Commercialization assessment: Zinc rice in Bangladesh

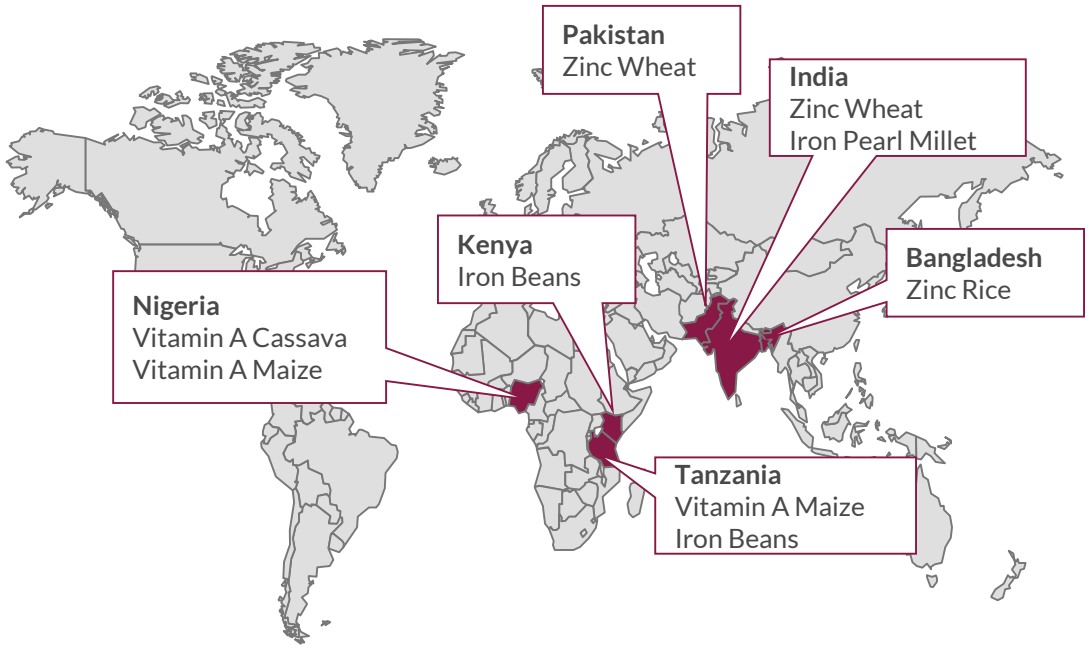
FINAL REPORT FOR GAIN AND HARVESTPLUS

DECEMBER 2019

Recap: Programme context

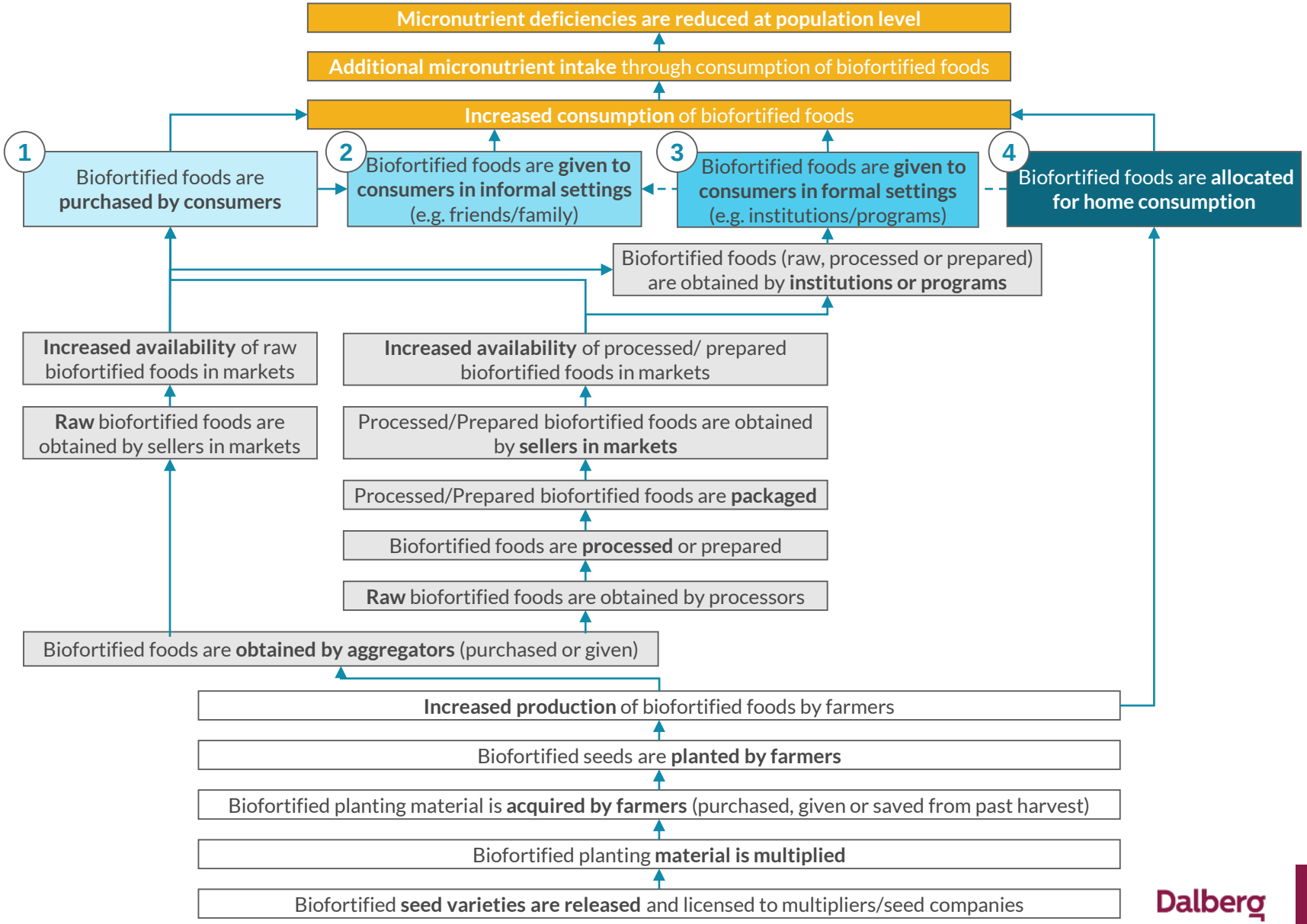
- GAIN and HarvestPlus share an ambition to expand coverage of biofortified nutrient dense foods to at least 200 million consumers. The overall vision of this program is to scale up the commercialization of biofortified foods. Zinc rice in Bangladesh is one of the nine selected crop/country combinations under this programme.

- In parallel to the GAIN and HarvestPlus teams jointly developing country-level strategies for commercialization, Dalberg is conducting assessments of the potential for scale/commercialization of zinc rice in Bangladesh. This is the draft assessment report, based on literature review, interviews with relevant stakeholders, and a small number of focus groups.



- This draft report is designed to fit into the GAIN-HarvestPlus planning processes. As such, it is aligned with the Programme Impact Pathways in two ways
  - The potential routes to scale are codified in terms of the Programme Pathways: 1. Biofortified foods are purchased by consumers, 2. Biofortified foods are given to consumers in informal settings (e.g. friends/family), 3. Biofortified foods are given to consumers in formal settings (e.g. institutions/programs), 4. Biofortified foods are allocated for home consumption
  - The report focuses on barriers to commercialization, rather than being a systematic and comprehensive report of all aspects of the value chain.

Recap: Programme Impact Pathways



What is commercialization?

