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Cost Analysis of Rice Fortification in Bangladesh

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I. Introduction

Cereal food fortification of products from wheat, maize and rice is widely used in many countries around the world to address micronutrient malnutrition. Based upon the information that is provided by the Food Fortification Initiative (FFI), 82 countries require mandatory fortification of wheat flour and/or maize flour and/or rice. The rationale for mandatory fortification of staple foods is that fortification is designed to address micronutrient malnutrition for all the national population that consumes the staple food. Six countries have mandatory fortification of rice: Costa Rica, Nicaragua, Panama, Papua New Guinea, Philippines, Solomon Islands and the United States.

Rice is one of the main staple foods for 160 million people of Bangladesh. The supply chain for rice from field to table is mainly made up of two parts. The first part is the commercial supply of rice whereby consumers purchase rice at market prices. The second part is the supply of rice procured by the government and distributed among the social safety net programmes reaching the most vulnerable population groups in the country and the Government agencies such as the armed forces, police etc.

II. Methodology

The objective of the report is to conduct a cost analysis on rice fortification with focus on the following:

- Components in the price development of fortified rice;
- Costing breakdown of fortification of rice per tonne;
- Development of cost components at different levels of production and consumption;
- Scope of reducing the cost components;
- Break-even price for fortified rice producers of various types of rice at different production levels;
- Potential investments to reduce the various cost components;
- Role of WFP in cost development and potential cost reductions;
- Cost benefit of fortified rice; and
- Compare findings with other countries where fortified rice is sold or provided in social protection settings.

A mission was undertaken to carry out an assessment of the cost of rice fortification in Bangladesh with support from WFP. In addition, Nutrition International (NI) Bangladesh and Global Alliance for Improved Nutrition (GAIN) Bangladesh also provided their expertise in developing the background and linking with different stakeholders for Key Informant Interviews (KIIs).

The mission was segregated in the following steps:

Phase 1	**Desk Review**	Data collection related to production costs, price development and future expectations on fortified rice production and potential sales of fortified rice in the commercial market. Prior to the mission, a desk review was carried out on fortified rice based on the supply of numerous documents provided by WFP Bangladesh as well as other documents through online literature searches.
Phase 2	**Key Informant Interviews (KII)**	Conduct interviews with key stakeholders in the Government, private sector, and strategic partners *(List provided in Annex).*
Phase 3	**Presentation of Findings**	Facilitate discussions between WFP Bangladesh, key WFP private sector partners, key development partners and the national business community.

III. Background

Since 2013, the Government of Bangladesh, the United Nations World Food Programme (WFP) and other multisectoral stakeholders have worked in partnership to scale up the production of fortified rice, making it more widely accessible and available. Since the start of the programme, the number of people in Bangladesh who have access to fortified rice has grown from 30,000 in 2013 to more than one million in 2018.

WFP supported the Government to distribute fortified rice through its national safety net programmes, including the two largest programmes - the Vulnerable Group Development (VGD) Programme and Food Friendly Programme (FFP) - and initially including also the Vulnerable Group Feeding (VGF) Programme. WFP successfully piloted the integration of fortified rice in the lunch meals and fair shops for workers in selected Ready-made Garment (RMG) factories, as well as in hot meals for students through WFP's School Feeding programme. Simultaneously, WFP is providing technical support to the private sector to ensure availability of affordable and good quality fortified rice in the commercial market for the wider population.

Consequently, WFP, along with its technical partners, is continuously working towards raising public awareness on the benefits of fortified rice through the sensitisation of Government officials, private sector, development partners, and consumers especially women, children and adolescents.

Importantly, the Government of Bangladesh has taken keen interest and ownership to mainstream the distribution of fortified rice among the ultra-poor households through its safety net programmes. National funds have been allocated to distribute fortified rice, and plans are in place to scale up the local production facilities for fortified kernels, blending units, and lab facilities to test all six micronutrients in fortified rice kernels, with the technical assistance from WFP.

At present, two local private companies in Bangladesh are producing fortified rice kernels for the Government's safety net programmes and for commercial markets, with more manufacturing companies showing interest in entering the fortified rice production business. In addition, beneficiaries involved in awareness-raising initiatives and receiving fortified rice through the national social safety net programmes are increasingly becoming interested in purchasing fortified rice from commercial markets.

The findings, analysis and recommendations in the Cost Analysis provided below have been based on the desk review before the mission and KII conducted during the mission in Bangladesh.

1.1. Supply Chain of Fortified Rice

A supply chain chart for fortified rice was used to define the key points of the process from the farmer to the rice millers and ultimately to the consumer.

