Rice Fortification Landscape Analysis

Bangladesh

Final Report

By Food Fortification Initiative

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Enhancing Grains for Healthier Lives

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List of abbreviations

BINA	Bangladesh Institute of Nuclear Agriculture
BRRI	Bangladesh Rice Research Institute
DHS	Demographic and Health Survey
GAIN	Global Alliance for Improved Nutrition
GDP	Gross Domestic Product
GoB	Government of Bangladesh
IRRI	International Rice Research Institute
MMT	Million Metric Tons
MT	Metric Tons
NI	Nutrition International
OMS	Open Market Sales
USAID	United States Agency for International Development
VGD	Vulnerable Group Development
VGF	Vulnerable Group Feeding
WFP	World Food Program

EXECUTIVE SUMMARY

The objective of mandatory food fortification programs are to provide additional intake of essential vitamins and minerals through widely and commonly consumed foods. Oil and salt must be fortified in Bangladesh but fortification of wheat flour and rice is still voluntary.

Parboiled rice is the primary staple grain in Bangladesh at 468.9 grams per capita per day (g/c/d); wheat flour trails at 41.6 (g/c/d). At its high consumption and broad coverage across the population, rice fortification would be an ideal food vehicle for improving dietary intake of vitamins and minerals across the population.

Efforts thus far in rice fortification have focused on introducing fortified rice into Bangladesh's rice-distributing social safety net programmes, such as the Food Friendly Program (FFP), Vulnerable Group Feeding (VGF), and Vulnerable Group Development (VGD). Through efforts spearheaded by the Government of Bangladesh and technical support from Nutrition International and the World Food Programme, fortified rice was distributed to 7 million individuals as of 2022.

However, rice fortification has yet to be scaled up across the social safety nets that distribute rice – these efforts cover less than half of the beneficiaries eligible under FFP or VGD. And in a population of 166 million, existing rice fortification efforts only cover 4% of the total population. Even if all rice distributed through social safety net programs in Bangladesh were fortified, this would only cover 4.5% of the total rice consumed in the country. Mandating fortification through legislation or requiring fortification specifications in mandatory standards could achieve rapid scale-up of rice fortification *if* the rice milling industry were automated and industrialized.

This report's objective was to fill existing information gaps on the rice milling industry in Bangladesh to understand the proportion of rice that is industrially milled in Bangladesh, and thus can be considered "fortifiable".

An estimated 2.7MMT, 7.2MMT and 9.6MMT (a total of 56%) of milled rice is processed by large, medium and small scale commercial mills respectively. This accounts for 56% milled rice that can potentially be described as industrial. The remaining 44% is self-milled or non-commercially milled. However, due to large number (2000+) of small commercial mills, FFI only considers 9.9 MMT of milled rice processed through the large- and medium-scale mills (28% of the total rice

supply) *fortifiable*. Fortifying 9.9 MMT of milled rice would involve about 230 large- and medium-scale mills.

Recommendations to identify a way forward for rice fortification in Bangladesh

The following are the recommendations to address the weaknesses and take advantage of the opportunities for rice fortification.

- Update a list of key stakeholders that can be involved in fortification in Bangladesh; engage and document their roles and responsibilities. Stakeholders to include: international technical support partners, responsible government ministries, private mill, consumer groups, regulatory bodies, etc.
- Convene a stakeholders meeting with above mentioned stakeholders to discuss the findings and recommendations in the rice supply chain diagnostic as well as the wheat flour supply chain diagnostic completed in 2020 by FFI on behalf of NI. A holistic food fortification strategy of multiple fortified vehicles should be considered.
- Come to an agreement with the Government of Bangladesh on the short term and long-term strategy regarding mandatory cereal grain fortification.
- Put together an implementation plan for the strategy.

COUNTRY OVERVIEW

Bangladesh, with a projected population of 166 million in 2021, living on a landmass of 147,570 square kilometers, is ranked the 10th most densely populated country in the world[1]. An estimated 15.4 million (9.3%) of the population is under 5 years of age, while the proportion of the rural population has steadily declined from 76% in 2000 to 61% in 2020[2], meaning more people migrating to the urban centres.

Bangladesh graduated to lower-middle income country status in 2015. Over recent years, Bangladesh has experienced sustained economic growth and achieved significant development gains, especially in Universal Primary Education, gender parity, basic education, and child and maternal mortality. Poverty and extreme poverty have been declining, at 31.5% and 17.6% respectively in 2020, with further reductions expected[3]. In 2019-20, agriculture sector contributed 13.35% in total GDP of the economy. In addition, livelihoods of most rural households (88%) directly and indirectly depend on agriculture.

However, despite the progress and the improved availability of food due to increased production, 40 million people (25% of the population) remain food insecure and 11 million suffer from acute hunger[4]. Micronutrient deficiencies continue to be a health concern in Bangladesh. The National Micronutrient Survey (NMS) of 2011/2012[5] found that micronutrient deficiencies are relatively similar across NPNL populations, at national and subnational levels, indicating a general need for micronutrient interventions across all populations. NPNL women living in slums women have higher vitamin B12, vitamin A, and zinc deficiencies, but NMS did not report whether these differences were statistically significant. The prevalence of vitamin B12, folate, and zinc deficiencies indicate a public health need for food fortification with these nutrients.

The objective of mandatory food fortification programs are to provide additional intake of essential vitamins and minerals through widely and commonly consumed foods. Prevalence of vitamin A deficiency was relatively low across national and subnational populations of NPNL women (<5.4%) and this may have been due to NMS 2011/2012 taking place after the introduction of a national oil fortification program.

[1] World Population Review (2021): Bangladesh Population 2021 (Live)-https://worldpopulationreview.com/countries/bangladesh-population
[2] World Population Review (2021): Bangladesh Population 2021 (Live)-https://worldpopulationreview.com/countries/bangladesh-population
[3] USAID (2018) Bangladesh Nutrition Profile
[4] USAID (2018) Bangladesh Nutrition Profile
[5] National Micronutrient Survey 2011/2012. icddr,b, UNICEF-Bangladesh, GAIN, Institute of Public Health and Nutrition. January 2013.

This report aims to describe the opportunity for mandatory fortification of rice in Bangladesh, which would rely on large-scale, industrial mills carrying out the process of fortifying rice. This report is complementary to another FFI report which has assessed the opportunity for fortifying wheat flour in Bangladesh[6].

METHODS

This report used mixed data collection methods: a desk review and key informant interviews with representatives from SKF, Perfect, Miltech, and other enterprises in the milling industry. The desk review focused largely on online documents from internet sources. Due to COVID-19 travel restrictions to Bangladesh, it was not possible to have face to face interviews with key informants in country during 2021. The interviews were held remotely.

GRAIN CONSUMPTION AND FOOD FORTIFICATION STATUS

Daily per capita availability of cereals (rice and wheat) is estimated at 510.5 grams, with rice and wheat at 468.9 grams and 41.6 grams respectively[7,8]. Bangladesh is currently one of the highest per capita consumers of rice (about 170 kg annually); rice is the primary staple food of the people of Bangladesh. Urban households spend 18.2%, 15.8% and 12.8% of their food budget on fish, rice and meat respectively[9]. Estimates of per capita rice consumption vary widely depending on the source and the survey methodologies, but the long-term trend across all sources suggests that per capita consumption has been declining over time.