Commercialization can be thought of in three ways:

1. **An end state.** This would see the programme drive towards an end state which *is* commercial (does not require ongoing subsidy) even if the tools deployed to get there are *not* commercial themselves e.g. provision of grants for value chain actors[1]. Pathway 3, for example, might fall outside of this definition if public procurement was used to purchase and subsidize biofortified crops for the poor.

2. **A set of levers or intervention modalities.** This would include using market-based tools e.g. access to finance, strengthening value chain linkages, etc. as ways to drive scale, even if the biofortified crop itself was *not* sold [but consumed on farm]. This understanding could mean that all four Pathways are 'commercial', as long as the seed is sold to farmers in Pathway 4.

3. **A subset of the programme Impact Pathways.** GAIN's definition, for this programme, is that "Commercialization shall be defined as the process of introducing a new product into commerce or making it available in the market, rather than producing solely for family consumption." This would mean that Pathway 4 is only relevant for its role in production of crops for sale.

The Dalberg assessments do not take a position on which of these is the most appropriate framing for the programme, rather seek to lay out "*If* GAIN and HarvestPlus want to pursue [Pathway 1-4], *then* these are the barriers, and this is what might be required".

Alignment on the understanding of commercialization will potentially have significant impacts for scale that is feasible, programming, and resource allocation across the portfolio, amongst other things. On farm consumption and public procurement are significant parts of the value chains for a number of the crops under consideration.

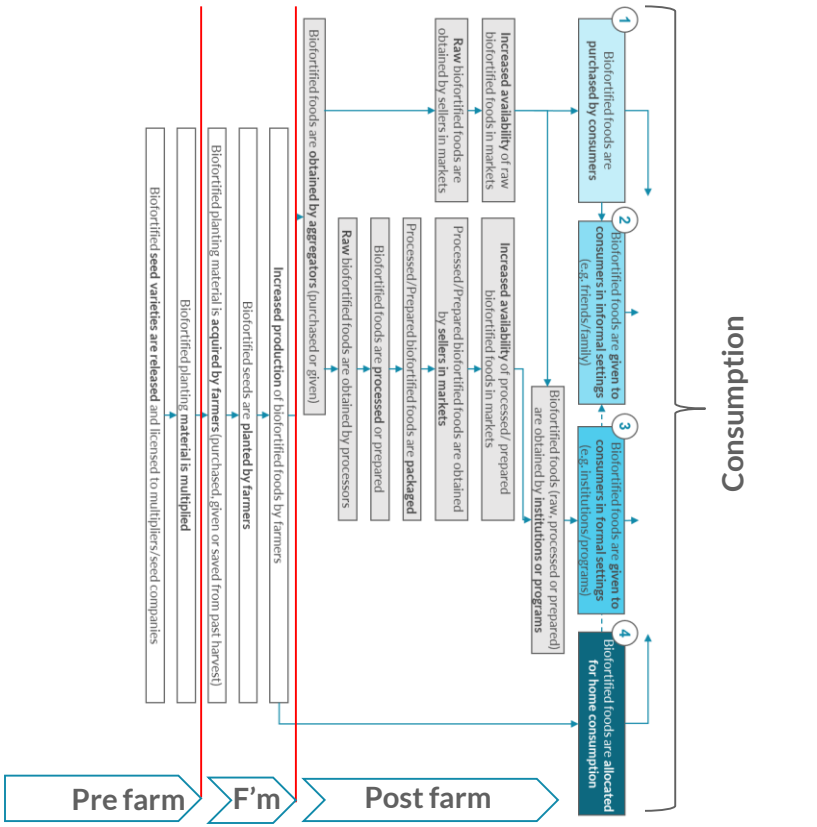
1. With the expectation that after the grant, no further subsidy is needed because the market failure is corrected

Prologue

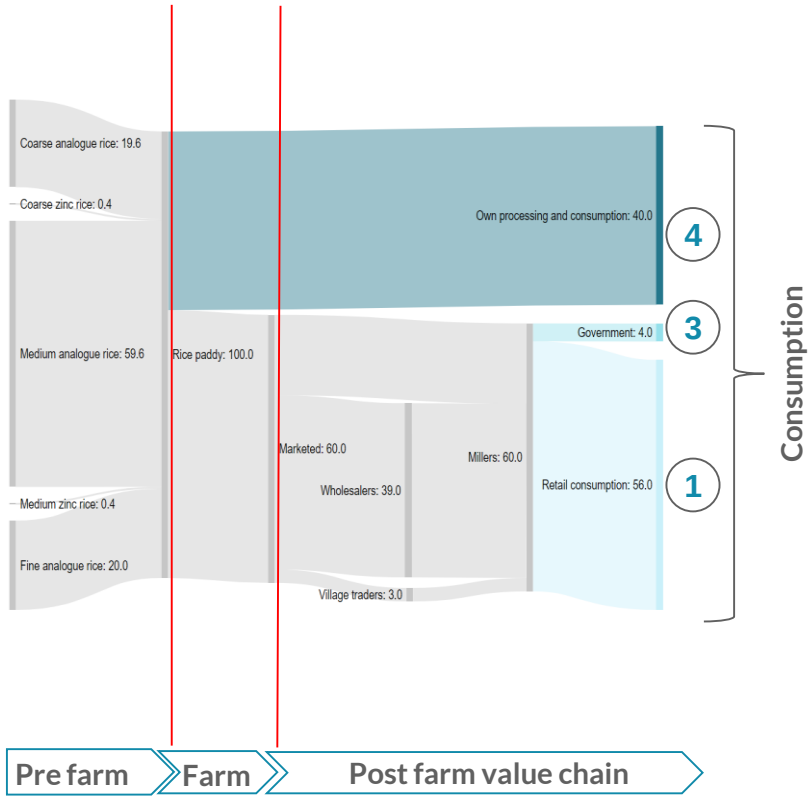
How to read this report (1/2)

This report assesses the potential for commercialization of the crops through the programme Pathways. This page highlights how the pathways correspond to the value chain and key drivers of consumption for zinc rice in Bangladesh,

Conceptual outline of the value chain



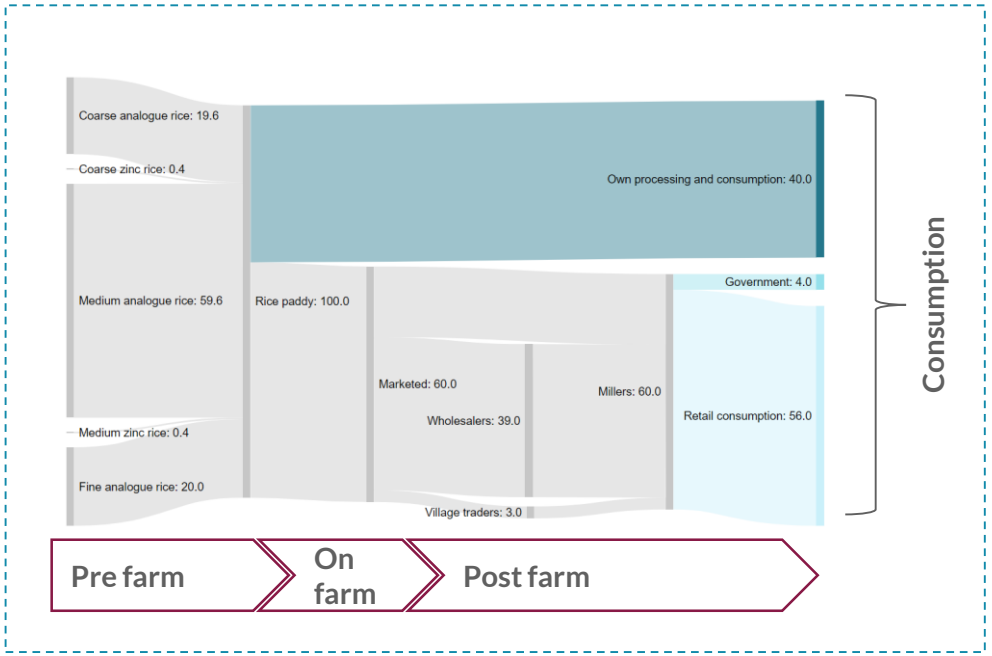
'Sankey diagram' showing relative flows through the value chain



