce seed. The millers are also indifferent towards GR. They only follow the market needs. But there should have research on the milling system of GR in Bangladesh. Therefore, the system is interlinked along the supply chain. If the GR has much demand in the market and consumers', the farmers will produce it and the seed growers will produce the seed. For this, there should have an effective awareness-creating program about the importance of golden rice. The terms 'GMO' and 'Golden Rice' could create a negative mindset for the consumers. So, the recommendation is to use 'Vitamin A Rice' instead of 'Golden Rice'. Moreover, there should have a pilot program to create a unique supply chain network from seed grower to the consumer for disseminating the GR. The yield is the most important factor for adopting a variety. There should be a complete cultivation guideline of GR so that the farmers can minimize the yield gap. As the grain color is yellow, the traders would not be agreed to purchase the paddy, as it would be a problem to mix up with similar types of grains. This is a great positive site from Bangladesh's perspective as well. The yellow color will segregate the GR from other rice and maintain the purity from mixing up. There should develop a complete milling guideline for golden rice so that the nutrient content remains unchanged. Finally, there is no alternative to increasing the popularity and creating the demand for GR by building awareness about the importance of nutrients and vitamin A for the human body. The awareness programs should focus on creating the questions and answer in the peoples' minds- why vitamin A, why golden rice, how it would be beneficial for a human being; especially, for the children and women. Finally, the deployment plan should consider the issues of seed growers, farmers, paddy and rice traders, millers, and consumers towards popularizing GR in Bangladesh. Based on the findings, this study has drawn a roadmap for designing the deployment plan of upcoming 'Golden Rice' in Bangladesh.

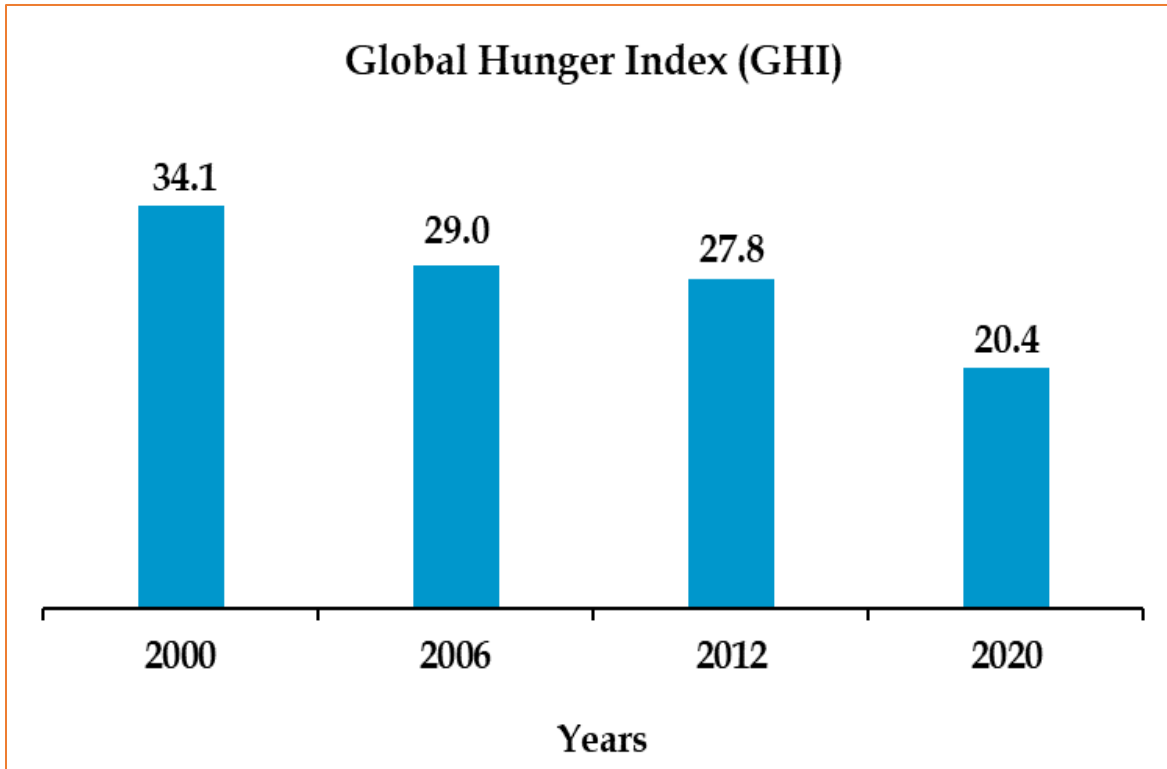
## 1. Background

Food and health are the most important basic needs for living beings. Therefore, all human beings should have adequate nutrients to lead a healthy life. Vitamin A deficiency (VAD) is a major problem in large parts of the developing world. Apart from acute eye symptoms, VAD also weakens the immune system, thus increasing the incidence and severity of infectious diseases. For adults, the implications can be serious too, especially for pregnant and lactating women (Zimmermann and Qaim, 2004); furthermore, UNICEF (2013) recognized that VAD is a severe public health problem. Around 190 million children and 19 million pregnant women globally are affected by VAD. Whereas approximately 300 thousand children globally go blind every year due to VAD (WHO, 2009). The most affected are the poor, whose diets are predominated by less nutritious staple foods on account of lacking purchasing power and limited awareness. It is worthwhile to mention that 24 percent of the population in Bangladesh is still poor, and about 13 percent are extremely poor (**Figure 1**). To mitigate this problem, ‘Golden Rice’ has been developed through genetic engineering at Swiss and German universities (Ye et al., 2000). Golden Rice has been genetically modified to produce beta-carotene in the grain’s endosperm. It is genetically modified with the gene for Phytoene synthase from maize and the Phytoene desaturase gene from a common soil microorganism. Therefore, it is a new type of rice that contains beta carotene, which is converted into vitamin A inside the body as needed and gives the grain its golden color. It is grown just like ordinary rice and aims to provide 30-50 percent of the estimated average requirement for vitamin A. It could improve the vitamin A status of deficient food consumers, especially women and children in developing countries. Some optimists praise it as the solution to overcome malnutrition and VAD. It has been released already in the Philippines and hopes to release in Bangladesh soon. It has immense need in the context of Bangladesh. About 31 percent of the country’s children under 5 years are stunted, 9 percent are severely stunted, about 22 percent are underweighted, and 8 percent are the prevalence of wasting (NIPORT and ICF, 2019). About 5.4 percent of women and 20.9 percent of school-age children are suffering from VAD. The prevalence is more in the slum areas of the country (NMS, 2012). About 13 percent of households are unable to afford a nutritious diet (WFP, 2019). Only 46 percent of the vitamin A requirement of children in Bangladesh is being met up by the daily food intake (HIES, 2016).

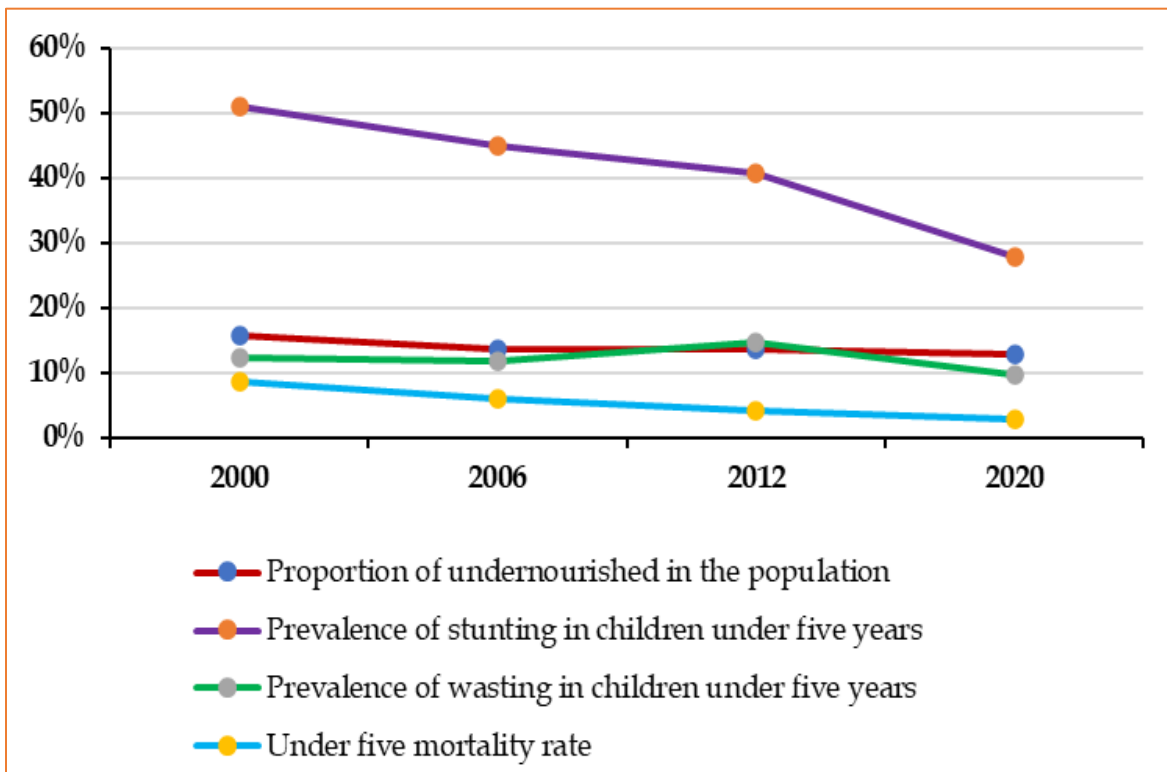
Regarding zinc and Vitamin-A deficiency, Bangladesh ranks high burden in south Asia (Beal et al., 2021). In the 2020 Global Hunger Index (GHI), Bangladesh ranks 75th out of the 107 countries with sufficient data to calculate GHI scores. With a score of 20.4 (see **Figure 2**), Bangladesh has a level of hunger that is serious (von Grebmer *et al.*, 2020). The GHI report also showed that 13 percent population in Bangladesh is undernourished, the under-five mortality rate is 3 percent, 28 percent is the prevalence of stunted children under five, and the prevalence of wasting under five is 9.8 percent (see **Figure 3**). Therefore, nutrient enriched staple food is much important for Bangladesh so that the poor can be benefited from it.



**Figure 1:** Poverty status of Bangladesh. Prepared by the authors' based on the information from different issues of Bangladesh's Household Income and Expenditure Survey reports.

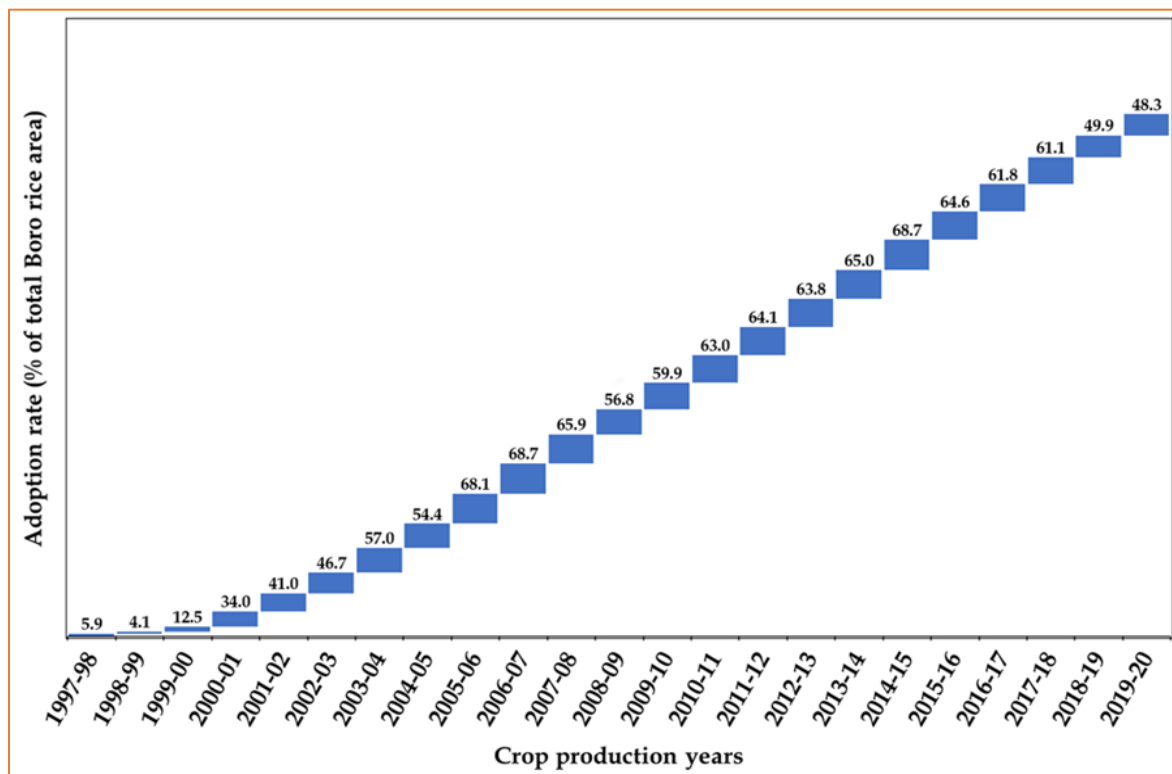


**Figure 2:** The global hunger index of Bangladesh. Prepared by the authors based on the information from von Grebmer *et al.*, 2020.