On the other hand, the UN's "The Food Outlook" 2021 expects rice consumption to increase in 2020-21 to 181.kg per year, translating to 496 g/p/d, the highest in Asia. Sources suggest that due to COVID-19, rice has become even more important for ensuring food security in the country. The International Rice Research Institute (IRRI) conducted a survey comprised of different rice value-chain actors in which respondents indicated an increase in per-capita consumption of rice as a result of COVID-19 because "rice is easily available and cheaper than other foods" and the Grain and Feed Annual Report (2020) found that he Government of Bangladesh has increased its procurement target of rice to support local farmers (as a result of cushioning farmers against impact of COVID-19 and keep market prices stable.

[6] Food Fortification Initiative. Feasibility of Wheat Flour Fortification in Bangladesh: An assessment of the wheat flour milling industry and regulatory monitoring system. 2020

[7] FAO Food Balance Sheets 2018

[8] Maize is largely grown for animal feed, not human use, and thus does not feature in the discussions here.

[9] Zabib Igba 2020

Table 1: Rice consumption/availability by source and years

	Consumption/availability (g/c/d)			
Food	2015[A]	2017, FAO	2018, FAO	2020[B]
Rice	468.9	494		494
Wheat flour	41.6	97.5		97.5

[A] Monzur H and Yunus M (2016) *Estimates of Per Capita Consumption of Food Grains in Bangladesh*. Bangladesh Development Studies Vol. XXXIX, Nos. 1& 2 Available from: https://www.researchgate.net/publication/319931702_Estimates_of_Per_Capita_Consumption_of_Food_Grains_in_Bangladesh [accessed Jul 08 2021

[B] The Business Standard (12th November 2020): Per capita rice consumption in Bangladesh to be highest in Asia in 2021: FAO- https://www.tbsnews.net/bangladesh/capita-rice-consumption-bangladesh-be-highest-asia-2021-fao-157333

[C] Global Fortification Data Exchange, national industry report, private sector industry report

Table 2: Grain consumption/availability and food fortification status in Bangladesh

Food	(g/c/d), 2015[A]	(g/c/d), 2020[B]	% Industrially milled	Fortification status, 2020[C]	Nutrients in standard[D]
Rice	468.9	494	--	Voluntary	Iron (ferric pyrophosphate), B12, folic acid, thiamin and vit A
Wheat flour	41.6	97.5	79[D]	Voluntary	Calcium, iron, zinc, B6, B12, folic acid, niacin, riboflavin, thiamin and vit A

[A] Monzur H and Yunus M (2016) *Estimates of Per Capita Consumption of Food Grains in Bangladesh*. Bangladesh Development Studies Vol. XXXIX, Nos. 1& 2 Available from: https://www.researchgate.net/publication/319931702_Estimates_of_Per_Capita_Consumption_of_Food_Grains_in_Bangladesh [accessed Jul 08 2021

[B] The Business Standard (12th November 2020): Per capita rice consumption in Bangladesh to be highest in Asia in 2021: FAO- https://www.tbsnews.net/bangladesh/capita-rice-consumption-bangladesh-be-highest-asia-2021-fao-157333

[C] Global Fortification Data Exchange. www.fortificationdata.org.

[D] Food Fortification Initiative. Feasibility of Wheat Flour Fortification in Bangladesh: An assessment of the wheat flour milling industry and regulatory monitoring system. 2020

Fortification of oil and salt is mandatory in Bangladesh; rice and wheat flour are voluntary[10]. "*In Bangladesh, micronutrient-enriched fortified rice was first introduced in July 2013 through an acceptability trial targeting ultra-poor women from 3,000 households in Kurigram District and 6,000 in Satkhira city in Khulna District. The fortified rice, branded as Pushti Chal in Bangla, contained vitamins A, B1 and B12, and folic acid, iron and zinc*"[11].

Fortified rice was first been introduced in social safety net programs distributing to poor women and children (Vulnerable Group Development) and food insecure households after natural

[10] Global Fortification Data Exchange: Bangladesh Fortification dashboard- https://fortificationdata.org/country-fortification-dashboard/?alpha3_code=BGD&lang=en

[11] Reaz Ahmed (2020) Bangladesh introduces micronutrient-enriched fortified rice first time in open market sales, DhakaTrubune, Aug 10, 2020-https://www.dhakatribune.com/bangladesh/2020/08/10/bangladesh-introduces-micronutrient-enriched-fortified-rice-first-time-in oms#:~:text=However%2C%20for%20the%20first%20time,Folic%20Acid%2C%20Iron%20and%20Zinc.

disasters (Vulnerable Group Feeding). These pilots, which operated in a subset of the total beneficiaries eligible for VGF or VGD, distributed fortified rice to 30,000 in 2013. More recent efforts include VGD as well as incorporation of fortified rice into a lean-season food distribution program (Food Friendly Program); all existing efforts collectively covered 5 million individuals in 2020[12] (~183,500 MT of fortified rice). In their September 2021 country brief[13], World Food Program reports that it continues to support the distribution of fortified rice in government food based social safety net programmes and commercial markets (open market sales), reaching more than 7 million beneficiaries. In September 2021, WFP increased access to fortified rice for 60,000 beneficiary households (300,000 people) in 19 upazilas in the Chittagong Hill Tracts. International partners are also providing technical assistance to the Ministry of Food to mainstream rice fortification across safety net programmes by 2030.

The voluntary rice fortification standards are in **Table 3.**

Table 3: Voluntary rice fortification standards[A]

Nutrient	Compound(s)	Level[B]
Folate	Folic acid	1.5-1.9 mg/kg
Iron	Ferric pyrophosphate	50-70 mg/kg
Thiamin	Thiamin mononitrate	4.5-6 mg/kg
Vitamin A	Retinyl palmitate	1.85-2.15 mg/kg
Vitamin B12	Cyanocobalamin	0.0115-0.0145 mg/kg
Zinc	Zinc oxide	35-45 mg/kg

[B] Bangladesh standard specificiation for fortified rice, BDS 1897:2015, ICS 67.060. Bangladesh. 2015
[B] All ranges reflect target range at factory

RICE PREFERENCES AND CONSUMPTION PRACTICES

Bangladesh cuisine revolves around rice[14]. Rice varieties are selected according to the growing seasons: Boro (winter), Aus (summer) and Aman (autumn) and primarily for features such as yield, drought, salinity, and pest resistance.

According to the 2010 Household Income and Expenditure Survey (HIES), higher incomes are associated with higher purchases of well-milled, slender, long-grained polished rice[15] – described as *miniket* and *najirshali*. Lower income households have higher purchases of coarse rice, which is short grain and comparatively wide compared to *miniket*. *Miniket* rice may not be a variety itself (traders appear to use term *miniket* as if it were a variety, but the Bangladesh Rice Research Institute, which produces and introduces rice varieties, does not recognize it as a distinct variety;

[12] World Food Programme. The Journey of Scaling Up Rice Fortification in Asia. April 2021.
[13] WFP Bangladesh (2021): Country Brief September 2021- https://docs.wfp.org/api/documents/WFP-0000132955/download/?_ga=2.177504544.406753416.1635322204-1499772958.1619766133
[14] M.H. Haider (2017) Food for Thought: Understanding Bangladeshi Cuisine; The Daily Star, February 24, 2017
[15] Mottaleb KA and Mishra AK. Rice consumption and grain-type preference by household: a Bangladesh Case. Journal of Agricultural and Applied Economics, 48, 3 (2016): 298–319

instead, it appears to encompass multiple varieties that have similar shape and size). However, common practice is for millers to over-mill coarse rice in order to market it as higher-end *miniket* rice[16]. As Bangladesh's middle class grows, there will likely be a corresponding increase in the demand for highly-milled rice to satisfy consumer preferences for *miniket* rice.