How to read this report (2/2)

- This report is broken down into five sections:
  - Executive summary
  - Pre-farm and on-farm
  - Post-farm
  - Consumption
  - Policy and financing

- The barriers Dalberg identifies at each stage of the value chain should align with and complement the 'Contextual analysis' and 'Barriers' that each team is feeding into the Country Strategy Development template



Slides 15-27	Slides 29-37	Slides 39-46

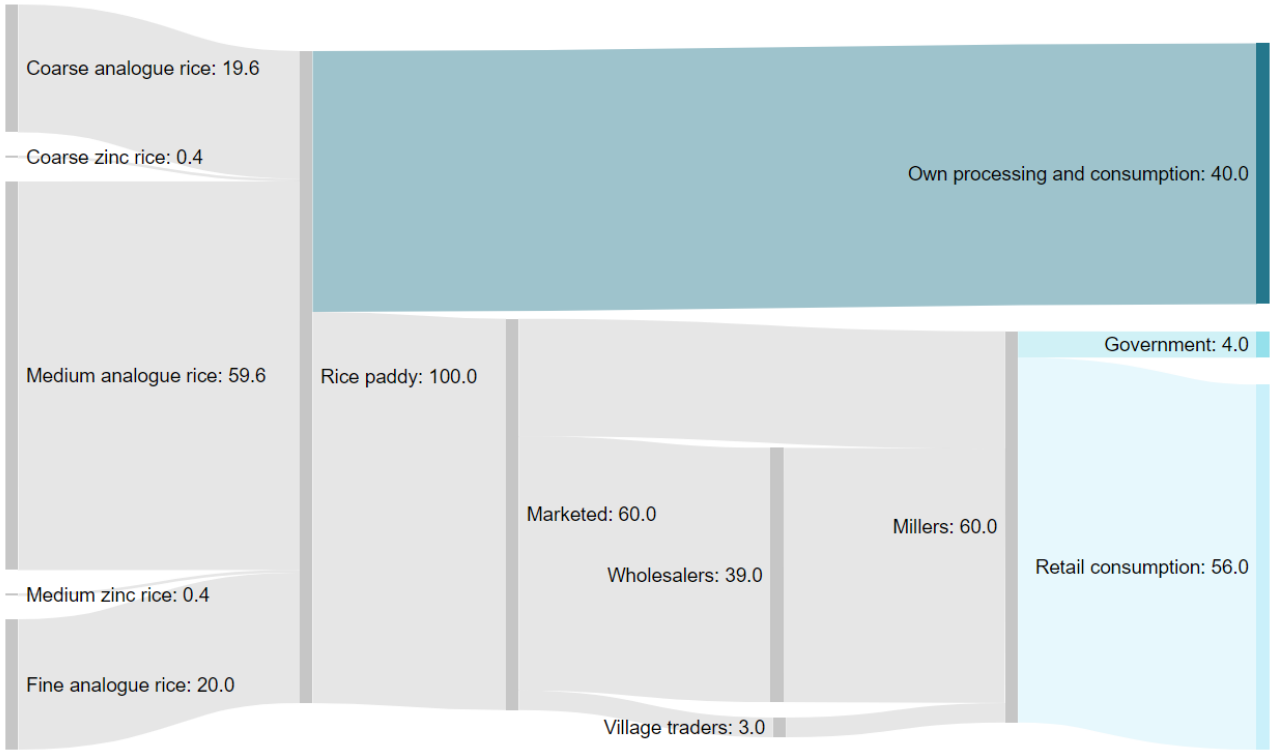
Executive Summary

Current state of the rice value chain in Bangladesh

- The majority of rice produced in Bangladesh (56%) is processed for retail consumption
- A significant minority of production (40%) is consumed on-farm
- Government procurement is a small component of the rice market (4%)

Gifting channels are not traced

Flow mapping of rice value chain in Bangladesh[1,2,3]
In % of overall volume, Boro season



Key consumption pathway in Bangladesh[4]

1. **Allocated for own consumption**
2. **Used in government programs**
3. **Sold for retail consumption**

Pre farm → On farm → Post farm → Consumption

Source: (1) Reardon, et al. "The transformation of rice value chains in Bangladesh and India: Implications for food security," 2012 (2) Technoserve, "HarvestPlus Bangladesh Final Report," 2018. (3) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012 (4) Dalberg analysis

Dalberg

Executive summary: Overview

- **In Bangladesh, an estimated 90.5 million individuals are zinc deficient (~55% of the population). Forty five percent of pre-school-aged children (~3.5 million) and 57% of non-pregnant, non-lactating women (~20 million) are deficient in zinc,** an important micronutrient whose deficiency is associated with diminished immune function, stunting and diarrheal disorder. This population-wide zinc deficiency is one key reason why stunting affects 41% of children in Bangladesh aged under five years (about 6.3 million).[1]

- **Bangladeshis currently get zinc through the meat and dietary supplements they consume, if any. However, either the consumption is very low compared to their needs or unaffordable for the masses.** Those that can afford meat and dietary supplements are at a lower risk of zinc deficiency. The lower-income households primarily consume rice with vegetables/ meat when they can afford it. The rice heavy diet does not typically provide enough zinc for proper nutrition.

- **To drive widespread consumption of zinc, GAIN and HarvestPlus have introduced bio-fortified 'zinc rice'.** Rice is the staple food of Bangladesh, with daily per-capita rice consumption is c. 390 grams for the poorest income quartile and 450 grams for the highest (vs. an average of ~145 grams globally).[2] Given its high degree of consumption, rice is a good vehicle to deliver nutrition interventions at scale. Rice biofortified with zinc ('zinc rice') could help address the critical gap by delivering up to 90% of their daily dietary requirements of zinc naturally (given average rice consumption patterns)[3]

- **While zinc rice is a promising solution, the uptake by farmers is currently very low**. In 2018, only 100,000 farm households were reported to be growing zinc rice, comprising less than 1% of the total rice grown. Only 10% of all zinc rice farmers chose to grow it for a second time, while the other 90% citied dissatisfaction with the agronomic performance of zinc rice varieties*. Key issues cited included coarseness of rice, lower yield compared to analogue varieties and relatively low market price for paddy (vis-à-vis analogue varieties). Of the farmers that did choose to produce zinc rice the second time, 80% did so for consumption by their household, and, in focus groups, cited potential nutritional benefits as the key reason for doing so[3]

- **To assess the path to increasing commercialization and consumption of zinc rice, we analyzed barriers and potential interventions for three demand segments:** (i) on farm consumption (40% of the overall rice market), (ii) government programs and procurement (~4% of the overall rice market) and (iii) retail consumption (56% of the overall rice market)[4]

Note: (*) This survey may not accurately reflect farmer opinion of BRRI-74/84, as the farmers surveyed had most exposure to BRRI-62/64, limited exposure to BRRI-74 and no exposure to BRRI-84
Source: (1) Rahman, et al. "Status of zinc nutrition in Bangladesh: the underlying associations," 2016. (2) World Food Program, "Improving nutrition through rice fortification," 2018 (3) Bashar, et al. "Results from the Bangladesh High Zinc Rice Adoption Study 2018", 2018 (4) Dalberg analysis, see full list of sources on Slide 8

Executive Summary: Barriers to commercialization

Creating demand for zinc rice across the three demand segments would likely require prolonged interventions across the rice value chain aimed at unlocking multiple barriers simultaneously.