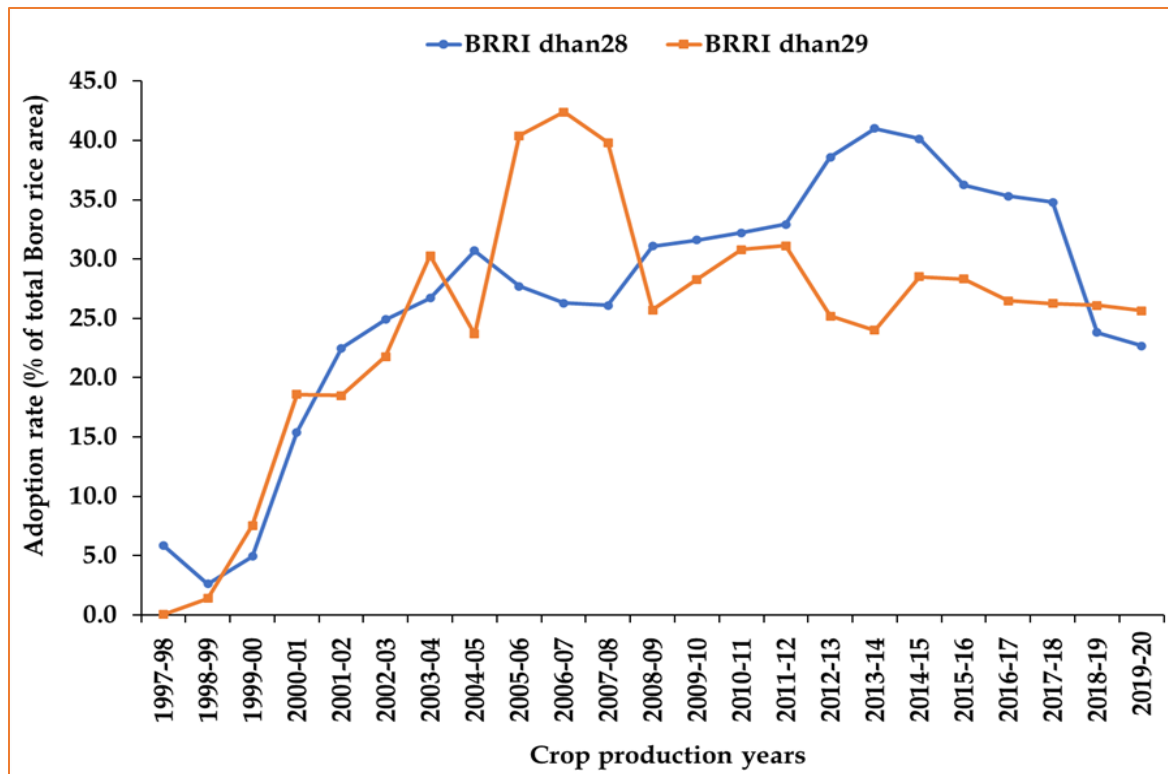


**Figure 3:** Nutritional status of Bangladesh. Adopted from von Grebmer *et al.* 2020.

Rice is the main staple in Bangladesh (Rahman et al., 2021a; Siddique et al., 2020; Rahaman et al., 2020; Islam et al., 2020), and the country stands 3<sup>rd</sup> for rice production in the world (Rahman et al., 2021b). It plays a vital role in the cereal crop sector of the country by generating 90 percent of overall food grain production (Rahman et al., 2020). About cent percent population of Bangladesh consume rice as their main food at 367 gm per person per day (HIES, 2019). Therefore, intrusion of Beta-carotene into rice would be much justified to reduce the VAD. Among the rice varieties in Bangladesh, the medium slender grain BRRI dhan28 and BRRI dhan29 are the mega varieties of the Boro season (dry season). The varieties are almost similar and combinedly covered about 48 percent of the total Boro rice area (**Figure 4**). It should be noted that BRRI dhan29 alone covered about 25 percent of the Boro rice area (**Figure 5**) because of its higher yield and grain quality (size-shape and taste). Therefore, choosing BRRI dhan29 for incorporating Beta-carotene is much justified.



**Figure 4:** Aggregated share of BRRI dhan28 and BRRI dhan29 on the total Boro adoption in Bangladesh. Prepared by the authors based on the data from BRRI.



**Figure 5:** Adoption rate of BRRRI dhan28 and BRRRI dhan29 in Bangladesh. Prepared by the authors based on the data from BRRRI.

‘Golden Rice’ in Bangladesh showing that it is the same as the parent (BRRRI dhan29) in all aspects, except for Beta-carotene in the grains. It will contribute positively towards addressing the VAD problem. The adoption and implementation of Golden Rice would benefit the country by at least 2,687 million dollars (Deb, 2016). Golden rice is waiting to get a biosafety certificate from the National Committee on Biosafety (NCB), Bangladesh, to release. It should be mentioned that Golden rice has been released already in the Philippines. In the Philippines, by the department of agriculture, the bureau of plant industry concurred that Golden rice is as safe for human food and animal feed as its conventional counterpart. The U.S. Food and Drug Administration declared that human and animal food from Golden rice is not materially different in composition, safety, or other relevant parameters from rice-derived food currently on the market except for the intended beta-carotene change. Health Canada concluded that the change made in the Golden rice variety did not pose a greater risk to human health than rice varieties currently available in the Canadian market. It would have no impact on allergies, and that there were no differences in the nutritional value of Golden rice compared to other traditional rice varieties available for consumption except for increased levels of pro-vitamin A. According to the Food Standards, food derived from Golden



rice is as safe for human consumption as food derived from conventional rice varieties. The science is relatively straightforward. But public institutions are averse to making unpopular decisions; regulatory policies are sometimes ambiguous and need evidence-based support to build public awareness to create a favorable policy environment. International Rice Research Institute (IRRI) and its international partners are helping ‘Golden Rice Project’ partner countries to generate different food and feed safety data following national and international standards required by regulators of the respective countries. Research on food, feed, and environmental safety issues is in progress to formulate a strategy to make Golden Rice available to farmers, value chain actors, and consumers. If found safe, efficacious, and approved by the government, a sustainable dissemination program will be undertaken to deliver Golden Rice to the areas in Bangladesh where it is needed the most. Prior to the release, the healthier rice team aimed to draw a deployment strategy of golden rice in Bangladesh. Therefore, this study has been conducted to assess the affordability and varietal choice of the targeted beneficiaries in the specific regions to draw some guidelines for making a deployment plan of Golden Rice in Bangladesh.

## 2. Methodology

### 2.1 Location of the Study and Data

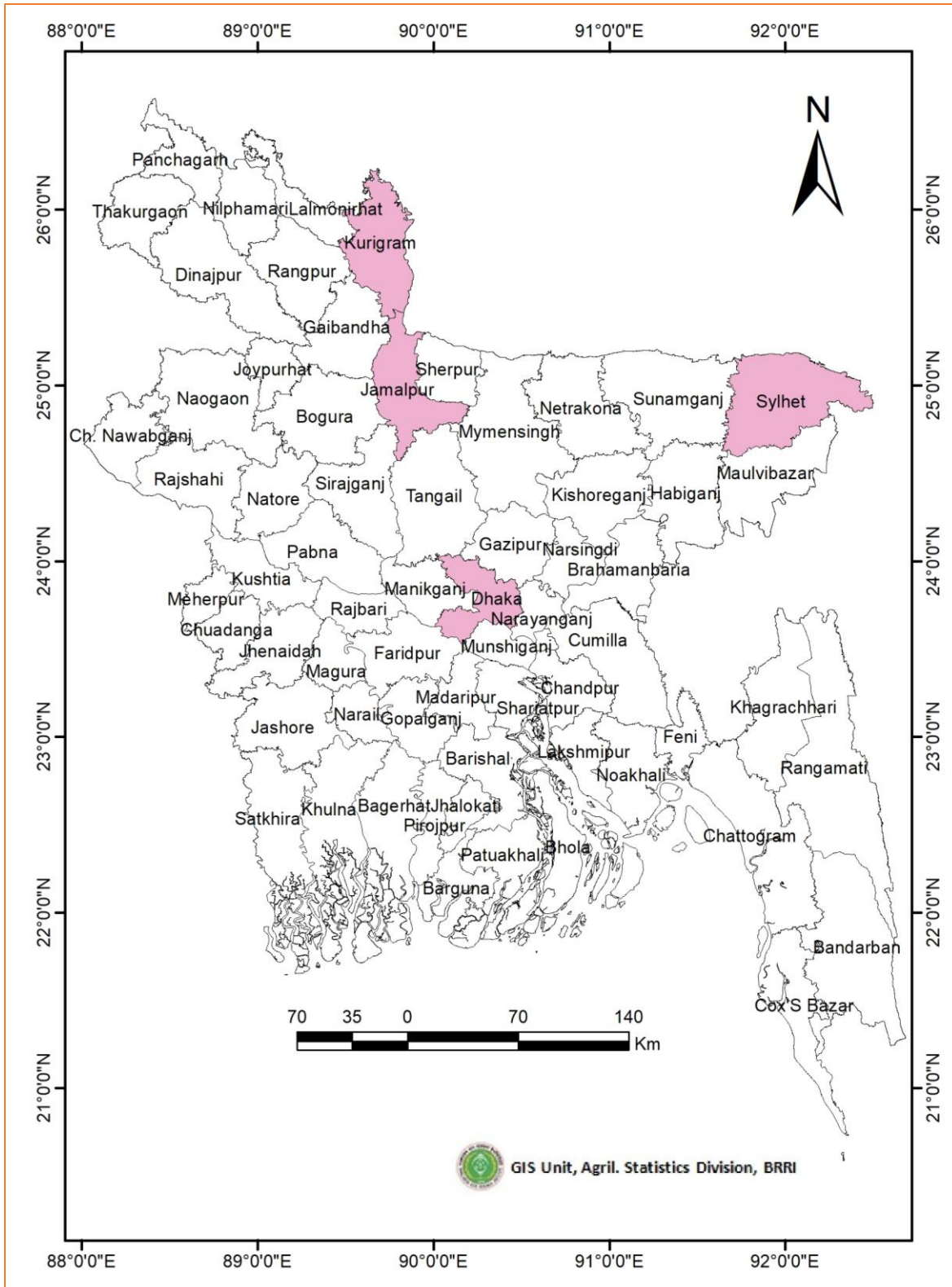
The location of the study has been selected purposively. The targeted areas of this study are three different districts of the country where the concentration of poor people is higher, and the adoption rate of BRRI dhan29 is relatively more (as golden rice is based on BRRI dhan29). Purposively selected Upazilas of Jamalpur (HCR: 52.5, HCR= Head Count Rates according to HIES, 2019), Kurigram (HCR: 70.8), and Sylhet (HCR: 13), as well as slum area of Dhaka, have been surveyed to figure out the objectives of the study (**Figure 6**). Structural questionnaires have been developed and pretested before the survey for consumers, farmers, seed growers, and postproduction value chain actors. Face-to-face interviews, Focused Group Discussions (FGDs), and Key Informant Interviews (KIIs) have been conducted to gather preliminary information. The sampling distribution of this study has been presented in **Table 1**. In total, 1080 households were surveyed for capturing consumers' status and attitude towards Golden Rice. Total 660 farmers were involved in the FGDs. Representative samples of seed growers and postproduction value chain actors were surveyed in this study. The secondary information has been gathered from various published

literature. Descriptive statistics and tabular techniques have been employed to analyze the collected data.

**Table 1:** Sample distribution.

District	Upazila	Union	Block	Consumer (Household)	Wholesaler	Retailer	Miller	Seed grower	FGDs	Producer (farmer FGD)
Kurigram	Sader	2	6	90	7	10	2	3	6	60
	Rajarhat	2	6	90	7	10	2	3	6	60
	Chillmari	2	6	90	7	10	2	3	6	60
	Nageshwari	2	6	90	7	10	2	3	6	60
Jamalpur	Sarishabari	2	6	90	7	10	2	3	6	60
	Madarganj	2	6	90	7	10	2	3	6	60
	Melandho	2	6	90	7	10	2	3	6	60
	Dewnganj	2	6	90	7	10	2	3	6	60
Sylhet	Jakiganj	2	6	90	7	10	2	3	6	60
	Balaganj	2	6	90	7	10	2	3	6	60
	Usmaninagar	2	6	90	7	10	2	3	60	60
Dhaka	1 Slum	-	-	90	7	10	-	-	-	-
<b>Total</b>				<b>1080</b>	<b>84</b>	<b>120</b>	<b>22</b>	<b>33</b>	<b>66</b>	<b>660</b>

**Note:** Prepared by the authors.



**Figure 6:** Location of the study. The map has been drawn in the GIS lab of the Agricultural Statistics Division, BRRI.