Due to price sensitivities, rice is typically lower-quality (25%+ broken) and parboiled. Rice is traditionally cooked through absorption methods, but there are anecdotal reports that urban households are more likely to cook rice with excess water.

If food consumption is restricted to rice and wheat, rice's relative demand and consumption will depend, among other things, on their relative prices, income levels, age, sex and household size. While the per capita consumption of cereals significantly differs between the poor and the non-poor in rural areas, it does not in the urban areas. As rice is the dominant component in the consumption of cereals in both areas, it does not differ significantly between the poor and the non-poor. On the other hand, per capita daily consumption of wheat significantly differs between the poor and the non-poor in both the rural and urban areas.

RICE PRODUCTION

Annual quantities produced, yield, major rice-growing regions, time trends is presented in **Table 4** below.

Table 4: Rice production and yield by year, 2016-2019

Rice	2016/17	2017/18	2018/19	2019/20
Production (paddy), MT/year[A]	50,452,866	54,148,000	54,416,000	54,586,344
Yield (MT/ha)[B]	4	4	4	5
Milled rice (MT/year)	34,710,000	34,909,000	35,880,000	36,300,000

[A] World Data Atlas: Bangladesh Rice, paddy production quantities: https://knoema.com/atlas/Bangladesh/topics/Agriculture/Crops-Production-Quantity-tonnes/Rice-paddy-production

[B] USDA (2016) 'Commodity'; http://www.indexmundi.com/agriculture/?country=rw&commodity=corn&graph=production

The Grain and Feed Annual Report (2020) shows three cropping seasons of rice in Bangladesh namely, Boro (winter), Aus (summer) and Aman (autumn). Varietal groups used for different seasons, are designated by the name of the respective cropping seasons. In the dry winter season, Boro is grown mainly in the irrigated fields. In the rainy summer season, short-duration Aus is grown in lowland as well as in upland areas. From summer to autumn, long-duration Aman is grown by transplanting (T. Aman) or by broadcasting (B. Aman). B. Aman rice is almost

[16] Faisal Atiq, BDnews24.com. The name of the scam is Miniket. https://tekdeeps.com/the-name-of-the-scam-is-miniket-chaal-daily-stockbangladesh. January 2021.

synonymous with deep-water rice that can elongate the internodes markedly in response to the rising water level.

Table 5: Bangladesh rice production trend by type of rice[17]

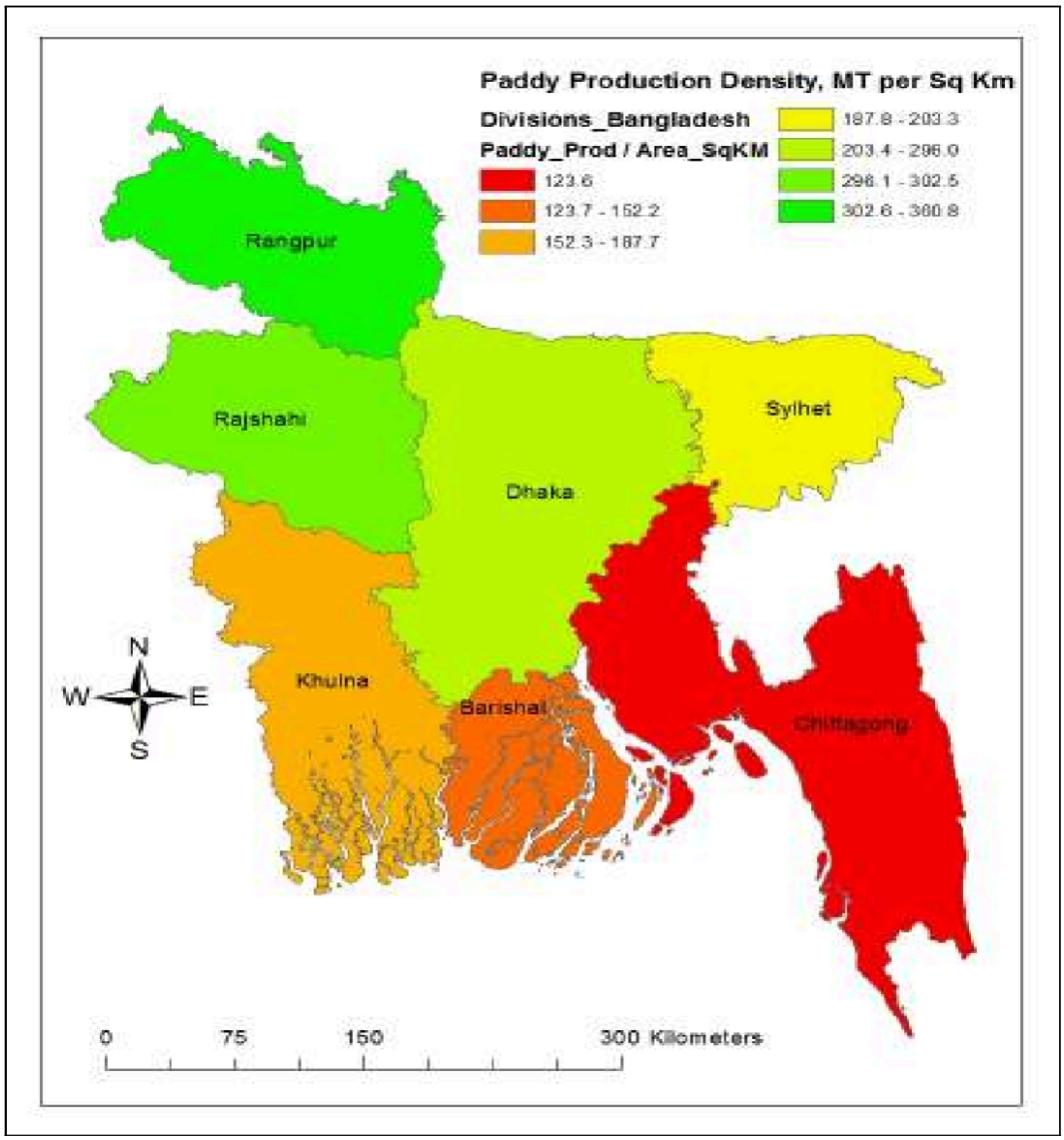
Rice Season	2018/19		2019/20		2020/21	
	Area 1,000ha	**Production 1,000MT**	**Area 1,000ha**	**Production 1,000MT**	**Area 1,000ha**	**Production 1,000MT**
Boro (winter)	4,752	18,909	4,850	19,400	4,750	19,500
Aus (pre monsoon)	1145	2,500	1,100	2,450	1,150	2,600
Aman (monsoon)	5873	13,500	5,880	14,000	5,900	14,200
Total	**11,770**	**34,909**	**11,830**	**35,850**	**11,800**	**36,300**

Furthermore, 2 minor groups of deep-water rice, Rayada and Ashina, occur in Bangladesh. Rayada shows a very long growth duration, and is cultivated in a restricted area along the river Madhumaty, a tributary of the Ganges. Ashina belongs to a small varietal group characterized by early heading. Nearly 10,000 landraces are considered to exist in Bangladesh.