BARRIERS	SEGMENTS IMPACTED
• **Zinc rice varieties produced currently are not in-line with consumer preferences, undercutting benefits of increasing awareness.** The most competitive variety of zinc rice (BRRI-74) is a coarse rice, while Bangladeshi consumers strongly prefer to consume fine rice. In head-to-head acceptability trials, consumers preferred existing, market-leading varieties of rice (BRRI-28/29) to BRRI-74.[1]	• On-farm • Government • Retail
• **Low awareness about the value proposition or even the existence of zinc rice**. While there is lack of awareness across the value chain for zinc rice, the lack of awareness among end consumers is the most important barrier because the rice market in Bangladesh is primarily demand-driven. Upstream value chain actors react to perceived consumer demand and preferences rather than attempting to proactively shape them. Because of this challenge, consumers do not demand zinc rice, and millers and aggregators have no incentive to create zinc rice products or pay a premium to farmers for zinc rice. Farmers, in turn, do not have the incentive to produce it.	• On-farm • Government • Retail
• **Currently available varieties of zinc rice seeds are generally not agronomically competitive with market-leading rice varieties, particularly for sale in a price-sensitive market, although newer varieties (BRRI-74/84) have highest commercialization potential.** Current varieties of zinc rice with meaningful uptake (BRRI-62 and BRRI-74) either have lower yield or lower expected revenue for farmers than the most popular varieties of rice (BRRI-28 and BRRI-29). BRRI-62, a fine-grain rice, offers lower yield than market-leading fine-grain varieties like BRRI-28/29 (~4 MT/ha vs. ~6 MT/ha), while BRRI-74 is a coarse-grain rice that retails at a lower price than finer-grain rice like BRRI-28/29 (~15 BDT/kg vs ~20 BDT/kg) but has a comparable yield to leading coarse-grain varieties like BRRI-11 (~7 MT/ha) .While 90% of farmers who try a zinc rice variety do not grow it again*, BRRI-74 has seen growth in forecasted demand for the 2019/2020 and 2020/2021 growing seasons.[2] Additionally, BRRI-84 (a high-yielding fine-grain rice) was also viewed by stakeholders to have high future commercialization potential, although it has not yet been released.	• On-farm • Government • Retail
• **No differentiated post-farm supply chain for zinc rice.** After the farmgate, rice is only separated by grade; farmers who are currently selling zinc rice commercially sell it to aggregators and millers mixed together with rice of similar grade. This reflects the lack of awareness and thus demand by end consumers for zinc rice. Thus, there is currently no channel for millers to source zinc rice or verify that the rice they procure from farms/ farmers is of similar grade and is actually zinc rice. This will become a more significant challenge if consumer or government demand for zinc rice were to increase.	• Government • Retail

Note: (*) This survey may not accurately reflect farmer opinion of BRRI-74/84, as the farmers surveyed had most exposure to BRRI-62/64, limited exposure to BRRI-74 and no exposure to BRRI-84

Source: (1) Taleon, Victor, "Preliminary findings from the Bangladesh zinc rice consumer acceptance study," private correspondence, 2019 (2) Bashar, et al. and HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019

Executive Summary: Potential opportunities (1/2)

Given these barriers, the path to commercialization for zinc rice in Bangladesh is likely quite challenging. We have highlighted potential opportunities for the partnership to pursue for commercialization and increased consumption of zinc rice, the prioritization and investment in which will depend upon the future strategy of GAIN and HarvestPlus in this crop / country combination.

MEDIUM TERM

- **If on-farm consumption is considered within the scope of this program, as a first priority, we recommend that GAIN and HarvestPlus focus on scaling on-farm consumption with a focus on the most agronomically competitive seeds (including new launches).** This intervention has the most likelihood of near term traction because it faces the smallest number of supply-chain challenges and because there is demonstrated interest from repeat growers in producing nutritionally richer zinc rice for on-farm consumption. BRRI-84, a recently-released zinc rice variety, may be the easiest variety to scale given its potentially-competitive agronomic characteristics.

- **GAIN and HarvestPlus could scale on-farm consumption through short-term financial incentives / subsidies, awareness creation and new partnerships for demand-generation to address barriers around awareness and agronomic competitiveness.** Given a high risk-aversion, farmer seed preferences are "sticky" and take several years of trialing to switch their production to a new variety. Thus, to increase uptake, it may be effective to create awareness about zinc rice and offer subsidized seeds to farmers in the short-term. It might be possible to remove the subsidy in the medium-term once farmers have switched to primarily producing zinc rice for own consumption. Given low awareness amongst farmers, any economic subsidy should be coupled with demand generation activities. For example, HarvestPlus and GAIN could forge a deeper partnership with the Department of Agricultural Extension to promote and market zinc rice varieties more widely.

- **Further, partnership with the government to integrate zinc rice into their social-security programs could be an effective method of reaching key populations and developing the supply chain while addressing barriers related to consumer preferences.** While these programs are small as a share of overall demand (<5% of the rice market), they could provide a stable source of demand for zinc rice growers year-over-year, helping create a separate supply chain which can also be utilized when end consumer demand fructifies. A key benefit of government programs is that they reach key demographics such as children and women in low-income households.

Executive Summary: Potential opportunities (2/2)

MEDIUM TERM (CONTINUED)

- **Partnership with a large automatic miller/agroprocessor to develop and promote a packaged zinc rice product could be an effective way to address barriers around access and awareness.** This product would likely have to be marketed at upper-income urban consumers, as they are likely the only segment of consumers with a willingness to pay more for a nutritious rice product (a new packaged zinc rice product will likely have additional costs associated with it, and will retail at a higher price than bulk rice of a similar grade). Although, this would be dependent on a successful branding campaign and ensuring quality of the zinc rice and integrity of the supply chain from farm to fork.

LONG TERM

- **Generation of awareness and influencing consumer rice preferences to build demand and willingness to pay for nutritious zinc rice could address all key barriers, in parallel.** This is a long-term and resource-intensive intervention, but is probably the most important and powerful lever to make the zinc rice value chain sustainable. Increased end-consumer demand and willingness to pay will alter the behavior of supply-chain actors and create systemic demand for zinc rice, raising the market price of zinc rice paddy for farmers and incentivizing millers to segregate supply chains for zinc rice.

- **Develop new varieties of seed which can be more agronomically competitive and match existing consumer preferences.** This is a long-term intervention, one that unlocks one of the most important barriers faced by zinc rice across the rice value chain. All things equal, namely seed traits, price and consumption characteristics, farmers and consumers could be inclined to switch from analogue varieties of rice to zinc rice varieties. Thus, once more competitive varieties of zinc rice are in the market, demand generation efforts can pivot from awareness creation towards establishing zinc rice as a sustainable product.