## 2.2 Measuring Poverty

The deficiency of income to satisfy basic needs is the most widely used definition of poverty status. Income poverty is determined by comparing household income to a poverty line estimated using a normative food basket and price attached to each unit of food items by following the cost of basic needs method (Hossain and Sen, 1992; Muqtada, 1986; Ravallion and Sen, 1996). This study measures the income poverty based on the absolute poverty line set at the level of the expenditure needed to provide a minimum balanced diet of 2,100 calories with a 30% (of poverty-level income) allowance for nonfood basic items per day for each household member.

In the context of measuring poverty in a population, the index of Foster *et al.* (1984) is commonly used, which is expressed as:

$$P_{\alpha} = \frac{1}{N} \sum_{i=1}^N \left[ \frac{Z - y_i}{Z} \right]^{\alpha} \quad (\alpha > 0) \text{ and } (y_i < Z)$$

where  $Z$  is the agreed-upon poverty line (US\$ 1.90/capita/day) converted to Bangladeshi Taka,  $N$  is the total household population,  $y_i$  is the household income per capita for the  $i^{\text{th}}$  person, and  $\alpha$  is a poverty aversion (sensitivity) parameter. The study used the international poverty line of US\$ 1.90/capita/day (WBG, 2016) for this study which is converted to taka per capita per year using the official exchange rate.

- 1) Head count ratio (HCR): When  $\alpha = 0$ ,  $P_0 = q/N$  where  $q$  is the number of poor people. The head count ratio shows the proportion of the total population whose annual per capita income falls below the poverty line. It is a measure of poverty incidence showing the percentage of households that fail to meet household members' basic food and non-food requirements.
- 2) Poverty gap index (PGI): When  $\alpha = 1$ ,  $P_1 = \frac{1}{N} \sum_{i=1}^N \left[ \frac{Z - y_i}{Z} \right]^1$  ( $\alpha > 0$ ) and ( $y_i < Z$ ) is the poverty gap ratio, which is the sum of all individual poverty gaps expressed as a fraction of the poverty line divided by the total number of households. It measures the *depth of poverty* by averaging the distance of per capita income of the poor from the poverty line income as a percentage of the poverty line income over the entire population.
- 3) Squared poverty gap index (SPGI): When  $\alpha = 2$ ,  $P_2 = \frac{1}{N} \sum_{i=1}^N \left[ \frac{Z - y_i}{Z} \right]^2$  ( $\alpha > 0$ ) and ( $y_i < Z$ ) is the squared poverty gap ratio, which is the sum of individual squared poverty gaps

divided by the total number of households.  $P_2$  is a measure of the severity of poverty in that it gives greater weight to the income shortfall, the greater the distance of income from the poverty line.

### 2.3 Household Dietary Diversity

Household Dietary Diversity Score (HDDS) is constructed based on the number of food groups consumed by the household. Food items were categorized into 12 different food groups as proposed by the Food and Agriculture Organization of the United Nations (FAO, 2011). Each food group adds one score point toward the HDDS if any household member consumed a food item from that group in the given one-day period. Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals. The household dietary diversity score (HDDS) is meant to reflect, in a snapshot form, the financial ability of a household to access a variety of foods. Studies have shown that an increase in dietary diversity is associated with socioeconomic status and household food security (household energy availability) (Hossain et al., 2016; Hoddinot and Yohannes, 2002; Hatloy *et al.*, 2000).

## 3. Results and Discussions

### 3.2 Socio-economic Status and Food Consumption Patterns of the Consumers

The average educational status of the sampled households head is much poor in the study areas. The highest average is in Kurigram (6.87) followed by Jamalpur (3.81) and Sylhet (3.66). The lowest average educational level of the households' heads is found in the slum area of Dhaka city (2.73). The average household size of the sample households is more than the national average (**Table 2**). According to HIES (2016), the average household size is 4.06. The largest average household size has been observed in Sylhet (5.37), and that of the smallest is in the slum area of Dhaka (3.87). The family size of Jamalpur and Kurigram has been found 4.71 and 4.60, respectively. All the family has active male and female members. Average male and female children, and old male and female members are less than 1, indicating some families without children and senior members. In the slum area of Dhaka city, the old member is absent from the family.

**Table 2:** Demography of the sampled households head in the study areas.

Size of family members (no.)	Jamalpur	Kurigram	Sylhet	Dhaka
Education of household head (year of schooling)	3.806 (4.467)	6.868 (4.715)	3.659 (3.506)	2.733 (3.692)
Household size (no.)	4.712 (1.564)	4.600 (1.593)	5.365 (1.803)	3.866 (1.534)
Active male members (15-65) years	1.914 (1.167)	1.803 (0.926)	1.929 (1.110)	1.400 (1.242)
Active female members (15-65) years	1.695 (0.857)	1.680 (0.798)	1.944 (1.045)	1.400 (0.632)
Male child members (<15) years	0.647 (0.742)	0.582 (0.752)	0.841 (0.896)	0.600 (0.737)
Female child members (<15) years	0.651 (0.831)	0.621 (0.830)	0.929 (0.986)	1.066 (0.798)
Old male members (>65) years	0.096 (0.296)	0.086 (0.281)	0.096 (0.295)	0
Old female members (>65) years	0.037 (0.208)	0.127 (0.358)	0.666 (0.249)	0

**Source:** Parentheses indicate standard deviation. Analyzed and prepared by the authors based on the information from the field survey.

**Table 3** shows the poverty status of the selected study locations. HCR was very low in Koryial slump (26.66%) under Banani area of Dhaka district, followed by Sylhet (44.07%), Jamalpur (48.32%), and Kurigram (55.32%) districts in Bangladesh. Likewise, PGI was very low in Koryial slump (3.85%) under Banani area under Dhaka district, followed by Sylhet (9.57%), Jamalpur (11.35%), and Kurigram (14.17%) districts in Bangladesh. Moreover, PGI was also very low in Koryial slump (0.99%) under Banani area under Dhaka district, followed by Sylhet (2.96%), Jamalpur (3.65%), and Kurigram (4.98%) districts. Therefore, Kurigram district faced higher poverty in all the indicators compared to other districts. It might be due to the low income generated by poor people during the lean period of agricultural activities.

**Table 3:** Estimated poverty status in different districts of Bangladesh.

Items	Jamalpur	Kurigram	Sylhet	Dhaka
HCR (%)	48.32	55.32	44.07	26.66
PGI (%)	11.35	14.17	9.57	3.85
SPGI (%)	3.65	4.98	2.96	0.99

**Source:** Analyzed and prepared by the authors based on the information from the field survey.

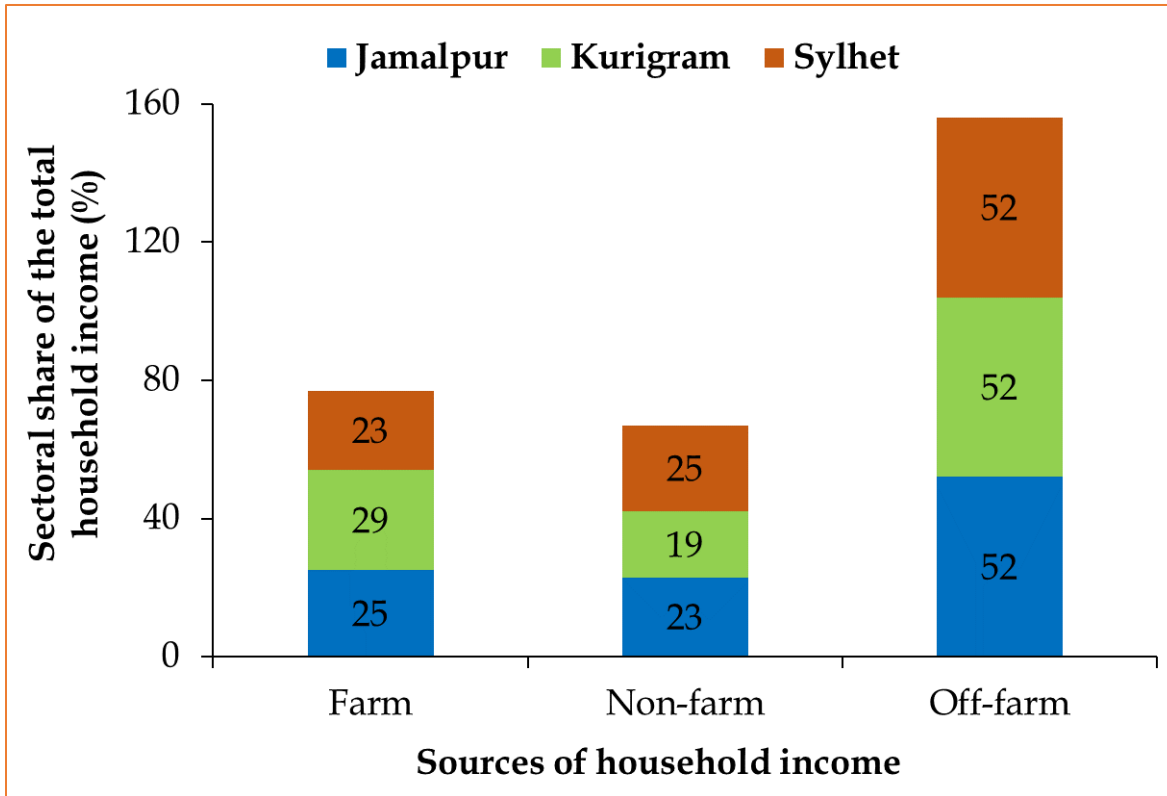
The lowest average annual household income (278800 Tk./year) was observed in the slum area of Dhaka city. Cent percent income in the slum area has been generated from off-farm sectors as there is no scope of farm activities in the city area. The highest average annual household income (326582 Tk./year) has found in Sylhet district followed by Jamalpur (314833 Tk./year) and Kurigram (286821 Tk./year). The off-farm sector contributes the most to the household income irrespective of the sample areas (**Table 4**). Its proportion is 52 percent of the total income. The contribution of the farm sector in the total household income is the most in the Kurigram district (29 percent) followed by Jamalpur (25 percent) and Sylhet (23 percent). The non-farm contribution to the annual average household income is 25, 23, and 19 percent in Sylhet, Jamalpur, and Kurigram, respectively (**Figure 7**).

**Table 4:** Sources of household income (Tk./year) in the study locations.

Items	Jamalpur	Kurigram	Sylhet	Dhaka
Farm income	78,708	83,178	75,114	-
Non-farm income	72,412	54,496	81,646	-
Off-farm income	163,713	149,147	169,823	278,800
Total	314,833	286,821	326,582	278,800

**Source:** Analyzed and prepared by the authors based on the information from the field survey.





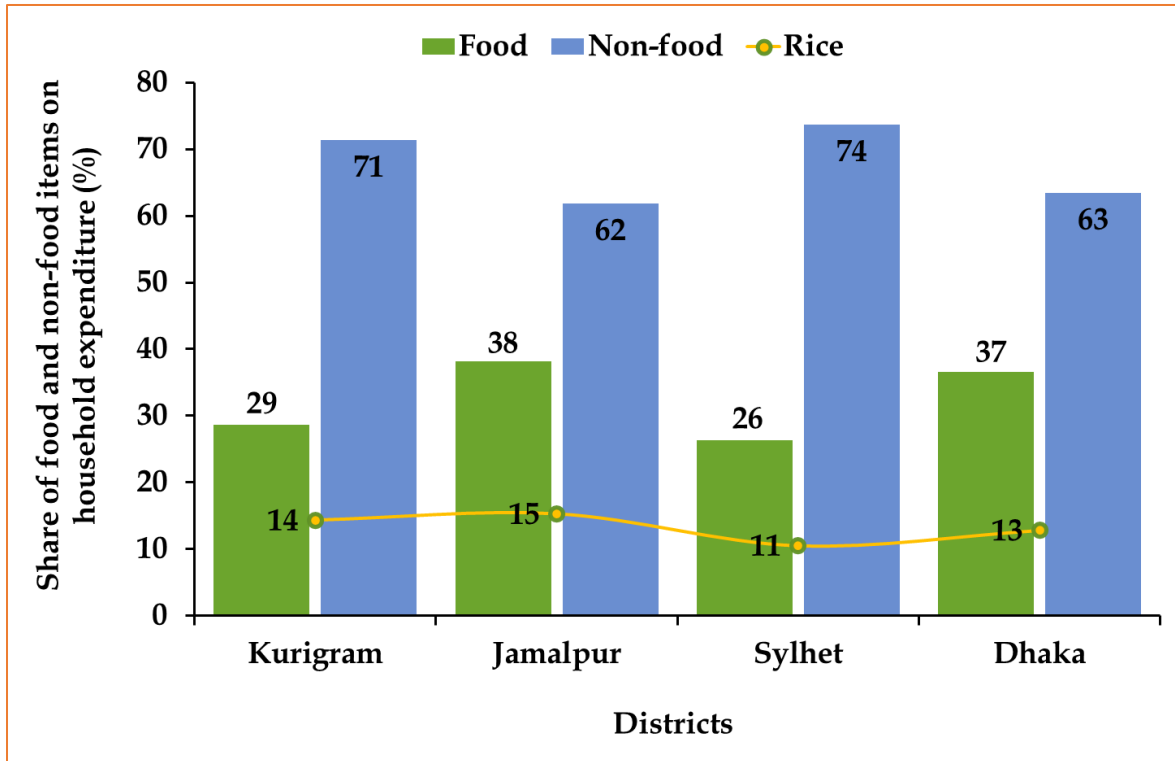
**Figure 7:** Share of different sectors to the household income in the study area. Prepared by the authors based on the information from the field survey.