The map shows that, paddy production is mainly concentrated in the north, north-western part of the country with average production in the west and eastern. The least rice producing regions are the central, southern and south eastern part of the country. The greatest population lives in central Bangladesh, in the vicinity of the capital, Dhaka.

Figure 1: Bangladesh Paddy Production Density by Division (MT per Sq KM)

[17] Grain and Feed Annual Report of 2020



Source: Mohammed Aminual Ahesan and Tarmiji Masron (2016), Proportionality assessment of rice mill distribution against paddy production in Bangladesh: A GIS spatial analysis
https://www.semanticscholar.org/paper/Proportionality-assessment-of-rice-mills-against-in-Ahesan-Masron/4cd11210ab34fbec7af92e19fcb5b7476a629cb8/figure/7

Major national rice production policies with potential to affect rice fortification

In their report, Kabir et al[18]. observe that, *"Bangladesh has achieved tremendous growth in rice production (3.5 times higher than 1971) due to increased cropping intensity (192%; higher adoption of high yielding variety rice in dry (99%), early wet (90%) and wet (80%) seasons, and better agronomic management and irrigation application. Agricultural farms are being*

[18] Jahangir Kabir et al. (2018) Rice Technological Innovation and Value Chain Development in Bangladesh: Current Status and Future Directions

transformed from subsistence to commercial production. Farm outputs are being sold to wholesale market traders and mills instead to village traders."

The country needs to produce an additional 8.22 and 11.80 million tons of clean rice, respectively by 2030 and 2050, to meet the demand for growing population from the shrinking land resources base. Moreover, harsher future environments (e.g., salinity, floods, droughts, colds, heat, and cyclones) might aggravate the challenges to future food and nutrition security in the country.

Accelerating genetic gain, adoption of climate smart technologies and location specific varieties, minimizing yield gap, curtailing adoption lag, and increasing profitability of rice farming can help to alleviate the barriers of achieving the target (44.6 MT) to food security for the growing population in 2050.

It is important to note that farmers' surplus that is traded under the above supply chains is about 80-90% for majority of farmers. However, marginal farmers have only about 50% of the produce as surplus that can be marketed, while the rest is for own consumption.

Bangladesh took some policy measures to control the price of rice, effective from 30th September 2020, fixed wholesale prices of fine rice (*miniket*) at Tk51.5 per kg[19] and at Tk45 per kg in the case of medium-quality rice, in an effort to avert further increases in prices of essentials. Also, as a procurement policy, the government purchased parboiled rice at Tk36 per kg, white rice at Tk35 per kg and paddy Tk26.

RICE IMPORT AND EXPORT

Although Bangladesh is the third biggest producer of rice in the world, the 2020/21 rice import forecast is 500,000 MT[20], to compensate for stock losses due to heavy floods and to address skyrocketing rice prices in the local markets. At that time Bangladesh government had an alarmingly low food reserve in hand but now it has a comfortable food stock of 1.3 million tons in government silos. *"The government claimed of having a bumper harvest in last Boro and on top of it, private and public sectors imported nearly 800,000 tons and over 500,000 tons of rice respectively in the last five months."*[21]

Different varieties of rice are imported. They include mainly aromatic rice, puffed rice, basmati and non-basmati rice, parboiled rice, brown rice scented. Amidst the shortages and high prices,

[19] 1USD=85.2Tk as at 14th September 2021
[20] USDA FAS Grain and Feed Report July 2021
[21] Reaz Ahmed (2021) Bangladesh Continues to Import rice from Myanmar, DhakaTribune, 24th June 2021

the country plans to cut the rice import duty from 62.5% to 26%[22], while allowing private traders to import rice up to a certain level to bolster reserves. Bangladesh will likely fulfil the entire import requirement from India because of its lower prices.

Using the 2020/21 production data, Bangladesh imports stand at 1.35 MMT[23] for both private and government sources; with local production of 37 MMT of milled rice, imports account for 3.5% of the national requirement, up from 1.4% in 2020.

Rice Storage capacity[24]

Bangladesh has adequate storage facilities all across the country for storing various types of food grains. These warehouses have huge storage spaces which are often underutilized during any given month or season of the year. But some of them are old which needs to be renovated. For storage of food grains, there are total 654 storage facilities of different types LSD-635, CSD-12, Silo-6 and 1 Multi-purpose Warehouse) with a total capacity of approximate 2,123,387 MT of rice.

These warehouses have good facilities in terms of equipment, skilled labour, stacking facilities, fumigation capacities at affordable prices, ventilation, augmented storage facilities, parking, security. In addition, 8 more Modern Silos and 158 LSDs with a total capacity of 640,000 MT were expected to be completed in 2020. Modern storage facilities in different strategic locations across the country will allow grain to be kept in bulk for up to 2/3 years in better conditions relative to the go-downs used currently, with reduced grain losses and enhanced nutritional value of the grain distributed.

Apart from the government storage, there are a number of private storage facilities that have been developed. These include capacities of World Food Program (WFP) of 20 warehouses with total capacity of 40,000 MT.

While storage facilities and functions assume great importance, particularly in the case of subsistence crop, little is known about the various aspects of the initial storage of rice and paddy. The big rice-millers have large storage godowns in their compounds. They perform a considerable

[22] Hasan R. NewAge Business. Bangladesh reduces duties on rice import by 36pc. August 12, 2021. https://www.newagebd.net/article/146161/bangladesh-reduces-duties-on-rice-import-by-36pc#:~:text=The%20government%20has%20reduced%20the,stable%20on%20the%20local%20market.
[23] Roushon Jamal MD. Bangladesh's rice policy paradox. Asia and the Pacific Policy Society. September 20, 2021. https://www.policyforum.net/bangladeshs-rice-policy-paradox/
[24] Wahid Zaman (2020) Logistical Capacity Assessment: Bangladesh Home page, World Food Programme.

part of this function in the area they are located. The traders at the primary market do not have any storage facilities.

Distribution of paddy rice

The Bangladesh rice production and marketing is dominated by rice millers who are the key players in the rice supply chain, controlling the forward and backward linkages. At the upstream of the supply chain, many farmers supply paddy to private brokers (largely wholesalers), who are well-organized and well-coordinated but are sometimes controlled by a few dominant millers. As a result, the wholesale and milling levels operate like duopoly. The millers control the farmgate paddy price and sometimes provide dedicated farmer groups with paddy production support. In the milled rice supply chain, a few rice millers and wholesalers (who are well-organized and coordinated) supply to a large number of consumers and de facto operate as an oligopoly[25]. The millers' association decides the quantity of paddy to be purchased and the price to be offered to farmers and at the same time fix the price for selling milled rice.

Table 6 below shows the amounts of paddy distribution through various channels to the different categories of paddy market.