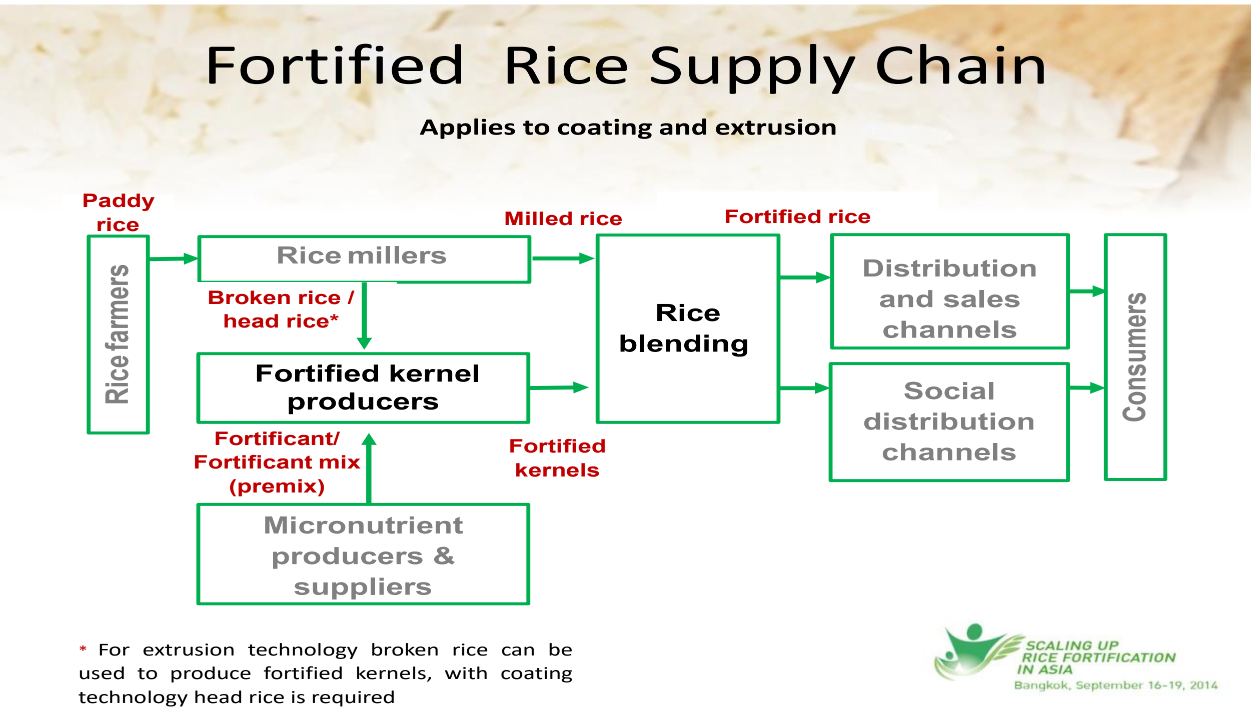

Figure 1: Fortified Rice Supply Chain. Source: Katrien Ghoos, WFP (Regional Office, Bangkok) 2014

The supply chain diagram above demonstrates how the introduction of fortified rice kernels adds additional steps to the existing non-fortified rice supply chain in Bangladesh. These include the following:

- The fortified kernel producers;
- The supply of broken kernels to make the fortified kernels;
- The supply of the micronutrient premix from producers and suppliers; and
- The storage and distribution of the fortified kernels to the rice millers and blenders.

Apart from the production of the fortified kernels and their cost components, the additional costs include storage and distribution of the fortified kernels and the blending cost of the fortified kernels to produce fortified rice.

1.2. Fortified Rice Value Chain in Bangladesh

Based on the diagram above, the following diagram illustrates the current Fortified Rice Value Chain for Bangladesh

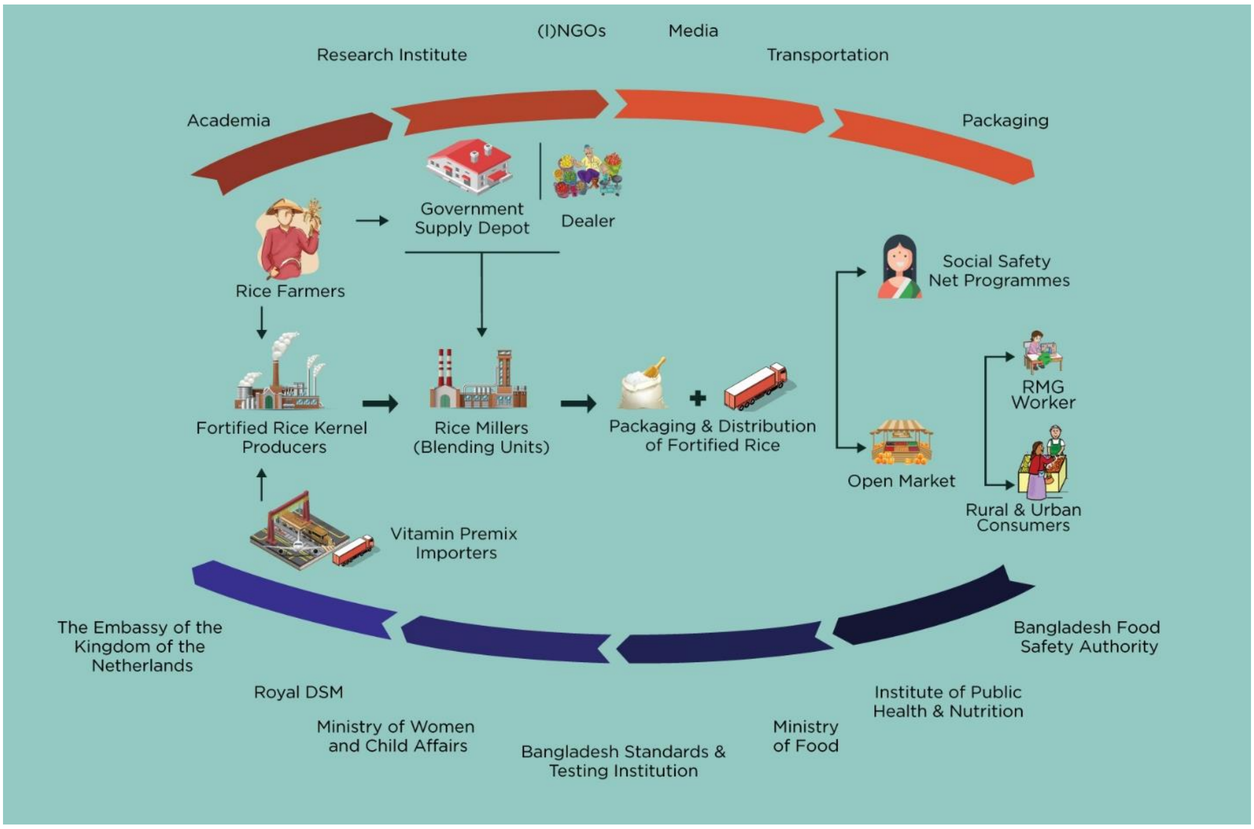

Figure 2: Fortified Rice Value Chain in Bangladesh. Source: Prepared by WFP Bangladesh 2019