The overall annual household expenditure is the highest in Sylhet (305565 Tk./year) among the study locations (see **Table 5**), followed by the slum area of Dhaka (249215 Tk./year), Kurigram (211149 Tk./year), and Jamalpur (185764 Tk./year). About one-third of the household expenditure is spent on food consumption. The share of rice on the expenditure ranges from 11-15 percent in the study area (**Figure 8**).

**Table 5:** Pattern of the household expenditure (Taka/year) in the study areas.

Items	Jamalpur	Kurigram	Sylhet	Dhaka
Food	70,978	60,570	80,565	91,224
Non-food	114,786	150,579	225,000	157991
Total	185,764	211,149	305,565	249,215

**Source:** Analyzed and prepared by the authors based on the information from the field survey.



**Figure 8:** Scenario of food, non-food, and rice expenditure in the study area. Prepared by the authors based on the information from the field survey.

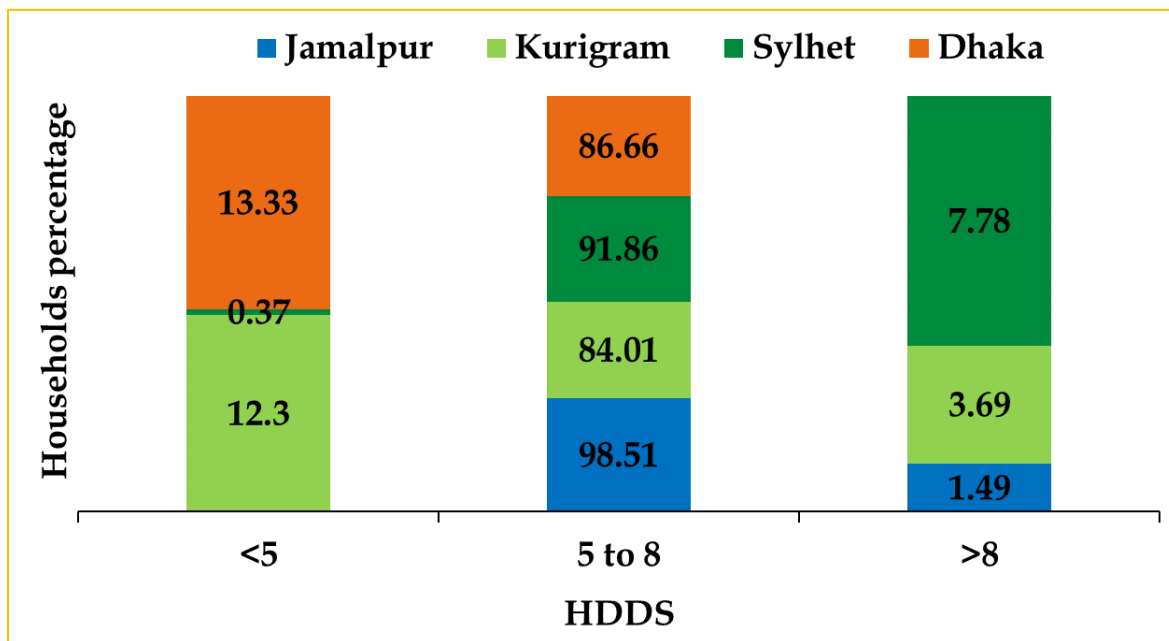
**Table 6** shows HDDS across selected study districts. HDDS (quality diet) was higher in the Sylhet district (6.92) and followed by Kurigram (6.27), Dhaka (5.93), and Jamalpur (5.70), districts, respectively. The study revealed that Kurigram district household-level data loosely clustered, so the standard deviation was greater than all other chosen sample districts. The maximum and Minimum range of HDDS were 9 and 2, respectively in the Kurigram district. In this district, consumption of food groups varied much daily data collection. Also, in the Sylhet district, household food consumption data concentration was not tight, so the standard deviation was slightly high. The maximum and minimum range of HDDS were 10 and 4, respectively in the Sylhet district. Dhaka and Jamalpur districts' HDDS were less than 6. In the slump area of the Dhaka district, household members consumed 5.93 food groups in a day. However, in the Jamalpur district, the household-level consumed lower food groups than other districts.

**Table 6:** Household Dietary Diversity Score (HDDS) (daily intake basis) in different districts of Bangladesh.

Items	Jamalpur	Kurigram	Sylhet	Dhaka
Mean HDDS	5.70 (0.947)	6.27 (1.502)	6.92 (1.138)	5.93 (1.222)
Maximum HDDS	10.00	9.00	10.00	8.00
Minimum HDDS	5.00	2.00	4.00	4.00

**Source:** Parentheses indicate standard deviation. Prepared by the authors based on the information from the field survey.

The distribution of the households according to the HDDS shows that Sylhet district is in a better position for dietary diversity. About 92 percent of households achieved HDDS between 5 to 8, and about 8 percent of households fall on the high HDDS (7.78). The high HDDS (>8) is achieved only by the 3.69 and 1.49 percent households in the Kurigram and Jamalpur districts, respectively. None of the households achieves high HDDS in the slum area of Dhaka city. It would be mention that more than 10 percent of sampled households in the slum area and Kurigram fall on the low HDDS. On average more than 85 percent of households, irrespective of the areas, fall on the medium HDDS (**Figure 9**). It indicates that more than 90 percent of household's dietary diversity is not satisfactory, and the consumed foods are not adequate to meet their nutritional demand.



**Figure 9:** Status of the Household Dietary Diversity of the sampled households in the study area. Prepared by the authors based on the information from the field survey.

About 70 percent of the sampled household in Sylhet district prefer medium-type grains, followed by Slum area Dhaka (59 percent), Jamalpur (55 percent), and Kurigram (50 percent). About 37 and 29 percent of households in the Kurigram and Jamalpur consume bold-type rice grains (**Table 7**). It does not mean that they prefer bold rice grains. This is because the price of the bold grain is lower than the medium type. The source of the bold grain in the slum area is mostly Open Market Sales (OMS)- a social security policy support of the government of Bangladesh. So, medium-type rice is preferred mainly by the consumers in the study area.

**Table 7:** Types of grain purchased by the consumers.

Grain types	Jamalpur		Kurigram		Sylhet		Dhaka	
	% of consumers	Average price (BDT/kg)	% of consumers	Average price (BDT/kg)	% of consumers	Average price (BDT/kg)	% of consumers	Average price (BDT/kg)
Bold	29	37	37	36	12	38	21	40
Medium	55	42	50	40	70	43	59	47
Slender	16	50	13	50	18	52	20	54

**Note:** Prepared by the authors based on the information from the field survey.

In the slum area of Dhaka city, consumers prefer whole rice grains. However, other districts' consumers are habituated to consume mixed (whole and broken) grain and prefer it too. Consumers prefer parboiled rice; the only exception is the Sylhet district, where 90 percent of consumers prefer un-parboiled rice. Cent percent of the consumers like white rice. They do not like to have brown or colored rice. Mainly two times a day consumed rice in the slum area, whereas rural consumers prefer rice three times a day. About one-third of the sampled consumers have to purchase rice from the market year-round.

In contrast, 42 percent of the consumers buying rice partially (for a few months). More than 25 percent of the consumers do not purchase rice from the market. They consumed their own produced rice. The own produced rice is stored in the house for more than three months, where the average purchased interval is a week (**Table 8**). It should be noted that only 32 percent of the required rice is supplied through the retail market. The farmers process other rice, and in some cases, the consumers purchase paddy from the farmers as well as market and milled for household consumption.

**Table 8:** Preferred attributes of consumed rice grain.

Grain quality attributes	Jamalpur	Kurigram	Sylhet	Dhaka
Broken	-	-	-	-
Whole	-	-	-	100
Mixed	100	100	100	-
Parboiled	100	100	10	100
Un-parboiled	-	-	90	-
White	100	100	100	100
Brown	-	-	-	-
No. of times rice consumed	2.78	2.80	2.65	2.15
<b>Source of rice supply:</b>				
Own	25	35	47	-
Purchase	75	65	53	100
Frequency of purchase (in a month)	3.25	3.6	2.5	20
<b>Site of purchase:</b>				
Urban market	35	28	37	100
Rural market	65	72	63	-
Qty. of purchase at a time (kg)	20	18	25	2.10
<b>Avg. storage time:</b>				
Own produce (months)	3.15	3.0	3.5	-
Purchase (days)	6.5	5.0	7.0	1.5

**Note:** Prepared by the authors based on the information from the field survey.

Almost all the consumers think about the price of rice while purchasing. Stickiness is a severe issue in Bangladesh. Therefore, amylose content in the grain is important to make it popular to the consumers. Consumers prefer white color grain, but they will consider it if other required attributes (price, taste, size-shape, softness, etc.) are satisfied. Generally, the quality of the cooked rice deteriorates if keep for a longer time. Consumer prefers a rice variety that retains its attributes for a long time after cooking (**Table 9**).

The consumers in the study areas are ignorant of the rice nutrient and Golden Rice. They only consume rice to satisfy hunger but nutrition. So, a nutrient is not considered while cooking the rice. On average, about 20 percent of the sampled households cook separately for the children and lactating women. The rice is kept for about 5 hours after cooking in the sampled household (**Table 10**).

**Table 9:** Factors considered while purchasing rice.

Criteria	Jamalpur	Kurigram	Sylhet	Dhaka
Price	100%	100%	100%	100%
Taste	90%	93%	85%	60%
Size-shape	88%	83%	89%	81%
Color (Whiteness)	58%	60%	50%	66%
Stickiness	91%	90%	88%	94%
Keeping after cooking	82%	85%	83%	60%
Softness	75%	78%	70%	68%

**Note:** Prepared by the authors based on the information from the field survey.

**Table 10:** Consumers' knowledge about food nutrition and quality.

Particulars	Jamalpur	Kurigram	Sylhet	Dhaka
Knowledge about nutrient rice (%)	0	0	0	1
Knowledge about GR (%)	0	0	0	0
Changed nutrient if cooked more time (%)	0	0	0	0
Separately cook for child and lactating women (%)	20	25	23	15
Considering nutrient while cooking (%)	0	0	0	0
Keeping time after cooking (hour)	5	5.5	4.5	5

**Note:** Prepared by the authors based on the information from the field survey.

In the study areas, the varietal choice of the sampled consumers varies with their household income. The low-income households consume mainly bold and medium bold type rice and the preference change with the changing income. The higher-income families consume especially medium slender and slender type rice grains. The income quartile-wise varietal choice of the sampled household has been presented in **Table 11**.

**Table 11:** Varietal choice of the sampled household in the study area.

Income quartiles	Variety name	Gran type	% of the household consumed
Quartile 1 (Average annual income 102000 Tk.)	Guti Swarna	Bold	19
	Hybrid	Bold, Medium Bold	10
	BR11	Medium Bold	23
	BRR1 dhan29	Medium Slender	18
	Mamun Swarna	Bold	4
	Ronjit Swarna	Medium Bold	5
	BRR1 dhan52	Medium Bold	12
Others	-	9	
Quartile 2 (Average annual income 162000 Tk.)	BRR1 dhan29	Medium Slender	28
	BRR1 dhan28	Medium Slender	17
	BR11	Medium Bold	12
	Ronjit Swarna	Medium Bold	13
	BRR1 dhan52	Medium Bold	12
	BRR1 dhan49	Medium Bold	10
	Others	-	8
Quartile 3 (Average annual income 264000 Tk.)	Pazam	Medium Slender	14
	BRR1 dhan28	Medium Slender	39
	BRR1 dhan29	Medium Slender	16
	Suman Swarna	Medium Slender	7
	Minikit	Slender	6
	BRR1 dhan49	Medium Bold	11
	Others	-	7
Quartile 4 (Average annual income 480000 Tk.)	BRR1 dhan28	Medium Slender	26
	BRR1 dhan29	Medium Slender	13
	Zira	Long Slender	8
	Minikit	Long Slender	19
	Katari	Short Slender	9
	Nazir	Slender	17
	Others	-	8

**Note:** Prepared by the authors based on the information from the field survey.

### 3.2 Status of Rice Farms and Varietal Choice in the Study Area

On average the farmers in the study areas are aged more than 40 years. The farmers in Kurigram are older (43 years) than of Jamalpur (40 years) and Sylhet (39 years). The sampled farmers were literate at the primary level. Most of the farmers hold a small size of the farm with an average of 97 decimals (**Table 12**). According to the farmers, farming is a relatively hard job, and young people do not prefer it, hence the number of farmers is reducing. The own farm size is decreasing with the increase in population, but per farmer cultivated land is increasing as people prefer non-farm activities.



**Table 12:** Socio-demography of the rice farmers in the study areas.

Districts	Farmers average age (years)	Education (Years of schooling)	Average farm size (decimal)
Kurigram	43 (12)	6 (4)	89
Jamalpur	40 (14)	4 (3)	92
Sylhet	39 (17)	5 (3)	109
Overall	41	5	97

**Note:** Values in the parentheses represent standard deviation. Prepared by the authors based on the information from the field survey.