Pre-farm and On-farm

Farmer preferences for rice seeds vary by their objective of rice production; yield and consumption traits are key drivers

Rice production for own consumption†

Production characteristics
- All farmers reserve a portion of their cultivation area for rice varieties intended for home consumption
- Typically coarse rice varieties, as these have highest yield

Primary traits looked for in rice seed
- Farmer rice consumption preferences (i.e., "consumption traits")
- High yield

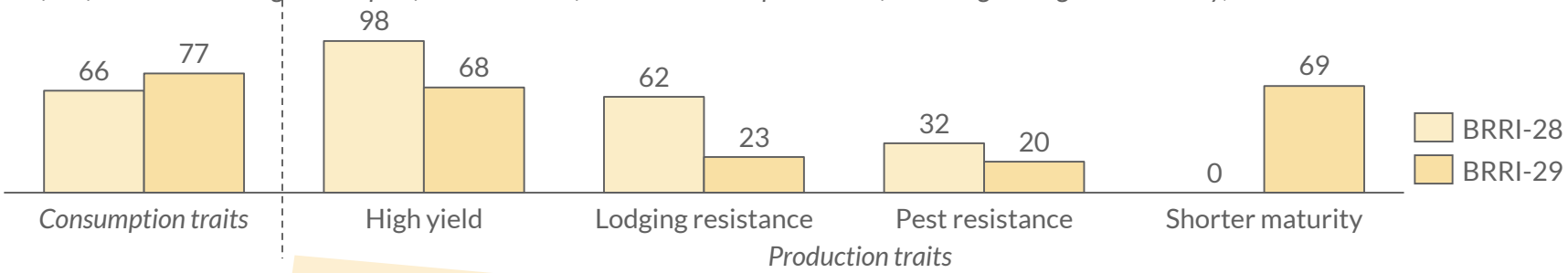
Rice production for sale in market

Production characteristics
- All farmers reserve a portion of their cultivation area for rice varieties intended for sale in the market
- Typically fine rice varieties, as these have highest revenue potential (market price multiplied by expected yield)

Primary traits looked for in rice seed
- High yield
- High market price (as determined by select consumption traits such as grain size)

Farmers consistently rate consumption traits and yield as influential reasons for why they choose to use market-leading rice varieties[2]

% of all farmers indicating that a specific trait was "influential" in their purchase of a leading analogue rice variety, 2005

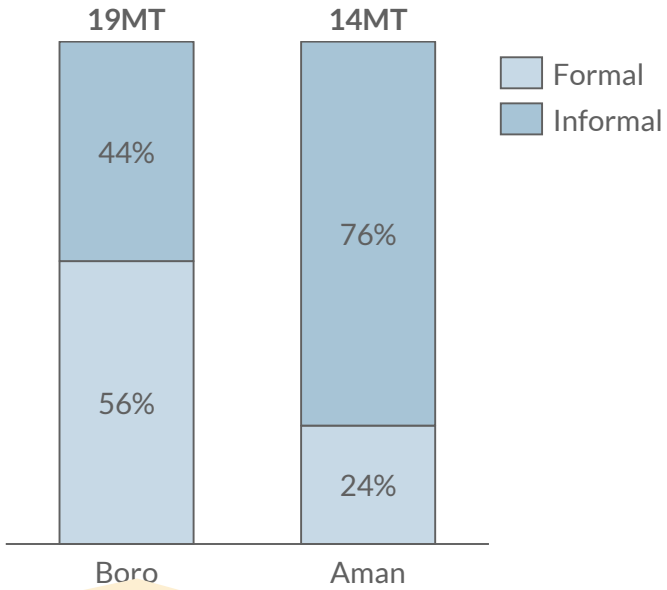


Consumption traits include factors like grain size and shape, taste, cooking time, and aroma. Select consumption traits – primarily grain size and shape – are key determinants of the market price of rice

Note: (*) Government procurement preferences have limited effect on farmer seed purchase decisions and therefore are not discussed in this section. (†) Only relevant if on-farm consumption is considered within the scope of this program.
Source: (1) Bashar, et al. and HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 (2) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012

Seed purchase behavior is also shaped by the season and by local influencers like extension workers and other farmers

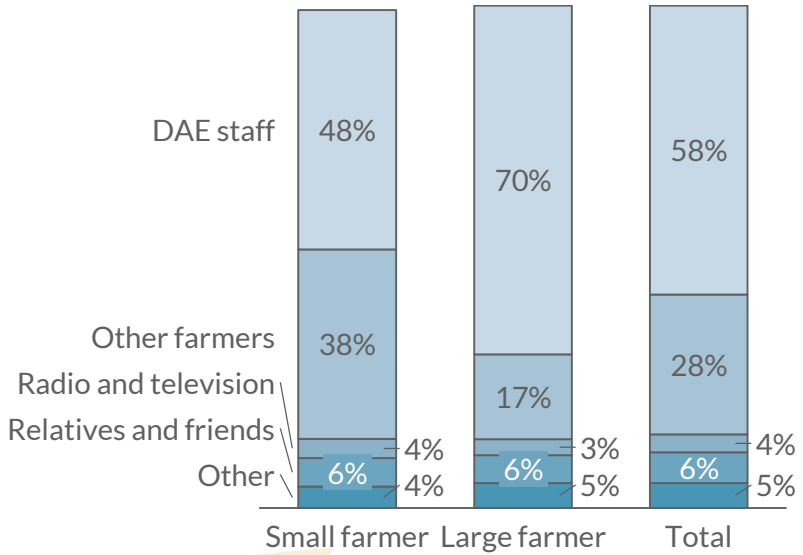
Farmers tend to purchase more seed in Boro season; in Aman season, they tend to reuse own seed[1]
% of rice seed used by source; total rice production in MT



Farmers tend to purchase more seed in Boro season because rice production is higher-yielding during that time, offering higher returns to quality seed for farmers. Accordingly, it is also the primary season for production for market sale

"Almost all the demand for seed is satisfied in the Boro season... farmers tend to reuse own seed in Aman season" – *Dr. Khalequzzaman, BRRI[2]*

For most farmers, agricultural extension workers are key influences on what seeds they buy in a season[1]
Most influential source of seed advice, %, 2005



DAE staff will likely be critical in promoting the adoption and diffusion of new zinc rice varieties. Conventional marketing channels (e.g., radio and television ads) are significantly less influential in shaping farmer seed preferences.

"We need the help of the national extension department to create farmer demand for zinc rice" – *Mr. Biswas, CCDB[3]*

Source: (1) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012 2012 (2) Interview with Dr. Khalequzzaman, 9/15/19. (3) Interview with Shamiran Biswas, 9/15/19

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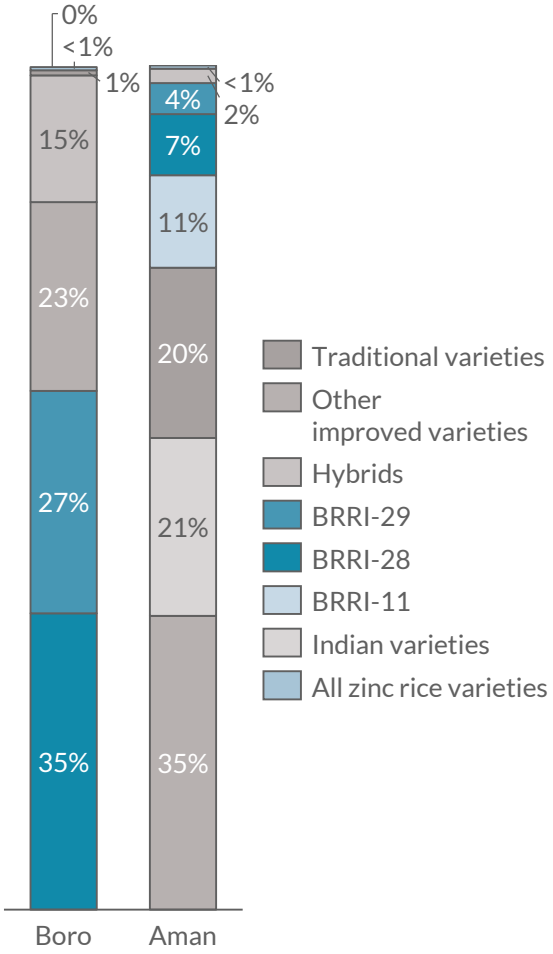
Currently, zinc rice represents <1% of the total seed market share in both Boro and Aman seasons