Paddy distribution takes different channels as follows: Part of the total paddy produced (about 1.8%) is retained as seed by the farmers. About 4% goes through government procurement process for institutional use (schools, the army and prisons etc). However, government gives tenders to private sector to mill the rice it distributes. About 13% of the paddy is supplied to husking mills and 27.8% is retained for self-consumption. Self-consumed paddy is either milled at the household using traditional manual tools or taken to milled in the numerous village husking/conventional mills for a fee. Increasingly, more paddy is being supplied to the private brokers who supply to commercial mills, with less retained for self-consumption. This leaves 56% (28.86MMT in 2019/20) of the paddy supplied by private brokers to industrial mills, which are increasingly becoming automated.

Table 6: Distribution of Paddy in Bangladesh

Category of Paddy Markets	Amount (MMT)	Percentage
Large mills	4	7.3
Medium	10.7	19.6
Small auto/semi auto	14.3	26.2

[25] Raha, S.K., Moniruzzaman, M., Alam, M.M. and Awal, M.A. (2013),"Structure, conduct and performance of the rice market and the impact of technological changes in milling", Working paper, Institute of Agribusiness and Development Studies (IADS) Bangladesh Agricultural University, Mymensingh

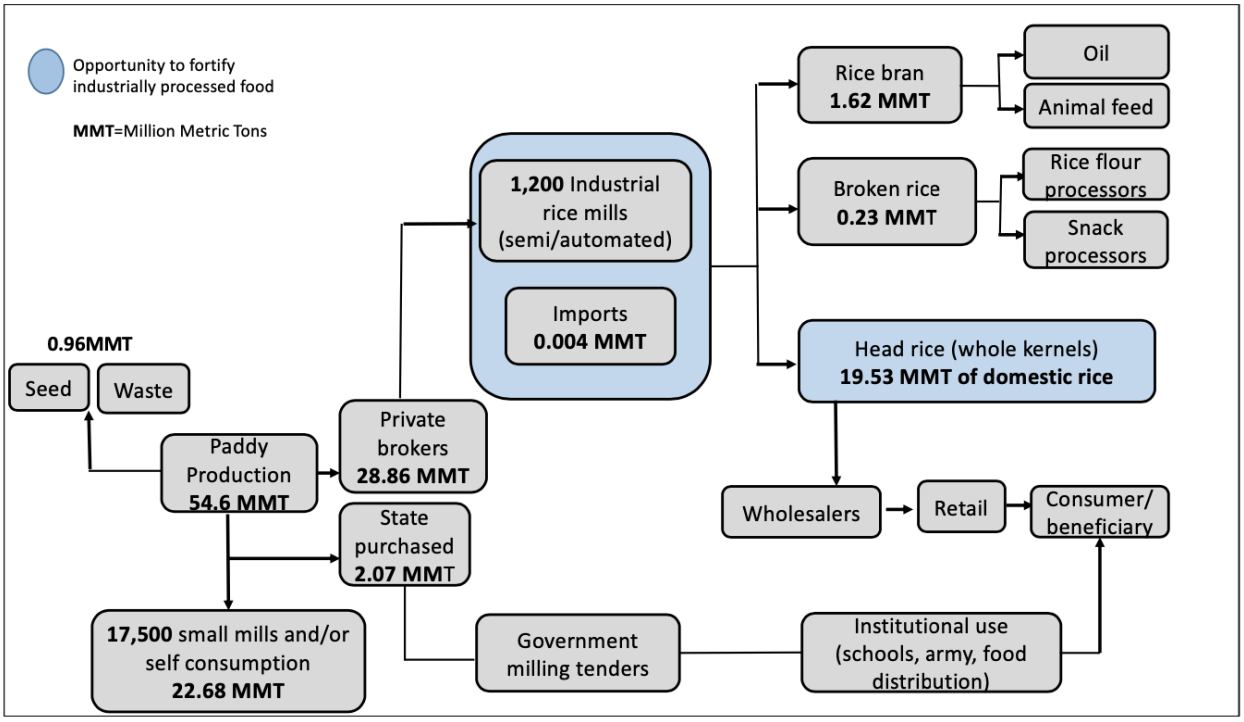
Conventional mills	7.4	13.6
Self-consumption	15.17	27.8
Government tender	2.07	3.8
Seed and waste	0.96	1.8
Total	**54.6**	**100.0**

Source: Author's calculations from Key informant interviews and literature reviews

SUPPLY CHAIN DIAGRAM

The supply chain analysis diagram cohesively ties together the entire rice distribution (production, imports, distribution, milling) to visually depict the flow of rice in Bangladesh. This is presented in **Figure 2** below.

Figure 2: Bangladesh rice supply chain diagram



In **Figure 2**, milled rice from husking mills, largely consumed by the producing households at the village level, is captured in *small mills and/or self-consumption,* consuming 26.68 MMT of paddy (40% of total paddy available). The small husking mills are located everywhere in the producing regions, where they offer toll service for milling. Rice from automated mills is distributed throughout the country through wholesalers and retailers, some of which are supermarkets.

There are four types of supply chains through which domestically grown goes from farmers to consumers. These include most traditional chains, rural-urban traditional chains, intermediate rice chains and what is commonly referred to as modern supply chain.

(a) ***The most traditional chain:*** geographically and intermediary-short. Farmers supply village mills with paddy rice. The village mills de-husk and polish the rice for sale to local consumers via the village market or sell the rice to wholesale paddy rice buyers. This supply chain is now limited.

(b) ***Rural-urban traditional chain***: most common and involves long geographical distances and many layers of intermediaries. Farmers supply village traders/brokers who either supply village mills or wholesale paddy traders. Village mills supply milled rice to wholesalers, who supply semi-wholesalers and retailers from whom consumers purchase rice. Meanwhile paddy wholesalers supply medium to large mills in urban centers. These mills supply milled rice to wholesalers, who in turn supply retailers.

(c) ***Intermediate rice chain*****:** This is a transitional supply chain, transitioning from traditional to a modern supply chain. This is geographical long but intermediary- short because farmers supply directly to mills who supply milled rice to wholesalers, then to retailers or supermarkets. Or the farmers sell to paddy traders who supply mills; millers to wholesalers and subsequently to retailers.

(d) ***Modern supply chain***: this supply chain involves few actors but large volumes. Farmers supply mills who supply supermarkets or mills supply wholesalers, who in turn supply supermarkets and traditional retailers. This is still small but steadily increasing as the income levels continue to grow.

With the objective of controlling increasing retail prices, in September 2020, the Ministry of Food fixed the wholesale price of rice for fine rice (*miniket*) at Tk51.5 per kg and at Tk45 per kg in the case of medium-quality rice[26]. However, the retail price of rice is not fixed.

MILLING INDUSTRY STRUCTURE

The milling industry in Bangladesh is in a transition stage. Although the industry is currently dominated by small, conventional manual mills, the capacity of automated mills is increasing. An

[26] Bangladesh Post. Govt fixes market price of rice. September 30, 2020. https://bangladeshpost.net/posts/govt-fixes-market-price-of-rice-43525

estimated 70% of automated mills process local *Miniket* varieties. Automated mills also process specialty rice varieties (e.g. Anand Bhog in Dinajpur and Chinigura aromatic rice types). In automated mills, the average extraction rate is ~67% while it is 65% in conventional mills. An advantage of automated mills is this higher conversion to of head rice.