About 42 percent of the farmers use their own produced seed in Boro season, and 47 percent use purchased. In the Aman season, the proportion of using own produced seed is about 57 percent (**Table 13**). The reasons behind using purchased seed are- avoiding the hassle of seed production and preservation, trust in the company, attractive packaging, and adoption of hybrids. The other sources of seeds are- government incentives, demonstrations, research organizations, and kinds from companies for popularization.

**Table 13:** Sources of rice seed in the study areas.

Districts	Boro season			Aman season		
	Own	Purchase	Others	Own	Market	Others
Kurigram	45	42	13	56	36	8
Jamalpur	41	49	10	53	41	6
Sylhet	39	49	12	61	31	8
Overall	42	47	12	57	36	7

**Note:** Prepared by the authors based on the information from the field survey.

Farmers usually prefer rice varieties that cultivation would be profitable. According to the sampled farmers, the most desired varietal trait is the yield (84 percent), followed by market price (66 percent). The other traits are interlinked with these two traits. Less pest infestation, shattering and lodging resistance reflect the yield performance. These along with growth duration reflect the costs of production. The taste and slenderness of the rice grain influence the market demand that reflects the market price (see **Table 14**).

**Table 14:** Most preferred traits of paddy by the farmers (multiple responses, %).

Preferred traits	Kurigram	Jamalpur	Sylhet	Overall
Higher yield	73	95	84	84
Good market price	63	67	68	66
Less pest infestation	38	33	41	37
Good taste to eat	41	38	39	39
Shorter growth duration	21	16	14	17
Slenderness	30	32	45	36
Shattering resistance	18	9	12	13
Lodging tolerance	19	13	10	14

**Note:** Prepared by the authors based on the information from the field survey.

**Table 15:** The exclusive rice based major cropping patterns and net cultivated area (NCA) in the sampled locations.

District	Net Cultivated Area (hectare)	Cropping Intensity (%)	Cropping Pattern	% of Net Cultivated Area
Kurigram	16596	214	Boro-Fallow-T. Aman	53.33
			Boro-Fallow-Fallow	4.07
Jamalpur	22973	222	Boro-Fallow-T. Aman	49.61
			Boro-Fallow-Fallow	23.00
			Boro-Aus-T. Aman	2.29
Sylhet	17736	150	Boro-Fallow-Fallow	39.64
			Boro-Fallow-T. Aman	15.74
			Fallow-Fallow-T. Aman	15.29
			Fallow-Aus-T. Aman	12.62
			Boro-B. Aman	3.10

**Note:** Prepared by the authors based on the information from the field survey.

Like other parts of the country, the sampled districts' cropping pattern is dominated by rice. The rice based cropping pattern covers more than 60 percent of the net cultivated area. The proportion is the most in Jamalpur (more than 70 percent). The dominant cropping pattern in Kurigram and Jamalpur is Boro-Fallow-T. Aman, whereas it is Boro-Fallow-Fallow in Sylhet (**Table 15**). The cropping intensity in Jamalpur is the highest (222 percent) followed by Kurigram (214 percent) and Sylhet (150 percent).

The farmers in Kurigram and Jamalpur prefer BRR1 dhan28, followed by BRR1 dhan29 and Hybrids in Boro season. In Sylhet, the most preferred variety is BRR1 dhan29 followed by BRR1 dhan28 and Hybrids. BRR1 dhan28 and BRR1 dhan29 have similar grain quality, but the growth duration of BRR1 dhan28 is relatively shorter. On the other hand, the yield of BRR1 dhan29 is

relatively higher. In T. Aman season, Swarna dominated in Kurigram followed by BRRI dhan52 and BR11. In Jamalpur, BR11 is the most popular variety followed by BRRI dhan49 and BRRI dhan52. Farmers in the Sylhet prefer BRRI dhan52 followed by BR22 and BR11 (**Table 16**).

**Table 16:** Most preferred varieties by the farmers in the study sites.

Districts	Boro season			Aman season		
	Rank 1	Rank 2	Rank 3	Rank 1	Rank 2	Rank 3
Kurigram	BRRI dhan28	BRRI dhan29	Hybrid	Swarna	BRRI dhan52	BR11
Jamalpur	BRRI dhan28	BRRI dhan29	Hybrid	BR11	BRRI dhan49	BRRI dhan52
Sylhet	BRRI dhan29	BRRI dhan28	Hybrid	BRRI dhan49	BR22	BR11

**Note:** Prepared by the authors based on the information from the field survey.

According to the farmers in the study area, the preference for BRRI dhan28 and BRRI dhan29 in the Boro season are higher yields and good quality (**Table 17**). BRRI dhan28 is also a shorter duration variety. The market price of these varieties is much higher than the other varieties because of their grain quality. On the other hand, the farmers mentioned that these two mega varieties are becoming susceptible to the blast disease. Therefore, releasing a similar variety with disease resistance would get similar popularity in Bangladesh.

**Table 17:** Reasons for farmers' preference of Boro season popular varieties in the study areas.

Reason for preference	First response (%)	Multiple responses (%)
<b><i>BRRI dhan29</i></b>		
High yield	94	99
Eating quality	5	58
Lodging resistance	0.8	60
Pest resistance	0.2	22
<b><i>BRRI dhan28</i></b>		
High yield	71	81
Eating quality	12	83
Shorter growth duration	11	88
Pest resistance	2	20
Lodging resistance	4	23

**Note:** Prepared by the authors based on the information from the field survey.

On average, about 26 percent of the rice area is covered by BRRI dhan29 in Boro season in the study area. The highest adoption of this variety was found in Sylhet, followed by Jamalpur and

Kurigram. Whereas, the productivity of this variety is the most in Kurigram, followed by Sylhet and Jamalpur. Overall, BRRI dhan29 yielded 6.30 tons/ha in the study areas (**Table 18**). Although BRRI dhan29 has a longer growth duration, the farmers take the risk of cultivating because of its yield advantage and higher market price.

**Table 18:** Area coverage and yield of BRRI dhan29 in the study areas.

District	% of total cultivated area	Yield (ton/ha)
Kurigram	21.21	6.46
Jamalpur	24.54	6.11
Sylhet	32.34	6.34
Overall	26.03	6.30

**Note:** Prepared by the authors based on the information from the field survey.

Because of the longer growth duration, the variable cost of cultivating BRRI dhan29 is slightly higher than the other modern varieties in the Boro season. The market price of the variety is higher because of its grain quality. Higher yield and market price brings a better gross return for the farmers (**Table 19**). The farmers of the study areas opined that cultivating BRRI dhan29 is much profitable than any other familiar variety. The estimation also shows that farmers are financially advantageous by cultivating BRRI dhan29 (BCR 1.71) than the other modern varieties (BCR 1.50).

**Table 19:** Profitability of BRRI dhan29 and other modern Boro varieties in the study areas.

Items	BRRI dhan29	Other MVs
Yield (kg/ha)	6300	5530
Paddy price (Tk./kg)	25	24
Return from paddy (Tk./ha)	157500	132720
Return from Straw (Tk./ha)	5,260	5,260
Gross return (Tk./ha)	162,760	137,980
Variable cost (Tk./ha)	95,319	91,768
Total cost (Tk./ha)	131142.00	126091
Gross margin (Tk./ha)	67,441	46,212
Net return (Tk./ha)	31,618	11,889
Unit cost of production (Tk./kg)	20.82	22.80
BCR on cash cost basis (undiscounted)	1.71	1.50
BCR on full cost basis (undiscounted)	1.24	1.09

**Note:** Prepared by the authors based on the information from the field survey.

### 3.3 The Informal Rice Seed Production Status in the Study Area

The authorized seed grower in Bangladesh is the Bangladesh Agricultural Development Corporation (BADC). The government also licenses the private seed companies. Other than BADC and companies, some seed growers produce rice seeds for commercial purposes. In the majority of cases, BADC contacts these seed growers for enhancing its seed stock. In the study areas, we found very limited rice seed growers. Relatively young-aged seed growers have been found in Jamalpur. However, the average age of the seed growers is 44 years old. Almost all the seed growers are literate, and the average literacy is above the primary level (8 years). We found the seed growers are experienced in their profession (17 years on average). One-third of the seed growers have training on modern seed production; the rest are producing based on experience and consultation with extension workers (**Table 20**).

The seed growers usually prefer the mega varieties for seed multiplication to avoid the risk of losing market value. The most popular varieties to the seed growers are BRRI dhan28 and BRRI dhan29 for Boro season and BRRI dhan49 for Aman season. The only exception is in Kurigram where the demand for Guti Swarna is much higher than BRRI dhan49 in the Aman season (**Table 21**). So, the seed growers follow the role of market demand to choose a specific variety for seed multiplication.

**Table 20:** Basic information of the sampled seed growers.

District	Age (year)	Year of schooling	Experience (years)	Seed production training (% of the respondents)
Kurigram	51	10	19	25
Jamalpur	30	8	18	33
Sylhet	50	5	13	40
Overall	44	8	17	33

**Note:** Prepared by the authors based on the information from the field survey.

The private seed growers in the study areas mainly contact growers of BADC. More than 60 percent seed is supplied to the BADC. The proportion is more in Jamalpur, where 78 percent of the privately produced seed goes to BADC. The remaining seeds are supplied directly to the farmers. In Kurigram, a portion (4 percent) of the privately produced seed goes to the local seed traders (**Table 22**). In the other districts, seed traders only prefer seeds from BADC and companies.

**Table 21:** Private seed growing scenario of the popular rice varieties in the study area.

District	Aman season	Average land allocation (decimal)	Boro season	Average Land allocation (decimal)
Kurigram	Guti Swarna	31	BRRRI dhan28	32
	BRRRI dhan49	19	BRRRI dhan29	28
	BRRRI dhan52	12	BRRRI dhan58	12
Jamalpur	BRRRI dhan49	38	BRRRI dhan28	52
	BR11	20	BRRRI dhan29	43
	Binadhan-7	15	BRRRI dhan62	8
Sylhet	BRRRI dhan49	43	BRRRI dhan28	31
	BRRRI dhan52	14	BRRRI dhan29	47
	BRRRI dhan51	10	BRRRI dhan58	11

**Note:** Prepared by the authors based on the information from the field survey.

**Table 22:** Distribution scenario of the commercially produced rice seeds by the private seed growers.

District	BADC (%)	Farmer (%)	Local Trader (%)
Kurigram	64	30	4
Jamalpur	78	12	-
Sylhet	69	31	-

**Note:** Prepared by the authors based on the information from the field survey.

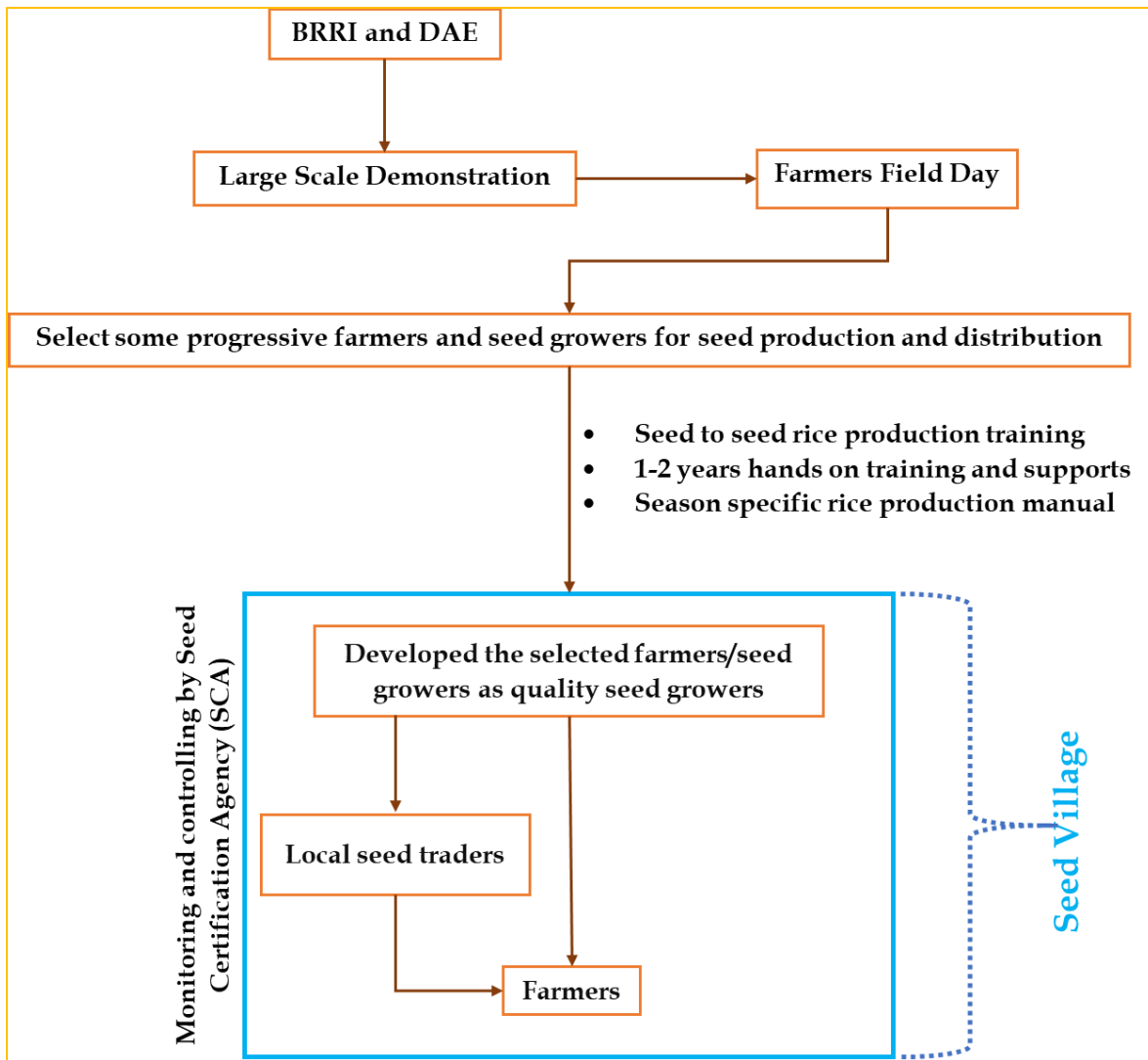
The private seed sector is not well developed in Bangladesh due to some constraints explained by the seed growers in the study areas. The seed growers do not have hands-on training for quality seed production. In many cases, they do not get a better price of the seeds, although the cost of production is increasing. They do not have a colorful packaging facility. The company has a good pack of seeds, and farmers trusted that. Rain in the harvesting of Boro paddy is the main problem of maintaining the quality of seed. A modern drying facility would improve the quality of locally produced seeds. The seed growers are always at risk of losing capital for the uncertainty of selling in time and instability of market price (**Table 23**).