BRRI-28 and BRRI-29 are market leaders in Boro varieties; zinc rice has <1% market share[1]

Share of seed market by season, %



Only one variety of zinc rice is currently directly comparable to BRRI-28 and BRRI-29, although it has lower yield

	Fine-grain varieties			Coarse-grain varieties		High-potential HZR varieties	
	BRRI-28	BRRI-29	BRRI-62	BRRI-11	BRRI-74	BRRI-84	BINA-20
Biofortified	No	No	Yes	No	Yes	Yes	Yes
Season	Boro	Boro	Aman	Aman	Boro	Boro	Aman
Grain type	Long slender	Long slender	Long slender	Medium bold	Medium bold	Medium slender	Long Slender
Additional zinc (mg/kg)	0	0	6.0	0	6.5	11.6	11.5
Growing Time (Days)	145	145	100	140	146	142	127

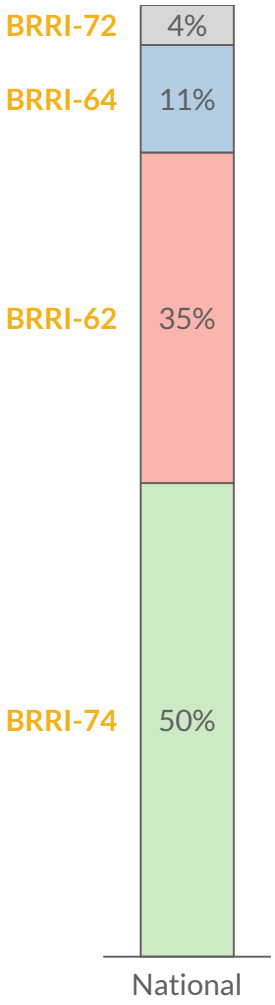
Note: Throughout this deck, zinc rice varieties will be highlighted in gold font in charts and figures

Source: (1) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012 (2) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019.

Of all zinc rice varieties, BRRI-74 is most widely grown; production is concentrated in districts with a preference for coarse rice

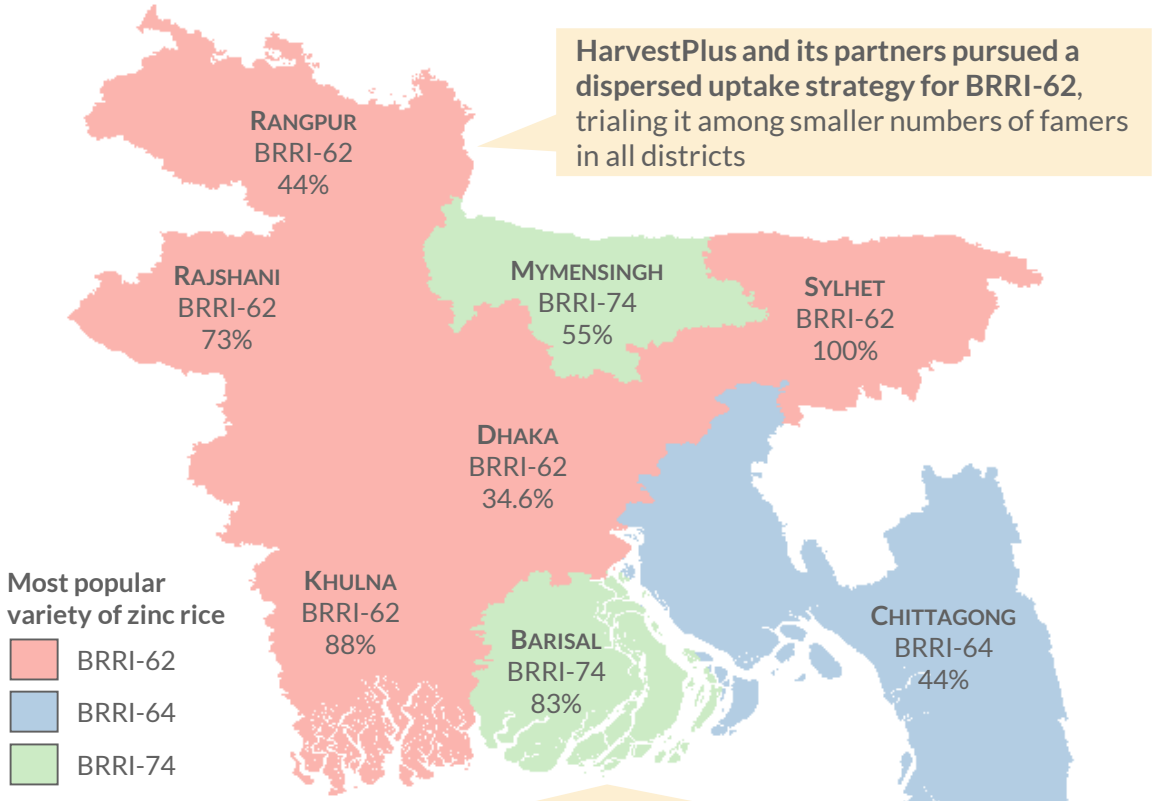
Nationally, BRRI-74 is the most popular variety of zinc rice[1]

% uptake among HZR growers



The uptake of BRRI-74 is concentrated in Barisal, a division that grows coarse rice at a relatively higher rate[1]

% uptake of most popular variety among all zinc rice growers in each district, Boro 2018



HarvestPlus and its partners pursued a dispersed uptake strategy for BRRI-62, trialing it among smaller numbers of famers in all districts

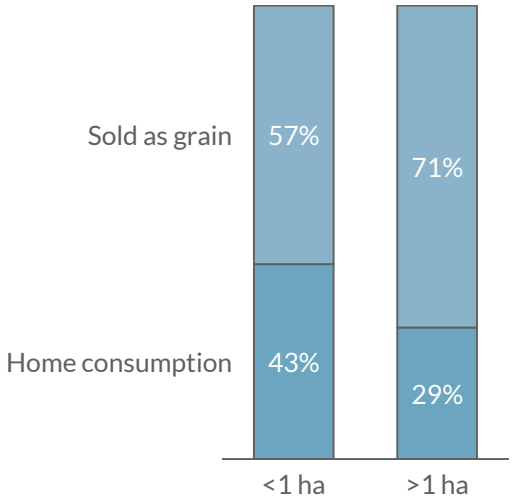
In contrast to BRRI-62, HarvestPlus and its partners **pursued a focused uptake strategy for BRRI-74 in Barisal** with secondary promotion efforts in Rangpur, Chittagong and Mymensingh. Barisal has a relatively higher concentration of coarse rice production.