The key points from the chart above are:

a. The key stakeholders in the value chain within Bangladesh at the national level.

b. The production of the fortified rice kernels by the manufacturers.

c. The production and distribution of the fortified rice from the rice mill to the end users/consumers. In other fortification programmes, the supply chain between the fortification component suppliers (premix and fortified kernels) and cereal (rice, maize and wheat) mills follows a Business to Business (B2B) model rather than a social safety net protection model. The B2B model for premix delivery is widely used in mandatory cereal fortification programmes around the world.

d. In the case of Bangladesh, there are two different end users. First, the beneficiaries in the Government's social safety net programmes and second, the consumers in the open market which include the RMG workers and the rural and urban consumers.

e. The key stakeholders and institutions at the Government level as well as donor offices in the country. (Donors are considered to be stakeholders as they are an integral part of the programme)

IV. Findings and Analysis

The following Cost Analysis is based on both desk research and KII conducted in Bangladesh with different key stakeholders in the Government, private sector partners and strategic partners.

1.3. Rice Transformation from Paddy to Rice Market

The following table provides the costs of rice from the farm to the table excluding the cost of fortification:

Table 1: Cost of rice in Bangladesh

Component	Cost per MT (BDT)	Cost per MT (USD)	Component[1] cost - Average cost basis	Source of information
Paddy Rice[2]	24,000 - 26,000	289 - 313	50%	*USDA GAIN report Aug 2018, Govt. of Bangladesh, Jan 2019
Milled rice, coarse FOB* mill[3]	36,000 – 39,000	433 – 470	75%	WFP Bangladesh

1 *USDA GAIN = Global Agriculture Information Network
2 Based on Milled rice market price
3 The typical conversion rate (extraction rate) from paddy rice to coarse rice is 68.0%. This conversion rate takes into account the parboiling step that many rice mills follow. Source: Technology of Cereals, 3rd Edition, N.L Kent; Rice

Component	Cost per MT (BDT)	Cost per MT (USD)	Component[1] cost - Average cost basis	Source of information
Milled rice, coarse market	45,000 – 55,000	542 – 662	100%	Shop and market visits
Transportation costs	500 – 1500	6 – 18	2.0%	DSM, WFP Bangladesh

** Freight on Board*

1.4. Milling Margins

Findings show that milling margins are an issue for millers. Milling margins and profitability for all cereal millers is a sensitive issue. However, using the cost information that the millers provided, the Gross Margin can be estimated based on the paddy rice price and the milled rice (coarse) FOB mill. The typical conversion **gross margin from paddy to milled rice is about 33%.**

1.5. Trading Margins

As with the millers, the traders' margins are a sensitive issue. Based on the same table above, the typical Gross Margin from the Mill gate (selling price at the mill) to Market price is about 25%.

The following chart based on the table above, illustrates the transformation from paddy rice to milled rice at the market:

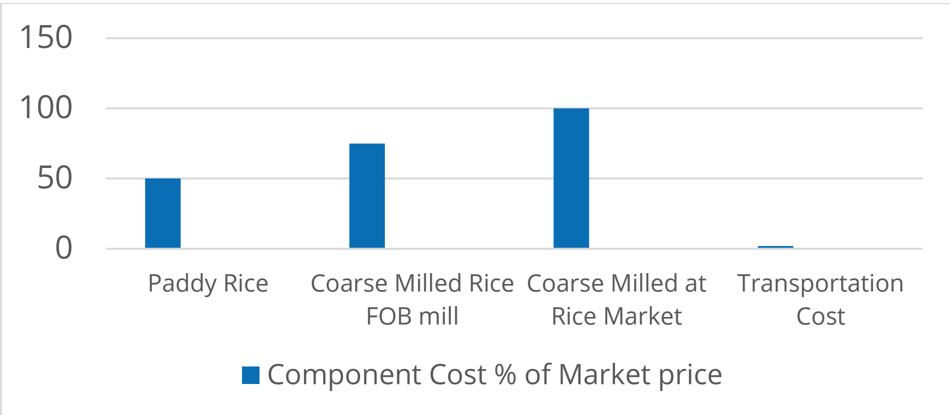

Figure 3: Cost component from Paddy rice price to Milled Rice Market price as expressed as a percentage

1.6. Cost of Fortification at the Mill

The cost of fortification of rice at the mill using fortified rice kernels (FRK) is based upon the following factors: the capital investment cost, the added ingredient cost (fortified rice kernels) and the operational cost associated with the production of milled rice.