Classification of Rice Mills in Bangladesh by Production Capacity of Milled Rice

Mills are generally categorized according to their installed capacities. The categorization as large, medium or small varies depending on the milling context of a country – i.e., what is defined as large in one country may be small in another. In Bangladesh, rice mills with capacity >16 MT/h are categorized as large, 8-16 MT/h is medium, 3-8 MT/h is small, and less than 3 MT/h fall under tradition husking mills. The table below shows Bangladesh rice mill categories, the total national annual production of milled rice and relative market power. Note that as the authors do not have the information available to break down the procurement of social safety net rice by size of the source mill, it is not clear the proportion of social safety net rice that could be considered industrially milled.

Table 7: National milling capacity by size category, 2020/2021

Mill category	Number	Estimated Rated capacity of Paddy	Estimated National Capacity (Milled rice)
Large modern rice mills	30	>16 MT/hr	2.7 MMT
Mid-range modern rice mills	200+	8-16 MT/hr	7.2 MMT
Small automated/semi-automated rice mills	1000+	3-8 MT/hr	9.6 MMT
Small conventional Rice mills	2000+	<3 MT/hr	5 MMT
Chinigura Specialty rice mills	5	<5 MT/hr	0.075 MMT
Total			**24.575 MMT**

Source: Calculated from key informants' interviews with stakeholders in Bangladesh

Note: The 2020/2021 data shown earlier indicated total production of 36.3MMT of milled rice. The table above accounts for only 24.575MMT. The balance of 11.725 is estimated to be self-consumption and other minor channels.

Large modern rice mills

Large mills are defined as those with installed capacity of >16 MT of paddy per hour, which, according to milling equipment providers, in most cases have more than two installed milling lines of 8 MT/hour each. The greater efficiency achieved by large mills is translating into industry consolidation, with small and medium-scale mills running at low utilization or closing altogether. At ~68.67% conversion (including broken rice), this translates to production of >10 MT of milled rice per hour. These mills are owned by large groups, led by the City Group with a single 8 MT/h for Chinigura rice (specialty rice) line and two lines of 32 MT/h each for an installed capacity of

70 MT/h, followed by several large industry players like Sheikh, Hashem etc. There are an estimated 30 such large mills, averaging about 24 MT/h installed capacity for paddy and producing about 15 MT/h of rice. In total, the annual production of rice in Bangladesh from large rice mills is approximately 2.7 MMT of milled rice. Rice mills of this size will have adequate capacity to run continuous, automated parboiling operations (which parboil 10-25 MT/h in a single unit).

Medium sized modern rice mills

Medium modern rice mills are those with installed capacity of 8 MT/h $\leq$ 16 MT/h of paddy, which translates to 5 MT/h – 10 MT/h of milled rice. The number of mills in this category is rapidly growing. This market is dominated by Satake, followed by Buhler, Miltech, and Perfect (the latter two being Bangalore and Chennai-based rice milling equipment manufacturers). There are an expected 200+ mills in this segment that are operating at about 16 hours a day and collectively mill about 7.2 MMT. Mills of this size are more likely to use less efficient batch parboiling systems, with parboiling capacity of 8 MT-24 MT/batch.

Small automated rice mills

There are small automated mills with installed capacity of 3 MT/h – 8 MT/h of paddy, yielding 2 MT/h – 5 MT/h of milled rice**.** This is the most dominant sector, with 80% of the above mills equipped with Chinese equipment manufacturers, such as Xingliang, Zhen Zhao machinery etc. While exact numbers are not available as count, it is expected that there are about 1,000+ rice mills of this size. However they do not run with their full installed capacity and process rice only about 10 hours /day, producing approximately 40 MT/d of milled rice. Collectively, on an annual basis these mills produce 9.6 MMT of milled rice. Mills smaller than 8 MT/h are not using mechanized or industrial parboiling units. Paddy is soaked and steamed in large, open concrete or earthen tanks heated with an open-hearth furnace and sundried prior to milling.

Small Conventional Rice mills: These are village toll mills or mills for personal consumption, with capacities <3 MT/h of paddy (<2 MT/h of milled rice). Many of the rice mills in this category are older and may include a few huller mills in each village that cater to local farmers. Interviewees estimated there are more than 2,000 such mills, but their utilisation is limited to just few hours per day. Collectively they mill about 5.0 MMT of the rice in Bangladesh. This category of rice will be parboiled using traditional methods – usually by parboiling paddy in earthen pots or drums and sun-drying; larger operations within this category may use larger-scale parboiling operations closer to that of small automated rice mills.

Chinigura Specialty rice mills: These are automated, relatively smaller rice milling lines of 5 MT/h of paddy processing capacity, with a specific milling process. There is approximately 25 MT/h of total paddy processing spread across five large mills, most using Buhler and other smaller friction type machines. Assuming 10 hour/d operation, these specialty rice milling lines produce just about 75,000 MT. Including other specialty smaller mills for the niche aromatic rice market, one may expect about a total of 200,000 MT of specialty milling. Specialty rice is usually priced at about 150 to 200 BTK/kg.

Given the higher milling needs of rice sold as *miniket* (whether it is actually *miniket* paddy or not), this kind of rice is likely only processed in the medium or large sized mills. An estimated 60-70% (6-7 MMT) of output from automated rice mills is marketed as *miniket*[27]. The *miniket* output may be even higher, if 2010 HIES reports of fine rice consumption are extrapolated to a total 7.8 MMT of fine rice consumption.