Source: (1) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019

When zinc rice is grown for a second season, on-farm consumption is the preferred objective…

For farmers of all sizes, the majority of all rice output is marketed rather than saved for own consumption[1]

Uses of rice production by farm size, % of total output, 2009

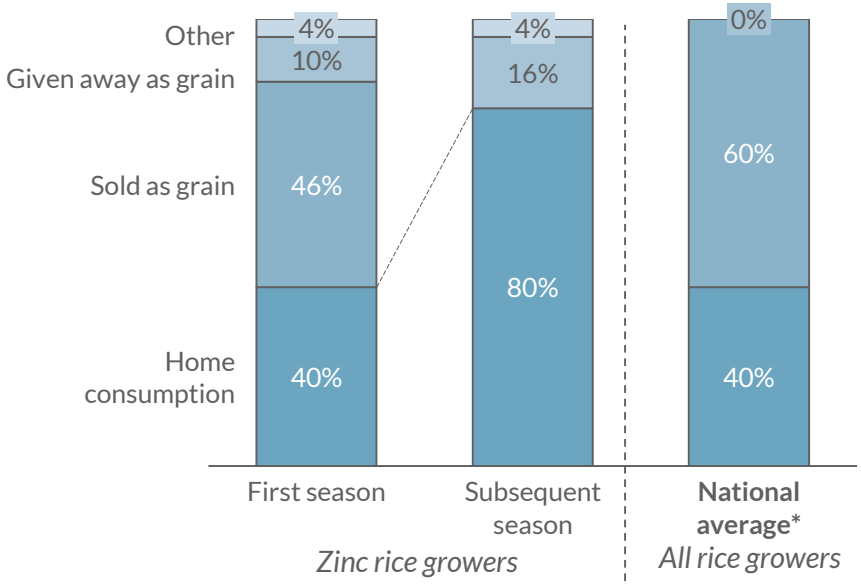


All rice growers

In Bangladesh, **even marginal[4] (<1 ha) farmers are "semi-subsistence"** – in general, they market a significant percentage of their rice output

In contrast, zinc rice growers – particularly repeat growers – use it for their own consumption[2,3]

Uses of rice production, % of total output, Boro 2019



Zinc rice growers *All rice growers*

This pattern of use suggests that farmers test the sale of zinc rice in the market; those that chose to grow it again **preferentially use it for own consumption**

- Zinc rice is grown by farmers (particularly repeat growers) for their own consumption – **FGD results indicate they value the fact that it provides additional nutrition.[5]**
- However, **it is likely that key barriers around agronomic competitiveness will need to be addressed** before farmers will grow zinc rice for market sale.

Source: (1) Reardon, et al. "The quiet revolution in staple food value chains: enter the dragon, the elephant, and the tiger," 2012. (2) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 (3) Technoserve, "HarvestPlus Bangladesh Final Report," 2018. (4) Most rice farmers in Bangladesh (60%) are marginal farmers who cultivate <1 ha of land (5) Focus groups with farmers and millers in Sherpur, Bogra.

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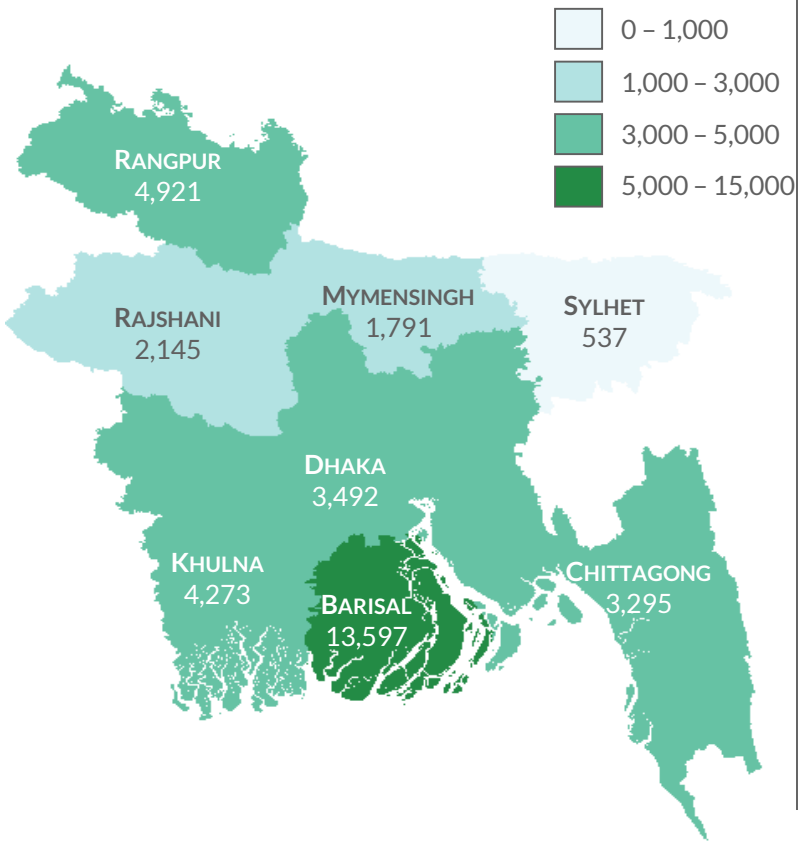
… although a district-wise assessment shows how limited the penetration of zinc rice is across the country

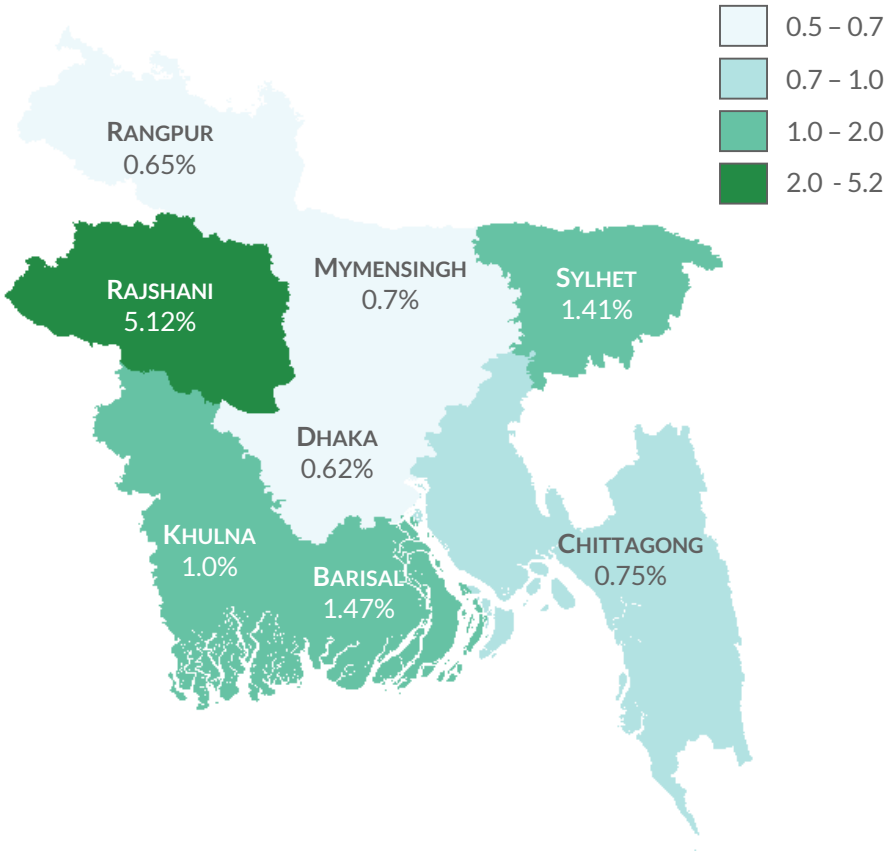
Nearly half of all zinc rice growers are located in Barisal district in southern Bangladesh[1]

Number of households growing zinc rice, Boro 2018



Though higher market penetration has been achieved in Rajshani[1], penetration across districts remains low

% of all farm households growing zinc rice, estimated, Boro 2018



Barisal district is known for its stronger preference for coarse rice, (as evidenced by the uptake of BRRI-74, a coarse-rice variety), and offers ample room for targeted expansion. While initial momentum has been achieved in Barisal, zinc rice penetration remains low.