Knowledge Bank: International Rice Research Institute; http://www.knowledgebank.irri.org/step-by-step-production/postharvest/milling

1.7. Capital Cost

Equipment and installation including set-up. In the case of rice fortification at the mill level in Bangladesh the equipment consists of:

1. A rice storage bin or storage area for rice in bags
2. A holding bin for rice with adjustable slides for the fortification step
3. A premix kernel storage area for the FRK
4. A holding bin for the FRK with adjustable slides
5. A sloped delivery conveyor beneath the holding bins containing the rice and the FRK.
6. A bucket elevator to convey the fortified rice
7. A blender to mix the rice
8. A packing machine to pack the rice
9. A bag sewing machine
10. Weigh scale to weigh the bags
11. Storage area for fortified rice finished product

Based upon KII and information supplied by partners during field visits, the estimated capital cost for the equipment of rice fortification is in the order of $12,000 - $15,000 (BDT 996,000 – BDT 1,245,000). This price does not include the provision of added building structures to house the processing and packaging line.

Typically, the depreciation period for cereal mill equipment, including rice mill equipment and feeders, is 10 years. However, the actual operational life span of the equipment is considerably longer.

1.8. Operational Costs

The operational costs are made up of the operation of equipment to produce the fortified rice through the controlled addition of the fortified rice kernels (FRK) with the rice, followed by blending and packing of the fortified rice. The operational costs will be based on the following steps:

The supply of rice	**Labour costs for the operators**
The supply of FRK	**Salary costs for supervisors and managers**
The packet for fortified rice	**Management and administrative costs**

Storage costs	**Energy costs – electricity etc.**
Packing costs	**Transportation costs for raw materials**
Financing costs	

Example: Fortified Rice Blending and Packing for Social Safety Net Programmes – WFP programme.

An example of summary table of operational costs to produce fortified rice for Social Safety Net Programmes has been provided below. It is on based information supplied by WFP Bangladesh who provide contracts for fortified rice for the Social Safety Net Programmes in the country.

It is important to note that these costs do not consider the actual costs (value) of the rice to be fortified. This example is for the transfer of rice to be fortified and repacked for distribution.

The figures below are estimated based on approximately 87.87 MT of rice to be fortified per month:

Table 2: Fortified Rice Blending and Packing Cost for Social Safety Net Programmes

	Cost Summary	Monthly Cost BDT	Monthly Cost[4] USD	Percentage (%)
A	**Cost of transportation** Inbound and out bound based on 87.87 MT rice per month @ BDT 795 per MT	139,666	1,683	51.5
B	**Storage packing and marking: rice** based on 87.87 MT per month @ 242 BDT per MT, insurance	40,919	493	15.1
C	**Direct processing: labour, energy and Equipment maintenance**	53,495	644	19.7
D	**Indirect Processing costs:** Management, admin, bank charges, miscellaneous cost	37,000	446	13.7
	Total	271,080	3,266	100
	Total per MT per month	***3,085***	***37.17***	

In this case, 66.6 percent of the total cost for blending (fortification step) and packing fortified rice is made up of the costs of transportation (based on typical average distances from the supplier to the mill), storage, packing and marking. There will be differences between mills located closer to main centre and those further away. The locations further away will have high costs due to higher transport costs.

Based on the price FOB rice mill (at the time of the mission) for coarse rice at BDT 36,000 – BDT 39,000 per metric ton (MT), the incremental cost of the whole fortification process (BDT 3,085 per MT) based on the table above, is 7.9 percent - 8.5percent.

[4] Exchange rate used: $1.00 = 83 BDT; Sources: WFP Bangladesh

The price of coarse rice quoted above corresponds to the price in the commercial market price for rice of comparable grades of rice

This price corresponds to the market price of similar grade rice provided in the social protection programme. This is based on information from the informant stakeholder interviews during the mission. Since the price of rice can vary during the harvest year, the percentage incremental cost may vary as well.

1.9. Fortified Kernel Production Costs

During the mission, information was collected on the components and ingredients that are used to manufacture the fortified kernel product. The following components and ingredients are used for the fortified rice kernel:

- Materials: Broken rice kernels and vitamin mineral premix
- Process costs: Equipment, capital depreciation, labour, management, energy
- Packaging: 3 ply 25 kg multiwall paper bags
- Distribution: Transport and storage
- Other costs: Indirect costs, insurance, banking charges

The following table illustrates the breakdown of the various cost components for FRK (premix)[5]:

Table 3: FRK Production Cost

Component	BDT per kg	Percentage (%) of cost
Raw Materials Vitamin-mineral premix 4.5% Broken kernels. 95.5%	118	58.4%
Processing Costs Equipment depreciation Processing Energy, Labour and Supervision	51	25.2%
Packaging 3 ply bag 25 kg (80-90 BDT)	4	2.0%
Transportation, distribution and storage	15	7.4%
Other costs, fees, banking charges etc.	14	7.0%
Total	***202***	***100%***

[5] Sources: WFP Bangladesh, FFI, DSM, Abdul Monem Ltd. (Igloo), Masafi Agro Food Ltd.

It is important to note that the raw materials and processing costs make up 83.6 percent of the total cost for manufacturing FRK. In addition, the costs provided for micronutrient premix includes duties.

Therefore, the greatest potential reduction in the FRK price lies in the formulation and processing of the FRK.

However, it is critical that any changes to the micronutrient levels and composition of the premix need to consider the micronutrient deficiencies of the target population groups that have access to the support programmes operated by both WFP Bangladesh and the Government of Bangladesh.

1.10. Fortification Process: Blending Costs

In the wheat and maize milling, the process and equipment design allow for the fortification step to take place as the flour is being milled. Since the flours and premix are two powders, the blending system is part of the milling process itself. In case of wheat and maize milling, the only additional equipment required is a feeder that is set up on top of the flour streams collection conveyor.