Table 8: Rice mills classified by milling capacity

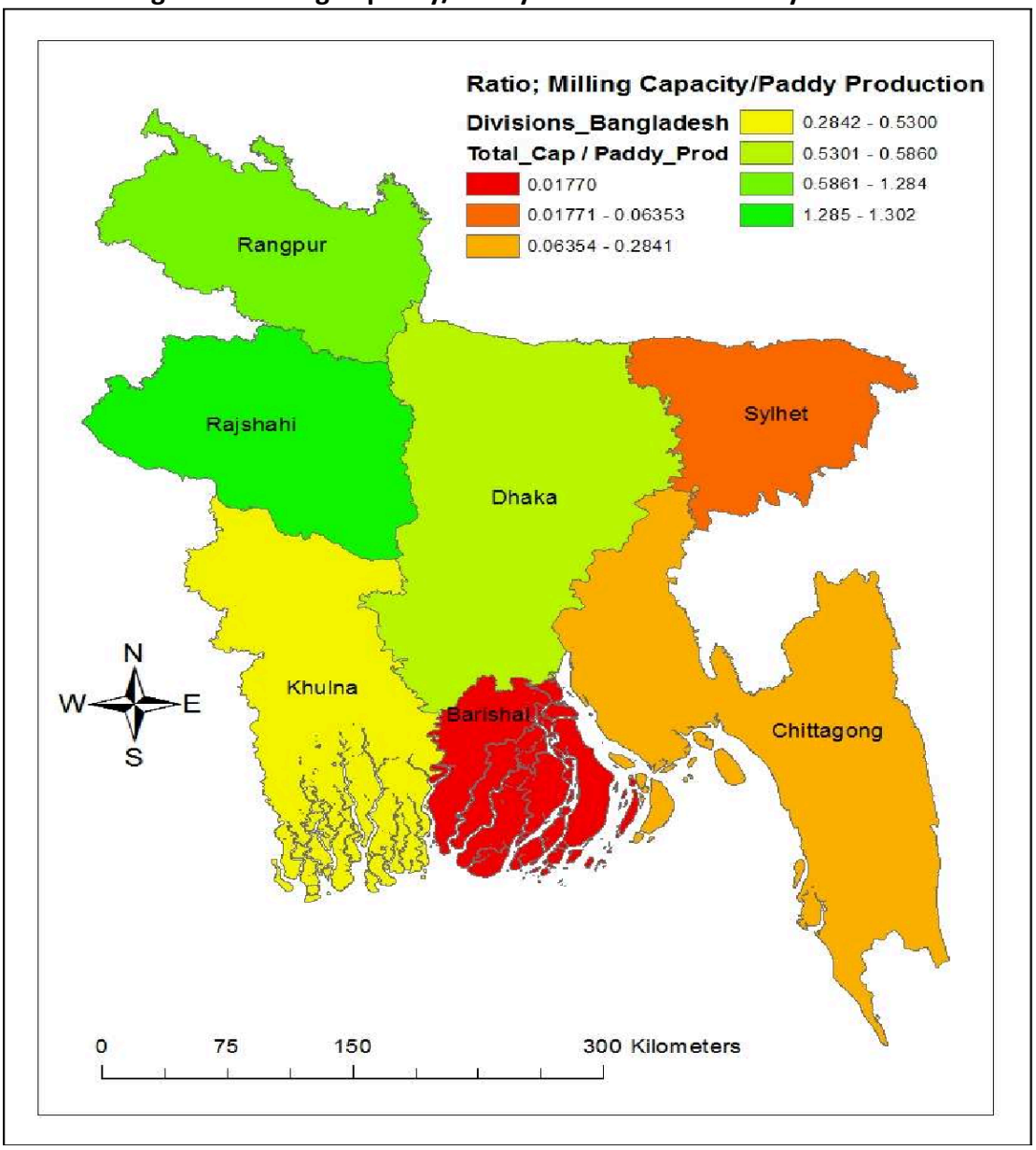
Category	Number	Estimated Rated Paddy Capacity (per facility)	Estimated National Production (milled rice)	% of national rice requirements (total = 36 MMT)
Large	30	>16MT/hr	2.7MMT	7.5%
Medium	200+	8-16 MT/hr	7.2MMT	20.0%
Small	1000+	3-<8MT/hr	9.6MMT	26.7%
Conventional Rice mills	2000+	<3MT/hr	5 MMT	13.8%
Home-milling/seeds	NA	NA	11.7MMT	32%

Source: author's interviews with milling industry contacts

Geographically, rice mills tend to be more concentrated in the rice growing divisions of Rajshani and Rangpur, followed by Dhaka for ease of distribution to urban retailers. The remaining divisions have fewer concentrated numbers of auto or semi-auto rice mills but conventional and home milling capacity are present. **Figure 3** below shows where mills are geographically distributed across the country.

[27] Faisal Atiq, BDnews24.com. The name of the scam is Miniket. https://tekdeeps.com/the-name-of-the-scam-is-miniket-chaal-daily-stockbangladesh. January 2021.

Figure 3: Milling Capacity/Paddy Production Ration by Division



Source: Mohammed Aminual Ahesan and Tarmiji Masron (2016), Proportionality assessment of rice mill distribution against paddy production in Bangladesh: A GIS spatial analysis[28].

RICE FORTIFICATION FEASIBILITY

[28] https://www.semanticscholar.org/paper/Proportionality-assessment-of-rice-mills-against-in-Ahesan-Masron/4cd11210ab34fbec7af92e19fcb5b7476a629cb8/figure/7

Rice fortification is technically possible at all but the most rudimentary rice mills[29], - all that is required is the ability to blend homogeneously at low ratios such as 1:100 weight by weight (1%) 1:200 weight by weight (0.5%). However, rice fortification will be most sustainable at rice mills where processes are automated, which reduces the need for human resources, the potential for human error, and eases monitoring and auditing activities to check appropriate blending rates. The number of rice mills that must be inspected should be within a reasonable number for the regulatory monitoring agency responsible for adherence to food regulations – a factor that increases the sustainability of fortification in a consolidated rice milling industry.

If only considering ~230 large and medium sized rice mills, 27% of the rice consumed in Bangladesh could be considered 'fortifiable'. While smaller 3-<8 MT/h paddy rice mills are also automated and could conceivably considered an opportunity for fortification, the prospect of monitoring 1,000+ rice mills for fortification requirements is likely an unrealistic burden for the Bangladesh Standards and Testing Institute (the current agency with the regulatory mandate over fortification compliance). Relatively low utilization (10 hours/day, or 42%) at these mills also indicates that there may be future consolidation within this category of rice mill.

Is fortifying 27% of the rice (9.9 MMT) in Bangladesh considered worthwhile? While not a majority, this still encompasses almost a third of the rice produced in Bangladesh and given Bangladesh's size, still a considerable quantity. For perspective, this quantity of rice exceeds the total volume of rice that is considered by FFI as fortifiable in 19 countries in the Africa region[30]. If 70% of outputs by large and medium mills are marketed as fine rice or *miniket* rice, then requiring fortification in large and medium rice mills will largely lead to fortification of rice that is purchased by higher income classes – with little penetration into lower income classes. The highest quartile households consumed on average 3.75x more fine rice (236 g/c/d) than the lowest quartile households (63 g/c/d)[31]. Considering the voluntary 2015 standards for fortified rice in Bangladesh, fortification will provide less than 50% of the EAR in the poorest quintile of households (orange cells in **Table 9**). When considering the RDA, only the richest quartile of households have 50% of their RDA contributed through fortified foods. Considering that the richest third and fourth quintile households exceed 50% EAR for iron and zinc at these fortification levels, the standards may need to be modified if mandatory fortification is introduced in Bangladesh.

[29] Technically, rice fortification does not need to happen at a rice mill if another centralized location is more amenable to kernel blending after milling. However, alternate blending locations to rice mills are considered an exception rather than the rule when consider large-scale fortification through mandatory legislation. Alternative points of fortifying rice have only typically occurred in school feeding programs, where schools may add fortified kernels during cooking.

[30] FFI, GAIN. Feasibility and Potential Coverage of Fortified Rice in the Africa Rice Supply Chain. 2016.

[31] Mottaleb KA and Mishra AK. Rice consumption and grain-type preference by household: a bangladesh case. Journal of Agricultural and Applied Economics, 48, 3 (2016): 298–319

Table 9: Expected nutrient contribution of food fortification by household income quartiles[A]

Nutrient	Target level (mg/d)[B]	% Contribution to EAR[C]				% Contribution to RDA[C]			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Vitamin A	1.50	19%	34%	50%	71%	14%	24%	36%	51%
Vitamin B1	4.00	28%	50%	75%	105%	23%	41%	61%	86%
Vitamin B12	0.0100	32%	57%	84%	118%	26%	47%	70%	98%
Folic acid	1.30	20%	37%	55%	77%	20%	37%	55%	77%
Iron	60.00	47%	84%	124%	175%	21%	38%	56%	79%
Zinc	40.00	37%	66%	99%	139%	32%	57%	84%	118%

*EAR and RDA are for women of reproductive age

[A] Consumption by household quartiles by quartiles: Mottaleb KA and Mishra AK. Rice Consumption and Grain-Type Preference by Household: A Bangladesh Case. Journal of Agricultural and Applied Economics, 48, 3 (2016): 298–319

[B] Nutrients and target levels: Bangladesh Standard Specification for Fortified Maida, BDS 1794:2008. Bangladesh. 2008.