**Table 23:** Problem faced by the private rice seed growers in the study area.

Constraint	Rank
Do not have adequate training on seed production	1
Lower market price	2
Farmers prefer company seeds	3
High costs of production	4
Do not have storage facilities	5
Rain in the harvesting period	7
Lack of drying facility	8
Price fluctuation	9
Do not have a good packaging facility	10

**Note:** Prepared by the authors based on the information from the field survey.

This study proposes a new seed dissemination model for rapidly distributing the newly released rice cultivars to the farm level. The model is based on the concept of ‘Seed Village’ at the farm level. BRRI and the Department of Agricultural Extension (DAE) will work collaboratively to form the seed village with their resources (**Figure 10**). The DAE will go for large-scale dissemination of the newly released varieties in the concerned regions. After the large-scale demonstration, farmers’ field day will be conducted at the farm level to select the progressive farmers and seed growers who are willing to produce seed for this new variety. The selected progressive farmers and seed growers will be provided seed to seed rice production training, support, rice production manual, and hands-on quality seed production and rice production support to become efficient seed producers and rice growers. The trained farmers and seed growers will supply quality seed to the local seed traders and farmers. Seed Certification Agency (SCA), DAE, and BRRI will monitor the entire system to ensure seed quality, timely dissemination, and adequate price to run the ‘Seed Village’ smoothly.



**Figure 10:** Proposed plan for the development of ‘Seed Village’ for ensuring availability of the quality seed of Golden Rice at the farmers’ level. Prepared by the authors based on the concept from Kabir *et al.*, 2019.

### 3.4 Status of Rice Markets in the Study Areas

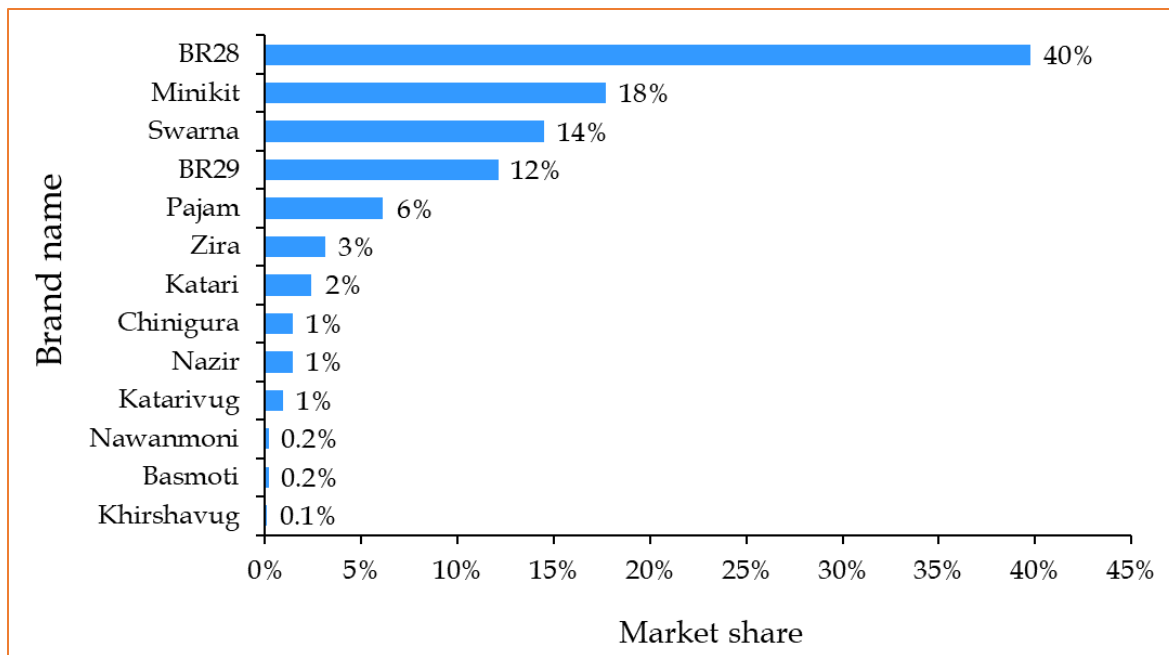
#### 3.4.1 Availability and price of the rice brand in the sample markets.

The status of the rice markets in the union and Upazila level is much different from the district and city markets. Therefore, presented the analysis of the markets in segregation. It would be worthy to mention that the brand name does not represent the corresponding paddy source. The paddy traders usually mix the similar types (size and shape) of purchased grain in the local markets and send it to the millers. The millers also milled out similar grains together. They polish the grains as

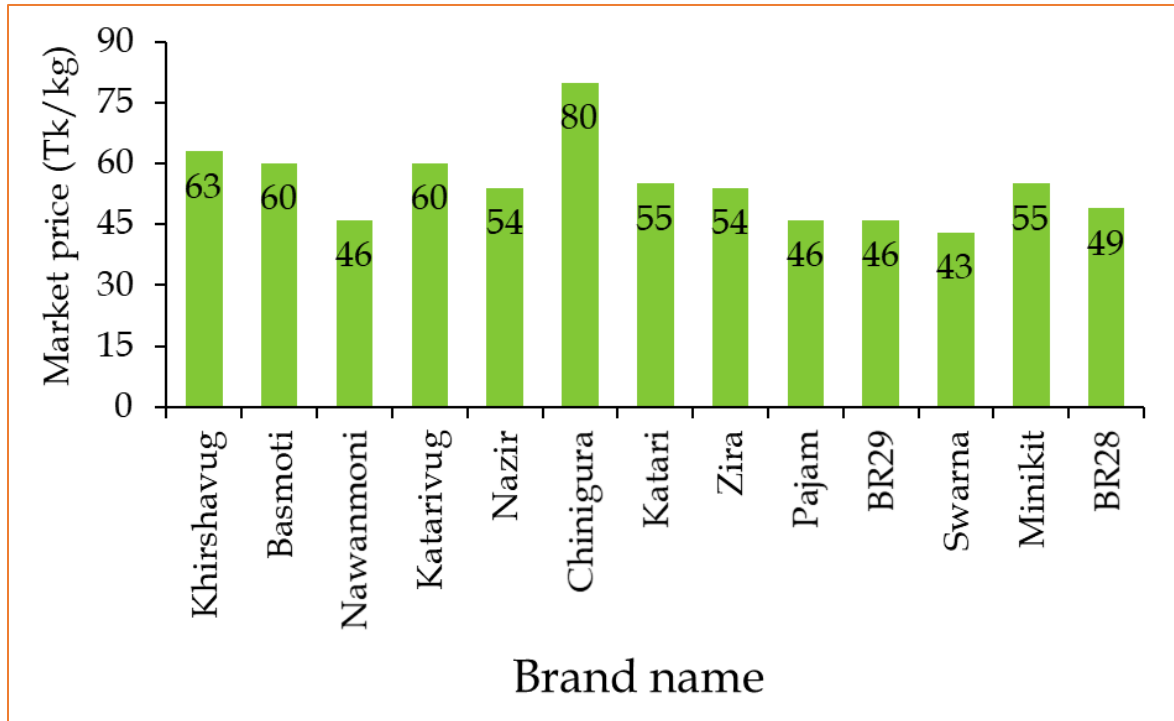


of required size and shape and put them into the given brand name sacks. For example, BR28 is a popular brand name in the market. But it is not necessarily milled out of BRRI dhan28. Similarly, ‘Minikit’ is a popular brand, and it captures a lion's share of the rice market in Bangladesh. In reality, there is no specific ‘Minikit’ paddy variety in the field.

In the union and Upazila level markets, the most popular rice brands in the study areas are BR28, Minikit, Swarna, and BR29. About 40 percent of the available brands in the union and Upazila markets are captured by BR28 (**Figure 11**). A preliminary finding of Agricultural Economics Division, BRRI, under the title, ‘*Tracking rice varietal authentication in Bangladesh: A path from farm to market (TRVA)*’ showed that a major source of producing BR28 is BRRI dhan29. The study also showed that the major source of Minikit is BRRI dhan28. BR29 sources from BRRI dhan29 and some medium slender type hybrids. The price of the popular rice brands in the union and Upazila markets is presented in **Figure 12**.

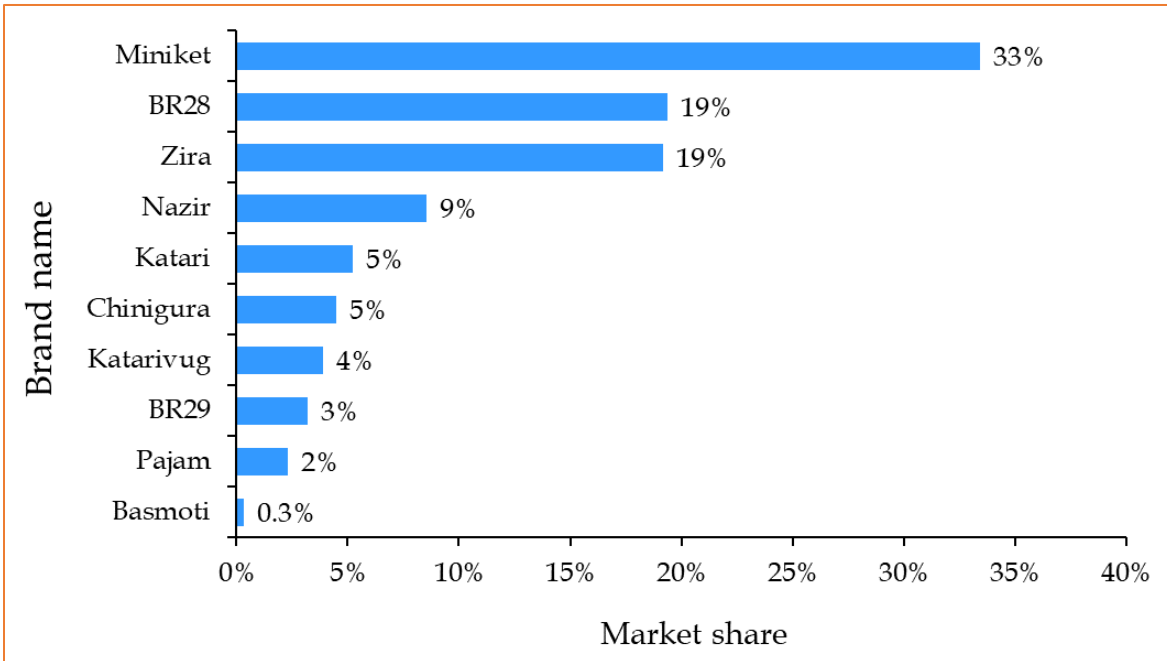


**Figure 11:** Market share of the major rice brands in the Upazila and union level markets. Prepared by the authors based on the information from the market survey and preliminary findings of the TRVA study.