Currently, rice the blending system is a post milling blending system. In other words, additional blending equipment is required to fortify the rice with the FRK. This requires an additional mixer device and blending step.

The following table shows the breakdown of the fortification process blending costs of adding the FRK to the milled rice.

Table 4: Fortification Process Blending Cost

Component	Cost BDT per kg of fortified rice	Percentage
Rice and FRK		
FRK	2	5%
Milled rice	32	87%
Total Rice	34	92%
Processing (blending)	0.8	2%
Transportation	1.4	4%
In and out		
Warehousing	0.9	2%
Total	37	100%

Since the blending ratio of FRK to milled rice is 1 percent of the total blend, the main influence on the blending cost will be the cost of the milled rice before blending.

The following chart shows Fortification Process Blending Cost at the rice mill:

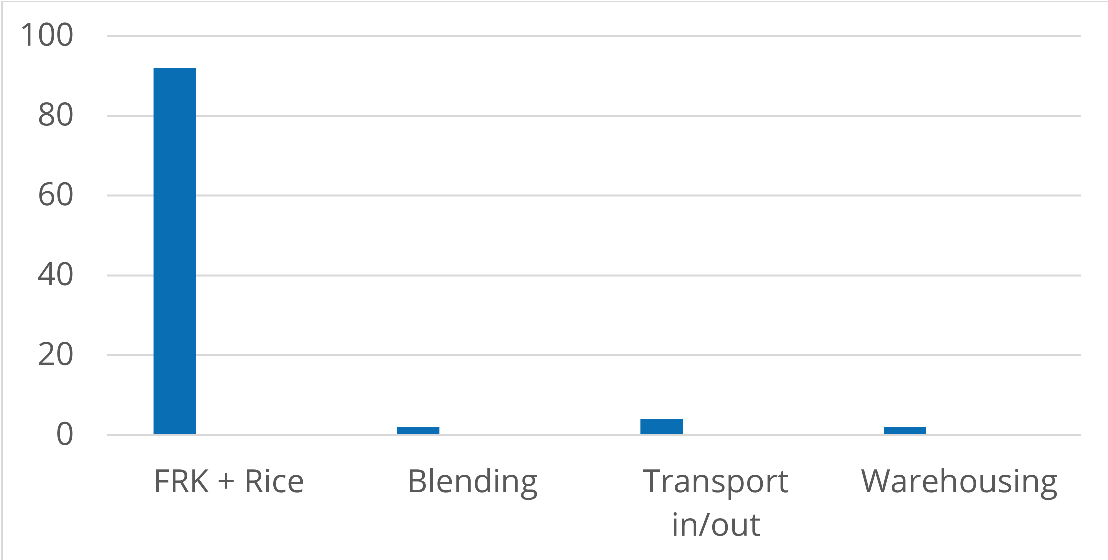

Figure 4: Fortification Blending - Component Cost as Percentage of Total Rice Cost

1.11. Fortification Costs and Influence on Premix Cost

During an initial meeting at the start of the mission WFP Bangladesh and key development partners including GAIN, NI, it was proposed that an additional activity should be carried out. The activity was an assessment of the ingredient (vitamin and mineral) costs would need to be carried out using different fortification levels and different compositions of the premix powder. The rationale for this was to determine if the fortification cost could be reduced by adjustments to the micronutrient levels and or the elimination of one or more of the vitamins in the premix.

The first step that was taken was to look at the current micronutrient component cost of the powder premix. The purpose was to determine which micronutrients had the highest cost.

The following tables shows the share of the total nutrient cost of the premix.

1.12. Current Premix

Table 5: Cost share of the total nutrient cost of current premix

Micronutrient	Fortification level Of active ingredient ppm	Share of total nutrient cost %
Thiamine	4	3
Folic Acid as folacin	1.3	2
Vitamin B12	0.01	2
Iron as ferric pyrophosphate	60	26
Zinc	40	21
Vitamin A	1.5	33
Excipient carrier, starch		13

The table above are based on the typical costs of the individual micronutrient costs that were provided by the vitamin and mineral suppliers and manufacturers and the active ingredient fortification level as found in the middle column. In other words, these are based ingredient costs that a powder premix manufacturer would have to pay to produce the blend. The blend would be then used in the manufacture of the FRK. The table above indicates (highlighted in yellow) that the three micronutrients with the highest cost as a percentage share of the total nutrient cost are vitamin A at 33 percent, iron as Ferric Pyrophosphate at 26 percent and Zinc Oxide at 21percent in descending order. It is important to note that the price of the vitamins and minerals used in the premix are subject to the global demand for them. Variation of the prices will occur which may affect the price of the premix used for making FRK

1.13. Modified Premix

The following table shows the share of the total nutrient cost of the premix without vitamin A.

Table 6: Cost share of the total nutrient cost of premix without vitamin A

Micronutrient	Fortification level Of active ingredient ppm	Share of total nutrient cost in percentage (%)
Thiamine	4	5
Folic Acid as folacin	1.3	3
Vitamin B12	0.01	3
Iron as ferric pyrophosphate	60	**38**
Zinc	40	**31**
Vitamin A	0	0
Excipient carrier, starch		20

The table above indicates (highlighted in yellow) that the two micronutrients with the highest cost as a percentage share of the total nutrient cost are Ferric Pyrophosphate at 38 percent and Zinc Oxide at 31 percent.

The following chart shows the share of cost of each micronutrient nutrient and compares the share of cost between the **current premix** and **a premix with no vitamin A**.