[C] Estimated Average Requirement and Recommended Daily Allowance for women of reproductive age from Institute of Medicine

The results from the National Micronutrient Survey of 2011-2012 suggest that higher income households likely still experience micronutrient deficiencies and could still benefit from fortification. Although survey did not stratify results by household income, assuming that higher-income households are more likely to be urban, micronutrient deficiencies are still prevalent in urban households. The majority of urban (54.5%) households were zinc deficient, 35% of urban non-pregnant non-lactating (NPNL) women were vitamin A deficient, 24% of urban NPNL women vitamin B12 deficient, and 11% of urban NPNL women folate deficient. Folate deficiency was the most prevalent in urban populations compared to rural or slum populations. Iron deficiency in urban NPNL women was 8.7%, slightly higher than in rural and slum areas as well.

While approximately a third of the rice could be fortified in Bangladesh, requiring fortification for only a subset of mills that are large enough to implement fortification sustainably would likely be a complicated proposal. On the other hand, mandatory fortification would immediately scale-up the production and availability of fortified rice and could expedite the expansion of fortified rice introduced into social safety net programs. There are indications that the rice milling industry is likely to further consolidate in the short term, which may make it more sustainable to introduce mandatory rice fortification to a majority of the rice consumed in Bangladesh.

Currently, fortification efforts are focused on targeting distribution of fortified rice to the most nutritionally vulnerable populations in Bangladesh through food distribution programs. According to the Ministry of Food, in the 2021/2022 fiscal year, the government distributed a total of 1.65 million MT of rice through all of its collective programs – this represents a 35%

increase from previous years, and 4.5% of the total consumed 36.7 million MT rice supply[32]. Although targeting these food distribution programs presents an obvious and immediate opportunity to reach populations most at-need of fortified rice, focusing only on the fortification of social safety net programs will have limited reach in the population and impact on the rice supply chain.

FFI recommends actively monitoring the milling industry for these consolidation trends and revisiting the milling industry landscape in 6 months. Since the introduction of any legislation or updated standards may take years, it may also be worthwhile to begin scoping conversations to understand political will for mandatory fortification of rice and its potential implications for expanding fortified rice in the social safety nets.

Recommended next steps to consider the way forward for rice fortification in Bangladesh

The following are the recommendations to address the weaknesses and take advantage of the opportunities for rice fortification.

- Update a list of key stakeholders that can be involved in fortification in Bangladesh; engage and document their roles and responsibilities. Stakeholders to include: WFP, UNICEF, WHO, responsible government ministries, private mill, consumer groups, regulatory bodies, etc.
- Convene a stakeholders meeting with above mentioned stakeholders to discuss the findings and recommendations in the rice supply chain diagnostic as well as the wheat flour supply chain diagnostic completed in 2020. A holistic food fortification strategy of multiple fortified vehicles should be considered.
- Come to an agreement with the Government of Bangladesh on the short term and long-term strategy regarding mandatory cereal grain fortification.
- Put together an implementation plan for the strategy

[32] Grain and Feed Annual, April 5, 2022. United States Department of Agriculture, Foreign Agricultural Service. Report Number BG2022-005. Available at: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Dhaka_Bangladesh_BG2022-0005.pdf

Annex 1: Table: District wise Food Grain Storage Capacity *(MT)*

Sl. No.	District	LSD/CSD		Silo
		Capacity	Effective Capacity	Effective Capacity
RAJSHAHI DIVISION				
1	DINAJPUR	72805	61000	
2	THAKURGAON	26500	26500	
3	PANCHAGARH	17750	16500	
4	RANGPUR	15000	15000	
5	LALMONIRHAT	10000	10000	
6	NILPHAMARI	18500	18000	
7	KURIGRAM	20000	17500	
8	GAIBANDHA	24600	24300	
9	BOGRA	76345	55100	25000
10	JOYPURHAT	16400	16150	
11	RAJSHAHI	22150	22150	
12	NAOGAON	34750	34250	
13	NATORE	7500	7500	
14	NAWABGANJ	19500	19500	
15	PABNA	57040	45530	
16	SERAJGANJ	25250	25250	
	Division Total	**464090**	**414230**	**25000**
KHULNA DIVISION				
17	KUSHTIA	15000	14000	
18	CHUADANGA	10000	10000	
19	MEHERPUR	5000	5000	
20	JESSORE	19890	19140	
21	JHENAIDAH	17500	17500	
22	MAGURA	10140	8000	
23	NARAIL	7640	6500	
24	KHULNA	134027	82960	800
25	SATKHIRA	17640	14000	
26	BAGERHAT	16500	16500	
	Division Total	**253337**	**193600**	**800**
BARISAL DIVISION				
27	BARISAL	35280	30280	

28	JHALOKATI	8625	8000	
29	PEROJPUR	16000	13000	
30	BHOLA	27500	14750	
31	PATUAKHALI	32140	19640	
32	BARGUNA	19640	15140	
	Division Total	**139185**	**100810**	**0**
DHAKA DIVISION				
33	JAMALPUR	15900	15500	
34	SHERPUR	15000	15000	
35	MYMENSINGH	60310	56250	
36	NETROKONA	16500	14500	
37	KISHOREGANJ	26700	20450	
38	TANGAIL	33118	33118	
39	DHAKA	50300	39025	
40	GAZIPUR	9000	8500	
41	NARSINGDI	15750	14250	
42	NARAYANGANJ	23500	12500	50000
43	MUNSHIGANJ	13140	13140	
44	MANIKGANJ	13640	13640	
45	FARIDPUR	16500	16500	
46	RAJBARI	10640	9500	
47	MADARIPUR	19500	18500	
48	GOPALGANJ	10500	9500	
49	SHARIATPUR	11000	10500	
	Division Total	**360998**	**320373**	**50000**
SYLHET DIVISION				
50	SYLHET	17900	13010	
51	MOULIVI BAZAR	11000	7500	
52	HABIGANJ	18750	15250	
53	SUNAMGANJ	21400	19900	
	Division Total	**69050**	**55660**	**0**
CHITTAGONG DIVISION				
54	COMILLA	33300	23300	
55	BRAHMANBARIA	16500	15500	50000
56	CHANDPUR	21500	13000	
57	NOAKHALI	24500	22000	
58	LAKSHMIPUR	9500	7500	
59	FENI	13030	9750	
60	CHITTAGONG	151853	108350	100000
61	COX'S BAZAR	21000	11000	

62	RANGAMATI	6750	6250	
63	KHAGRACHARI	6250	5250	
64	BANDARBAN	3500	3000	
	Division Total	**307683**	**224900**	**150000**
Bangladesh		1594343	1309573	225800