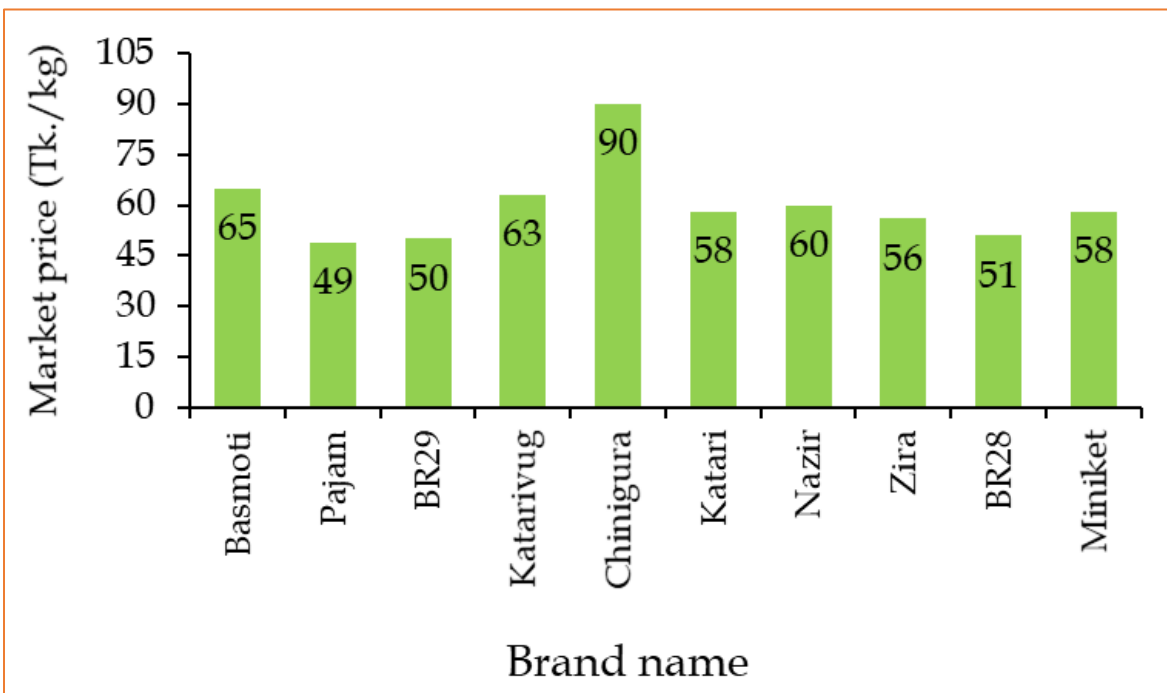


**Figure 12:** Price of the major rice brands in the Upazila and union level markets. Prepared by the authors based on the information from the market survey and preliminary findings of the TRVA study.

The popular rice brands in the district and city markets are Miniket, BR28, Zira, and Nazir (see **Figure 13**). Miniket has a lion share of the markets (33 percent), followed by BR28 (19 percent), Zira (19 percent), and Nazir (9 percent). The preliminary findings of the TRVA study also showed that Zira is a popular Indian rice variety largely being cultivated in the Rajshahi region of the country. The market price of the corresponding popular brands in the districts and city markets is presented in **Figure 14**. The price of a certain rice brand is higher in districts and city markets than the union and Upazila markets.

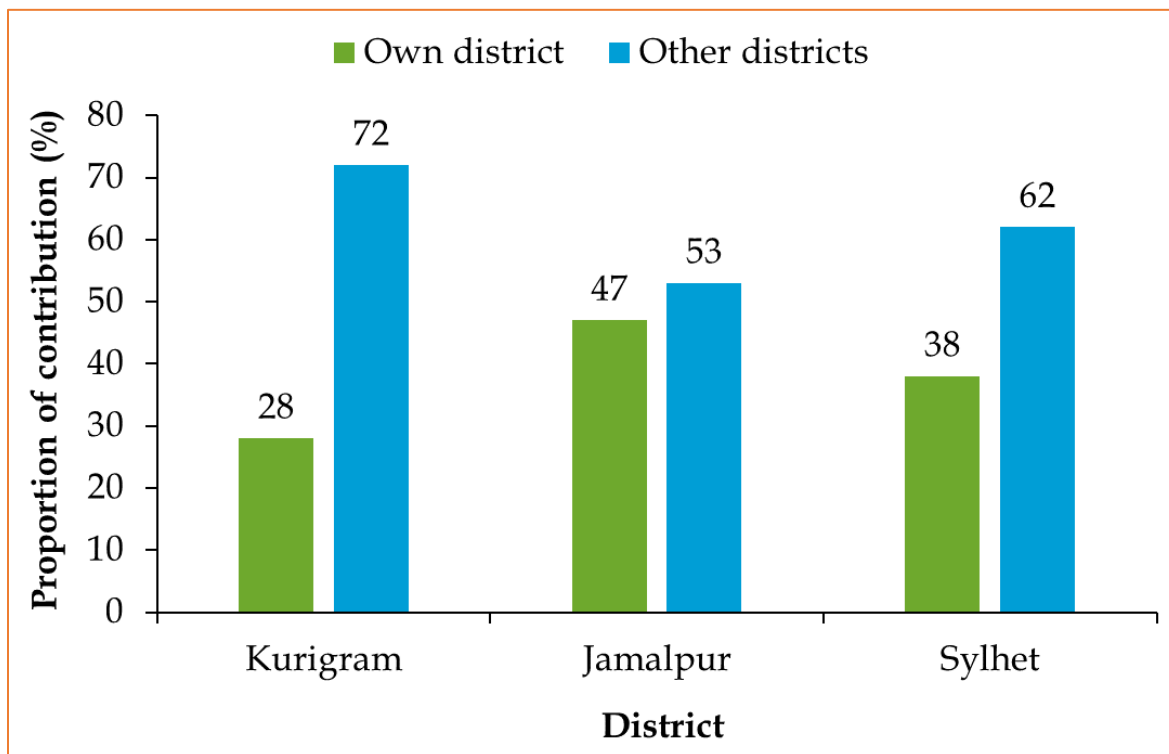


**Figure 13:** Market share of the major rice brands in the city and district level markets. Prepared by the authors based on the information from the market survey and preliminary findings of the TRVA study.



**Figure 14:** Price of the major rice brands in the city and district level markets. Prepared by the authors based on the information from the market survey and preliminary findings of the TRVA study.

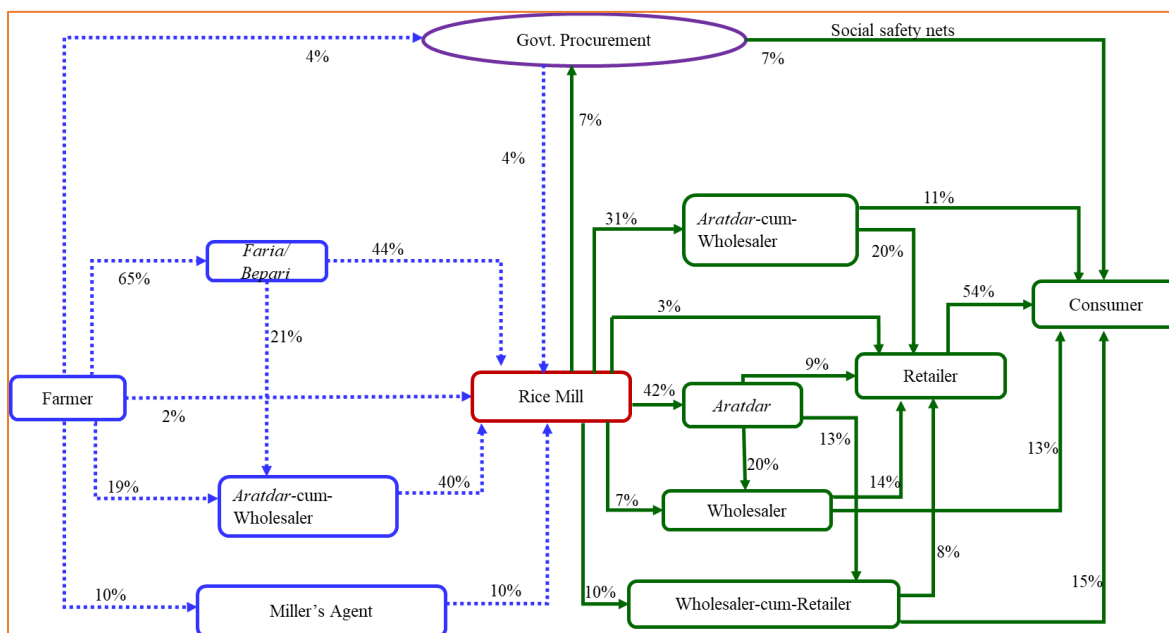
The findings of the market survey showed that the contribution of other districts' mills is much higher than that of their own districts' mills in supplying rice in the sampled markets. There is no recognized auto rice mill in the Kurigram district. About 72 percent of the rice in the markets is coming from other districts, where major contributors are Dinajpur and Rajshahi. Among the sampled markets, the market share of own districts mills is maximum in Jamalpur. About 47 percent of the available marketed rice is supplied by own district mills. The rest of the rice is coming from the adjacent Sherpur district and the Rajshahi region. The rice traders in the Sylhet district opined that about 62 percent of the marketed cleaned rice is coming from other districts (Figure 15).



**Figure 15:** Scenario of milled rice in the sampled markets. Prepared by the authors based on the information from the market survey and preliminary findings of the TRVA study.

The rice supply chain in Bangladesh consists of two segments. Segment 1 supplies paddy from farm to mill, and segment 2 supplies rice from mill to consumer (Rahman MC, 2018). In the study areas, the dominant actors are *Faria* and/or *Bepari*. They directly purchase paddy from the farm gate and supply it to the millers and paddy *Aratdars*. The *Faria* and/or *Bepari* are supplying about 65 percent of paddy in the market. The *Aratdar*-cum-wholesalers are collecting paddy from the

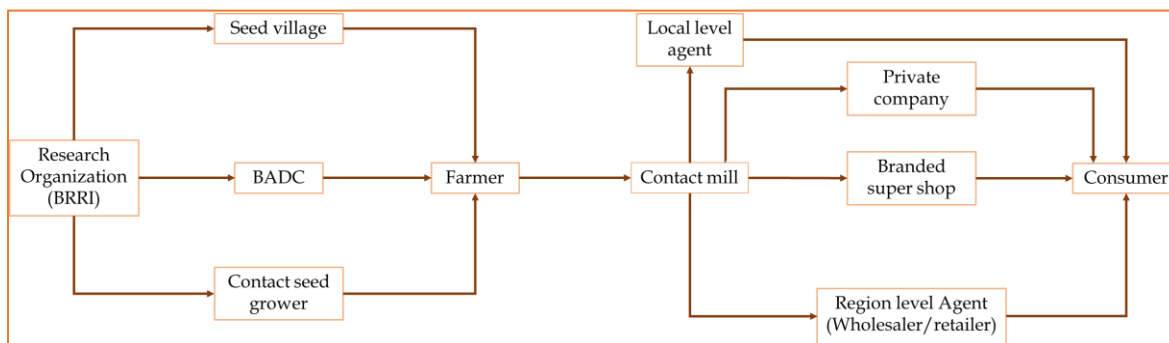
farmers and *Faria* and/or *Bepari*. *Aratdar-cum-wholesalers* are supply about 40 percent of the paddy to the millers. The *Aratdar-cum-wholesalers* have established a business place in the market, whereas *Faria* and/or *Bepari* are acting as a broker. In the second segment of the supply chain, rice *Aratdar* and *Aratdar-cum-wholesalers* are the most dominating actors in supplying rice from mills to the consumers. The *Aratdars/ Aratdar-cum-wholesalers* have a direct link with millers and control the pricing mechanism of the market. These actors are supplying more than 70 percent clean rice from mills to the market. More importantly, the government procures about 4 percent paddy directly from the farmers and supplies about 7 percent of the clean rice by social safety net programs (**Figure 16**). The millers are the most influential actors in the rice supply chain in Bangladesh. They are acting as speculative investors and regulating the rice market by controlling both the aforementioned segments. The millers and traders (*Aratdar* and wholesalers) exercise market power in the Bangladesh rice sector to capture a greater margin. According to Rahman et al. (2020), the rice millers and traders are yielding 33 percent and 29 percent market power, respectively, in the Bangladesh rice sector.



**Figure 16:** Paddy and rice supply chain network in the study areas of Bangladesh. Note: The dashed line represents paddy, and the solid line represents the rice supply chain. Prepared by the authors based on the information from market survey and concept from Rahman *et al.*, 2020.

As Golden Rice has a unique character (yellow colored grain) and mixing with similar rice varieties is not possible, the development of a segregated supply chain is essential. For this, a pilot

deployment plan can contact the supply chain actors from seed production to consumption. To fulfill the goal of developing Golden Rice, the targeted consumers are the poor households having inadequate mills and lower dietary diversity score. Targeting these households, the seed village can be established, and contact seed growers can be communicated. After getting a little popularity at the farmers' level, the BADC would produce the seed publicly. The selected rice growers from the large-scale demonstration can be involved in the contact rice growing scheme. There should have contact authorised sellers at the local and regional levels where consumers will get easy access to the Golden rice. After getting popularities at the consumer level, private companies and super shops will be encouraged to arrange Golden Rice on their product shelves. More importantly, the Golden Rice should be marketed with unique and attractive colored packaging. A segregated supply chain for the initial deployment of Golden Rice has been drafted in **Figure 17**.