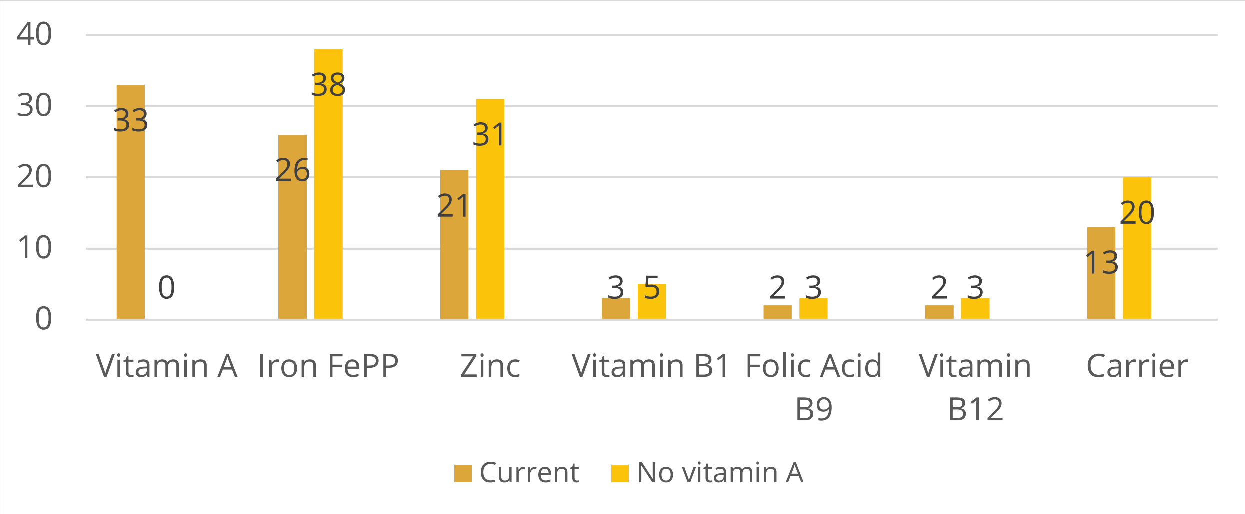

Figure 5: Micronutrient Cost as Percent of Current Premix: Current versus No vitamin A

1.14. Comparative Cost of Fortification of Rice (Vitamin A and No-vitamin A)

The following table shows the comparative cost of fortification using premixes with and without vitamin A.

It should be noted that these cost comparisons are based only upon the cost of the micronutrients and do not include any changes in the other factors involved in the manufacture of the fortified kernels used in the fortification of rice.

Typically, the cost of the micronutrients (ingredient cost) used to make the premix powder is about 80 percent. Therefore, the biggest influence on the cost of premix is the composition and content of the micronutrients used. The micronutrient cost component for rice fortification is similar to the ingredient cost component for wheat and maize flour fortification.

All the costs used in the table above and below have been based on typical prices that both vitamin suppliers and micronutrient powder blenders have provided.

They have all advised that the biggest influence on the price of the individual micronutrients is based upon the demand cycle of animal feed manufacturers at the global level. This is due to the significant differences of the demand volumes for micronutrients between the animal feed market and human nutrition

Table 7: Comparative Cost of Fortification of Rice (Vitamin A and No-vitamin A)

Rice Premix (Powder blend)	Cost per kg BDT	Cost per kg	Premix cost per MT	
		USD	USD	BDT
With vitamin A	1050	$11.61	$4.64	385
Without vitamin A	575	$6.93	$2.77	230

It must be noted that the additional fortification cost (including all the other costs associated with the fortification process) is in the range of BDT 3,000 – BDT 4,000 ($36.14 - $48.19) per MT. This is due to the other factors and cost components listed above.

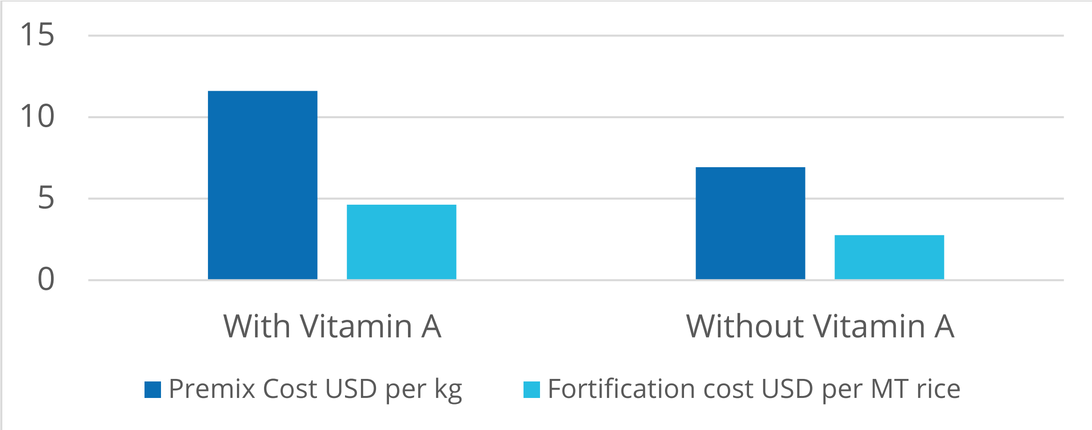

Figure 6: Comparison of premix cost with and without vitamin A in USD

The removal of vitamin A will result in a cost saving on the premix.

Removing vitamin A from the current premix will only provide a small cost reduction in the cost of the fortified rice.

The reduction in the cost based on the table above is estimated at BDT 155 per MT or BDT 0.155 per kg of fortified rice.

This represents a 40 percent reduction in the premix component. Based on the current cost of fortified rice, the cost saving of only BDT 0.155 per kg rice is less than 0.5 percent of the typical cost of the fortified rice.

However, it must be noted that there are other factors that must be taken into consideration.

These include:

1. The consumption of fortifiable foods by all levels of the population in the country. It was noted that vegetable oil is not widely consumed by those who currently benefit from the social support programmes and food distribution of rice. This means that the distribution of fortified rice in the country is the most effective fortified food vehicle and will have a positive impact on the public health status of the population with respect to vitamin A and iron.

2. In many countries vegetable oil is fortified with vitamin A and D on a mandatory basis. It is included in some subsidized food baskets.

The following table shows the information on the incremental costs of rice fortification:

Table 8: Incremental costs of rice fortification

Country	Incremental cost of fortification
Bangladesh	6.3 %
Costa Rica+	1.0%
India	5.6%
Mali	30%

Source of information:
+Rice Fortification in Costa Rica Case study, Roks et al; Judith Smit, DSM Switzerland; Luis Tacsan, Ministry of Health Costa Rica and Cecilia Fabrizio, Judith Smit World Food Programme Regional Bureau for Asia:

It is important to note that the incremental cost of rice fortification in India is only slightly lower than Bangladesh. Some of the recommended ways forward are:

- Any decision to change the composition standard for the FRK must be made by the key stakeholders and ministries within the Government of Bangladesh.
- WFP Bangladesh should provide any technical assistance upon request from the Government of Bangladesh and other national stakeholders.

1.15. Comparison of Findings with Other Countries Fortifying Rice

A number of other countries have fortified rice standards including Costa Rica, Nicaragua, Panama, Peru, Philippines, Solomon Islands, Sri Lanka, USA.

Costa Rica has mandatory fortification of rice. However, Nicaragua and Panama do not enforce the standard. Peru and Sri Lanka have developed standards. (Source: DSM)

- Consultation with WFP India offices to compare experiences in the costing models for rice fortification.

- Consultation with WFP India offices to determine if the incremental cost of rice fortification will be a barrier to the introduction of fortified rice in both the commercial markets and the food assistance programmes in the country.

Costa Rica

Based on discussions with Judith Smit DSM, and a review of the Roks paper, it was determined that there are two main reasons why the premix cost of fortification in Costa Rica is lower than in Bangladesh. The first is the addition rate is only 0.5 percent (5kg per MT of rice) and secondly, the premix does not contain iron nor vitamin A.

The second reason is that Costa Rican Government has strict price controls on both the wholesale and retail price for rice as well as mandatory fortification of rice and other staples. This has resulted in the cost of the fortification has been built into the pricing mechanism already.

The third reason is that Costa Rica has had mandatory food fortification for a number of years. The incremental cost of fortification has declined in Costa Rica from an initial level of 5 percent down to 0.9 percent.

Costa Rica has also vitamin A fortification in the following staple foods: sugar and milk. Mandatory iron fortification applies to wheat flour, maize flour and milk in the country.

In effect, Costa Rica is using other staple foods as the vehicles for both vitamin A and iron.

As discussed previously, both vitamin A and iron are the two most costly micronutrients in the premix for rice fortification in Bangladesh.

It is important to note that mandatory staple food fortification in North America has already built in the cost of the fortification of those staple foods. In some cases, such as wheat flour these costs were built in decades ago.

1.16. Other Findings

The following other points and issues have been added to the report on the basis that they will have potential impacts on the costing model for rice fortification in the commercial market and the public support programmes.

1.16.1. Economies of Scale

Studies on the implementation phases of national staple food fortification programmes have shown that the costs at the initiation and start-up phase are always high. As the case in Costa Rica shows, over time these costs do decrease as economies of scale with respect to premix costs, equipment and installation begin to come into effect. It is expected that the same will apply to Bangladesh for rice fortification. At this stage of the programme, it is difficult to determine what cost reductions might be achieved in terms of costs related to the value chain: raw materials (micronutrients, premix, FRKs), equipment, quality assurance and compliance, etc.

Recommendation
Provide support to the Government of Bangladesh by designing and establishing a cost monitoring system that can be based on the initial social safety net system that is being implemented.

1.16.2. Import Duties and Taxes

Import duties and taxes play a significant role on the landed price of the micronutrients and FRKs imported from India and elsewhere. One company reported that was charged a 99 percent tariff on premix due to a mistake in assigning the HS codes to the products.

In many countries around the world, where food fortification has started, many governments have removed the duty on premixes, vitamins and minerals used for fortification. The rationale for this is that fortification of staple foods is considered as a preventive health measure and the premixes, vitamins and minerals are rated zero duty in the same way that medicines and medical equipment are.

Recommendation
Advocacy and lobbying with the Government to eliminate duty on premixes, vitamins, minerals and FRKs.

1.16.3. Shelf Life of FRKs

The current shelf life of the FRKs is 12 months. With the current system of orders for fortified rice from the Government of Bangladesh the lead times and order patterns are not consistent, see 5.4 below. This may likely result in rice being fortified with FRKs whose shelf life may be past due in fortified rice within the national distribution system.

1.16.4. Inconsistent Order Patterns from Government of Bangladesh

During the visit to one of the FRK suppliers, they advised that they have produced 165 MT of FRK for the Government of Bangladesh safety net programme. The 165 MT order was placed by the Government of Bangladesh. However, the Government has only drawn down 20MT in the space of 2 months. Based on this current usage (10MT per month) rate the remaining 145 MT of FRK will take 14.5 months to use. This means that some of the premix will have passed the Best Use By date if the drawdown rate is not increased significantly. Since the shelf life of the premix is only 12 months, it is critical that government needs to start drawing down the stock.