**Figure 17:** Proposed supply chain of Golden Rice for initial deployment. Prepared by the authors.

#### 4. Respondents' Suggestions to Increase Awareness about GR in the Study Area

According to the respondents of the study area, the dissemination of upcoming Golden Rice requires awareness building among the rice consumers, producers, and post-production value chain actors. Almost all the respondents suggested that television is the best way to create awareness and popularizing Golden Rice. Rather than only advertising, short drama is much effective. Training on nutrition and Golden Rice, and a short visit to the schools and feeding to the children were also suggested by the respondents. The health workers' recommendation for Golden Rice would be significantly effective in popularization. There should employ multiple approaches for the popularization of Golden Rice among the stakeholders involved from farm to fork. However, the approaches would not be limited to the options mentioned in **Table 24**.

**Table 24:** Ways of increasing awareness about rice nutrients.

Ways	Jamalpur	Kurigram	Sylhet	Dhaka
TV	100	100	100	100
Radio	20	15	10	5
Training	80	88	78	68
Religious institute	40	43	33	41
Schools	76	68	63	81
Newspapers	43	38	46	64
Health center	83	85	78	91
Live drama	65	68	61	53
Leaflet/ booklet	51	49	56	43

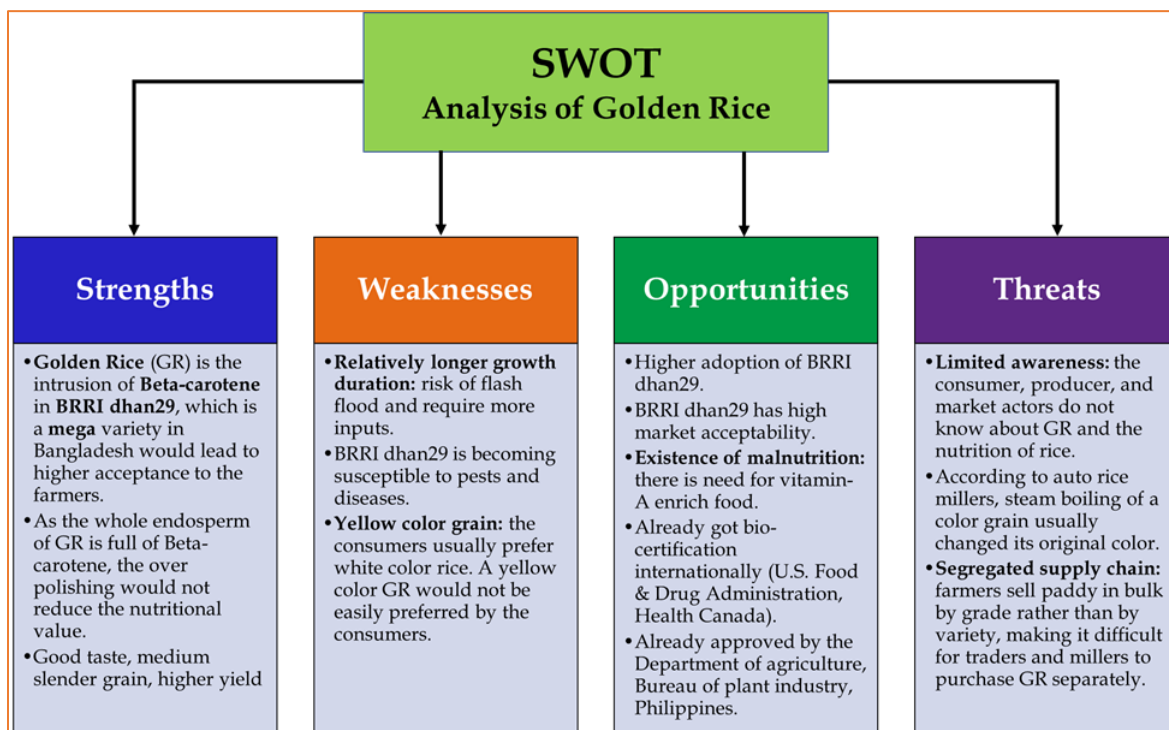
**Note:** Prepared by the authors based on the information from the field survey.

## 5. Suggestions to Disseminate Golden Rice

### 5.1 SWOT Analysis of Golden Rice

This study will propose a roadmap for drawing the deployment plan of the upcoming Golden Rice in Bangladesh. Before that, we are going to do a SWOT analysis of Golden Rice based on the aforementioned findings and reviewing the literature. The SWOT analysis would help us focus on the key points that should consider while drawing a deployment plan. The main *strength* of Golden Rice is the mother variety- BRRI dhan29. It is a mega rice variety in Bangladesh holding good taste, medium slender grain, and higher yield. The variety is much popular to the farmers, post-production value chain actors, and consumers. The entire endosperm of the Golden Rice is full of beta-carotene, therefore, polishing by the millers would not reduce its nutritional value. The main *weakness* of Golden Rice is its grain color, although it would be a strength to prevent from mixing with other rice gains. Consumers in Bangladesh usually prefer white-colored rice. Without a proper campaign, yellow-colored rice would not be preferred by the consumers. BRRI dhan29 is becoming susceptible to disease and pests nowadays, we hope the upcoming Golden Rice would overcome this weakness. Moreover, BRRI dhan29 has a little longer growth duration that requires additional inputs, and sometimes early flash floods affect the rice field. Golden Rice has ample *opportunities* in Bangladesh. Still, Bangladesh is suffering from malnutrition and VAD. Therefore, Golden Rice is necessary to overcome VAD. BRRI dhan29 has greater market acceptability, and the variety is being cultivated covering the highest rice-growing areas in Bangladesh. It also created opportunities by getting bio-certification internationally. Besides the

opportunities, Golden Rice has some bottlenecks or *threats*. One of the major threats is the lack of awareness about the nutritional value of rice and its importance among the farmers, post-production value chain actors, and consumers. The auto rice millers opined that steam boiling of a colored rice grain would change its original color. Therefore, yellow-colored Golden Rice may lose its original color if milled in the auto rice mills. The unique supply chain of any specific rice variety in Bangladesh is rare, only exception is BRRI dhan50 (*Banglamoti*) processing hubs in the Jashore region of the country. Establishing a segregated supply chain for Golden Rice is essential in Bangladesh. A unique supply chain and proper campaigning would convert the *weakness* of yellow color grain GR to a *strength* of preventing from mixing up with other rice grains. A summary of the SWOT analysis of Golden Rice is presented in **Figure 18**.



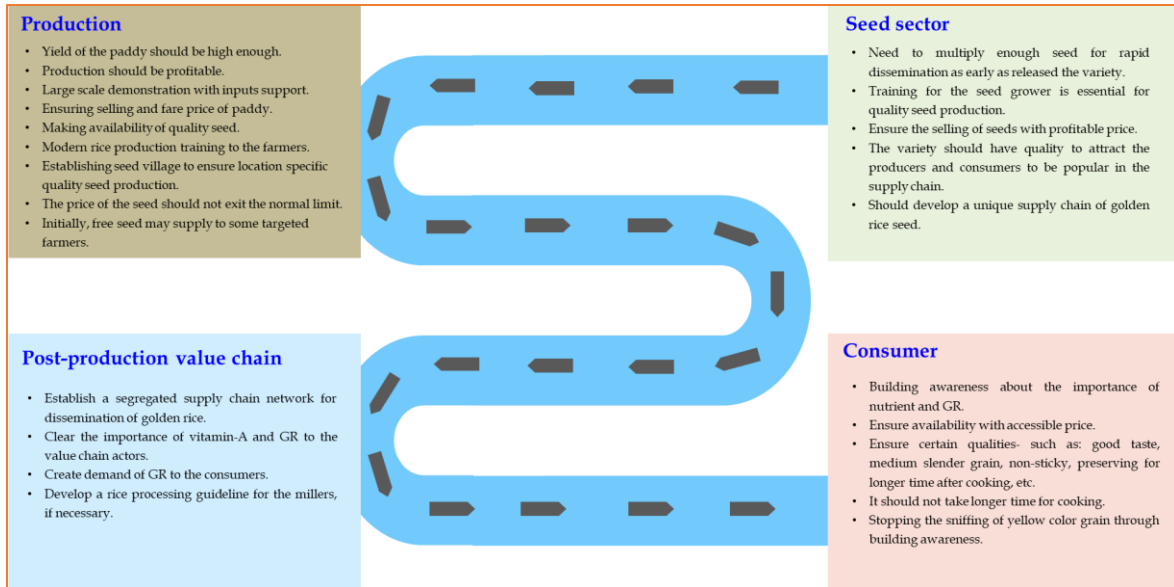
**Figure 18:** SWOT analysis of Golden Rice in Bangladesh. Prepared by the authors based on the findings from the field survey and reviewing the literature.

## 5.2 Proposed Roadmap for Mapping the Deployment Plan

This study is going to focus on some stakeholder-wise (seed grower, farmer, post-production value chain, and consumer) key points that should bring under consideration while drawing the deployment plan of GR in Bangladesh. The deployment plan should target a massive



demonstration of GR as soon as the variety release. It will require an adequate supply of quality seed. The seed growers usually follow the popularity of the variety to avoid the risk of selling. Therefore, the development of seed multiplication hubs- seed village is essential to train up the farmers and seed growers in producing and maintaining seed quality at the farm level. To attractive the farmers, the sampled seed growers suggested developing a segregated supply chain for the seed of GR. The yield of a variety significantly influences its adoption. Training in the seed village would also reduce the yield gap of GR that will help to popularize at the farmers' level and encourage wider adoption. The market price and costs of production are the key issues in making rice production profitable. Therefore, initial inputs support is essential in the demonstration of GR. The deployment plan should ensure a fair price of GR and its seed in the market. Intensive demonstration with inputs support and demonstration only with seed support can be implemented in a wider range. The traders are impartial about specific variety. They are mostly profit motives. Without a segregated supply chain, it is not possible to deliver GR from farm to fork. Therefore, the deployment plan should engage the post-production value chain actors in a camphane for motivation and behavioral change. That would not change their attitude but initiate a positive motive towards GR. Golden Rice targeted mainly the poor consumers. Therefore, the retail level pricing should not exit the consumers' accessibility. The deployment plan should work for preparing specific guidelines for the farmers, traders, millers, and consumers for effective and efficient production, processing, distribution, and consumption of Golden Rice in Bangladesh. Building awareness across the supply chain from farm to fork has no alternative. Building awareness about the importance of vitamin-A would motivate the consumers that would stop the sniffing of yellow color grain, create demand for GR and popularize it in the rice supply chain of Bangladesh. However, holding yellow color is a positive site of GR to avoid mixing up with other rice grains. A holistic approach is essential in drawing the deployment plan of GR in Bangladesh. The proposed roadmap for drawing the deployment plan of GR has been summarized in **Figure 19**. Although this study has been conducted in the targeted areas to draw a pilot deployment plan, the findings would guide to deploy the Golden Rice widely.



**Figure 19:** Roadmap for designing the deployment plan of Golden Rice (GR) in Bangladesh. Prepared by the authors.

## 6. Conclusion

The study found out the attitudes of the rice value chain actors and consumers towards upcoming golden rice to draw the possible deployment strategies as an ex-ante assessment. However, the findings of this study are based on the survey with rice producers, paddy/rice traders, millers, and consumers. The consumers in the study are showed their positive attitude towards golden rice. The yellow color of the cooked rice is not a major problem to the consumers if the importance of vitamin A is spread through awareness building. However, the taste of the rice should not be very much different from the popular varieties- BIRRI dhan29 or BIRRI dhan28. The mass media and special awareness-creating programs can play a vital role in that. The government can include golden rice in the social safety net programs (such as VGF, OMS, FFW, rationing, etc.). The producers demanded that the yield and market price should be ensured to make the rice production profitable. The traders expressed their opinion to create the market demand of the golden rice so that they should not face any risk of selling. The seed growers in the long run also will follow the market demand of golden rice to multiply seed. The millers are also indifferent towards golden rice. They only follow the market needs. But there should have research on the milling system of golden rice in Bangladesh. There should develop a complete milling guideline for golden rice so

that the nutrient content does not destroy/reduce. Millers and traders threatened the yellow-colored grain of the rice. Generally, the traders mix the similar grain types up and send them to the mills. The millers also do the same in producing clean rice. Mixing golden rice with similar varieties (BRRI dhan28, BRRI dhan29) would not be possible for its unique color. This is a weakness and also a strength of Golden Rice to prevent from mixing up. A segregated supply chain should develop to flow the golden rice from farm to consumer. In conclusion, the system is interlinked along the supply chain. If the golden rice has much demand at the market and consumers level, the farmers will produce it and the seed growers will produce the seed. A unique supply chain development towards targeted beneficiaries is essential to flow the golden rice. Modern rice production and quality seed production training program in the way of establishing a 'seed village' would be effective to ensure the profitability of GR. There should have an effective awareness-creating program about the importance of golden rice throughout the country. Delivering the importance of nutritional intrusion rather than the GMO myth would be effective. Specially, we are recommending to tell 'Vitamin A Rice' instead of 'Golden Rice'. Finally, deployment requires behavior change, communication, stakeholder outreach, and engagement. The deployment also requires marketing, pricing, and new partnerships for the dissemination of Golden Rice in Bangladesh and other relevant countries.

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