Recommendation
Provide logistics assistance to the Government of Bangladesh to accelerate the drawdown of the FRK so that the lot is used before the Best Use By date. Provide logistics assistance to the Government of Bangladesh to establish a logistics system for the timely provision of FRK to the rice mills.

1.16.5. Chemical Analysis of FRK

Currently, there is a long lead time and high cost for the quantitative test for FRKs to determine the levels of added micronutrients. This is due in part to the lack of national laboratory capacity with suppliers having to send samples out of the country to India for testing. During the mission, it was noted that local capacity is being proposed to allow for testing to take place in country. The expected date of implementation was not clear at the time of the mission.

Chemical analysis of FRK is just one of a number of activities that needs to be carried out to ensure the consistent manufacture of FRKs in Bangladesh. It is important that the FRK manufacturing should be carried out following the internationally accepted standards for food safety. This means that manufacturing facilities should be following and implementing internationally accepted food safety and quality systems such as Hazard Analysis and Critical Control, HACCP. The use of post-production quality testing is insufficient to ensure the consistency and safety of the FRK production process.

Recommendations
An action plan and budget need to be developed for the development of national laboratory capacity to provide chemical analysis of premix, FRK and fortified rice. This includes the allocation of resources to develop laboratory capacity and training to analyse fortified rice for micronutrient levels, vitamin A, iron and zinc. Provide the technical resources to assist the FRK manufacturers to implement Hazard Analysis Critical Control Points (HACCP) food safety systems. The Food Technologists in WFP HQ and Regional Bureau for Asia and the Pacific should be engaged to assist and guide FRK manufacturers to develop and implement HACCP plans. In addition, additional financial resources will be needed to help the FRK manufacturers to meet the internationally recognized standards for HACCP in the future and to provide additional technical capacity to meet HACCP standards.

1.16.6. Fortification Process: Validation, Process Control and Quality Control

In any food processing manufacturing systems, the development and use of HACCP systems is becoming mandatory in many countries. This means that the ultimate goal for the fortification of rice in Bangladesh will be the implementation of HACCP systems as a minimum.

WFP Bangladesh staff advised that a system has been set in place to validate the FRK addition at the blending operations. An example of a validation analysis sheet was provided. Process validation is an important step in the process.

Until the milling industry is in a position to implement HACCP systems in their mills the use of the process validation step will help to assess the capacity of the fortification system at the mill level is consistent.

However, it should be noted that at the beginning of the fortification implementation, process validations usually require 3 separate validation runs. It was not clear if three successive validation were being carried out at the blending step when the validation was carried out.

Recommendation
Future blending validations should be made up of three separate runs.

In other fortification processes such as wheat and maize flour, the mills include a check weighing step as part of the process control and Quality Control (QC) system. This is usually carried out during the production. Typically, this test is carried out every 2 to 3 hours of production.

The method used is the collection weighing of the FRK over 1 or 2 minutes as the FRK is discharged from the hopper above the rice stream. This system has been shown to provide good information on the degree of consistency in the fortification process.

Recommendation
The design of the continuous blending system should allow for check weighing of both the rice and the FRK. The technical and financial resources should be allocated and provided by the Government of Bangladesh to the mills so that the continuous blending systems at the mill can be controlled effectively to provide consistently fortified rice Provide technical and logistical assistance to ensure the consistency of the fortification process. This can be provided through the development of Standard Operating Procedures for rice fortification at the rice mill, the validation of the fortification step for blending consistency and Quality Assurance and Quality Control. The goal needs to be the adoption of Food Safety Management systems which includes GMPs and HACCP.

1.16.7. Rapid Iron Spot Test for Rice

The wheat and maize milling industry use a rapid iron spot test to demonstrate the presence of iron from the micronutrient premix is present in the flour. The Food Fortification Initiative, FFI, sponsored a study at Kansas State University by Dr Jeff Gwirtz to determine if the rapid iron spot test can be used on fortified rice kernels. The study showed that the same test can be applied to detect FRK in fortified rice.

The test has two features which can provide information on the fortification step, as follows:

1. The test demonstrates that it can be used as a detection tool to determine if the rice is fortified using FRK.
2. Because the test highlights the colour of the individual FRKs in the rice, it can provide information on how well the blending process disperses the FRK in the fortified rice.

Recommendation
That the use of the Iron Spot Test be considered for use as a QC tool at the blending stage and for regulatory personnel to determine if the rice is being fortified. That the Government of Bangladesh allocate resources and training to provide regulatory personnel with the tools such as the Iron Spot Test Kit to carry food control and quality

assurance on fortified rice in both the commercial rice market and the rice supplied through the social protection programme,

Provide technical support for the training and implementation phase of the food control programme.

Acronyms

BDT	Bangladesh Taka
B2B	Business to Business
DSM	Royal DSM N.V.
FFI	Food Fortification Initiative
FFP	Food Friendly Programme
FRK	Fortified Rice Kernel
GAIN	Global Alliance for Improved Nutrition
HACCP	Hazard Analysis Critical Control Points
IST	Iron Spot Test
KII	Key Informant Interviews
MT	Metric Ton
RMG	Ready Made Garment
SSNP	Social Safety Net Programmes
VGD	Vulnerable Group Development
WFP	World Food Programme

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