Source: (1) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019

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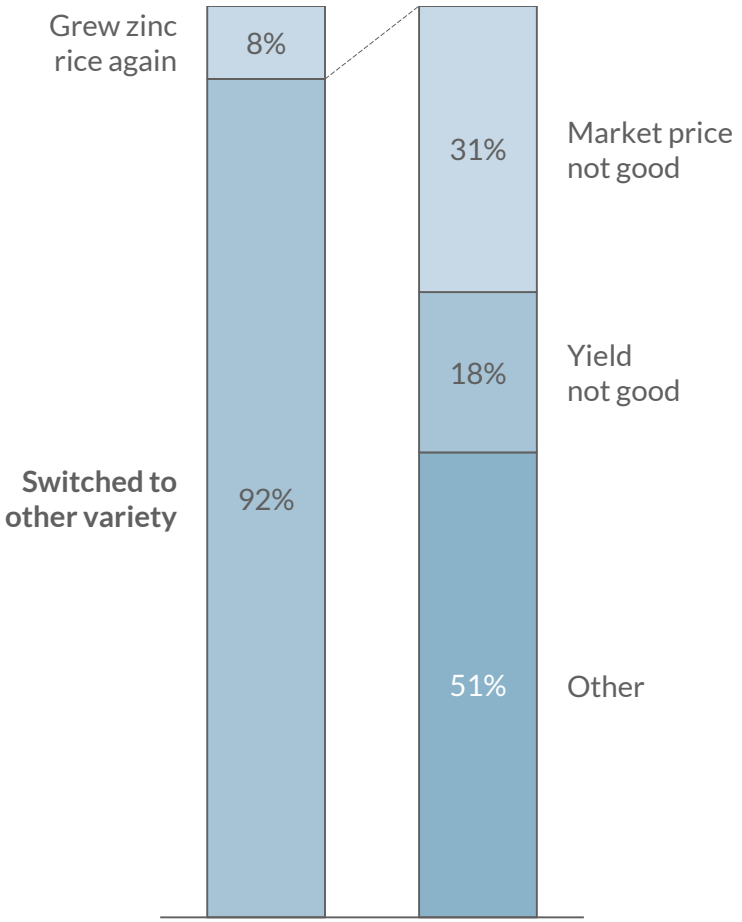
Three key barriers affect farmer uptake of these zinc varieties for on-farm* and/or retail consumption

Key barrier	Description	Relative priority†
Poor agronomic competitiveness	Farmers selecting seed for the portion of their crop sold to the market or their own consumption **may not select zinc rice because other varieties produce higher expected income or yield or are misaligned with seasonal preferences. However, BRRI-74 has been observed to be most agronomically competitive;** BRRI-84, which has not yet been released, may also be competitive	**High**
Limited awareness	**Low farmer awareness of zinc rice creates low market demand for zinc rice seed,** which means seed traders are less likely to carry it in their stock	**Medium**
Lag in seed production and uptake	Farmer risk aversion and seed system features **produce lag in seed uptake** and **slows the ability of the seed system to respond to perceived market demand**	**Low**

Note: (*) Relevant only if on-farm consumption is considered within the scope of this program. (†) These priorities are relative to the barriers being discussed on this slide

Agronomic competitiveness | Farmers have low preference for growing zinc rice due to poor performance across several key metrics

~90% of zinc rice farmers who try it do not grow it again; washouts cite poor market price and yield[1,*]
% of first-time growers and main reason for washout

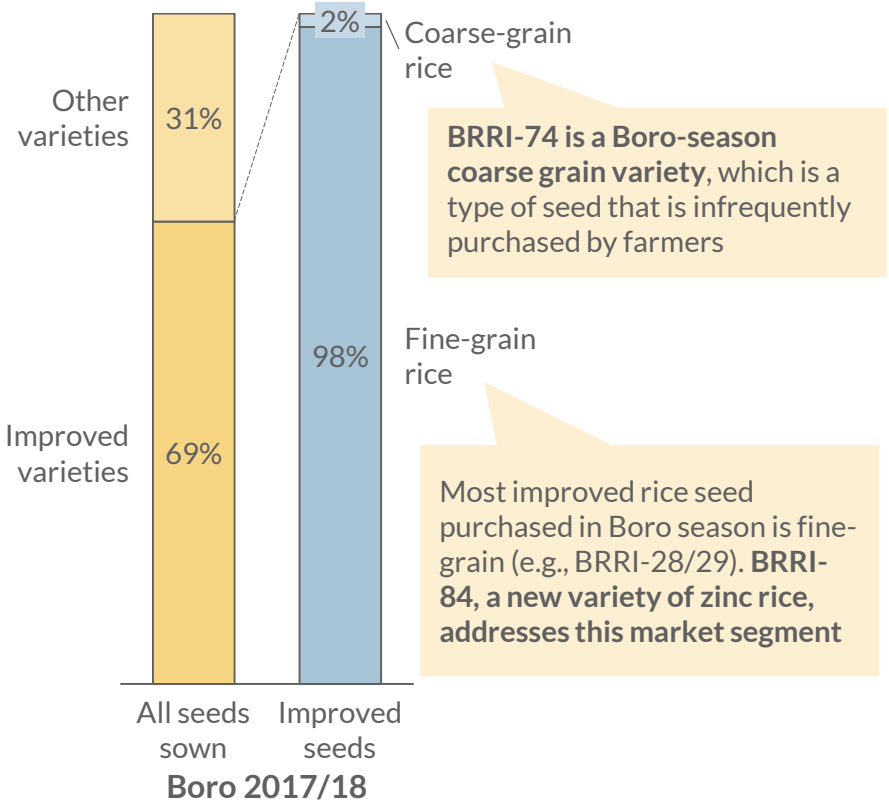


Key issue	Qualitative feedback†
Existing varieties of zinc rice may not have competitive traits for on-farm consumption	"I find zinc rice to be a bit coarse and heavy. We are used to eating smaller, less heavy rice" – *Farmer FGD, BRRI-74 grower* "This rice is not good for pulao or biryani – we use other rice for that" – *Farmer FGD, BRRI-74 grower*
Existing varieties of zinc rice may not provide enough revenue to be competitive for market sale	"I pay more for BRRI-28 [than BRRI-74] because it is slender and more beautiful, so it fetches a higher price [among rice consumers]" – *Miller FGD* "I primarily grow zinc rice [BRRI-74] for my own consumption because the market price is not as good [as other varieties]" – *Farmer FGD*

Note: (*) This survey may not accurately reflect farmer opinion of BRRI-74/84, as the farmers surveyed had most exposure to BRRI-62/64, limited exposure to BRRI-74 and no exposure to BRRI-84
(†) All farmer and miller FGD quotes are approximate, as they are translated from the original Bangla
Source: (1) Bashar, et al. "Results from the Bangladesh High Zinc Rice Adoption Study 2018", 2018

Agronomic Competitiveness | Existing varieties of zinc rice (i.e., BRRI-74) may be misaligned with farmers' seasonal preferences

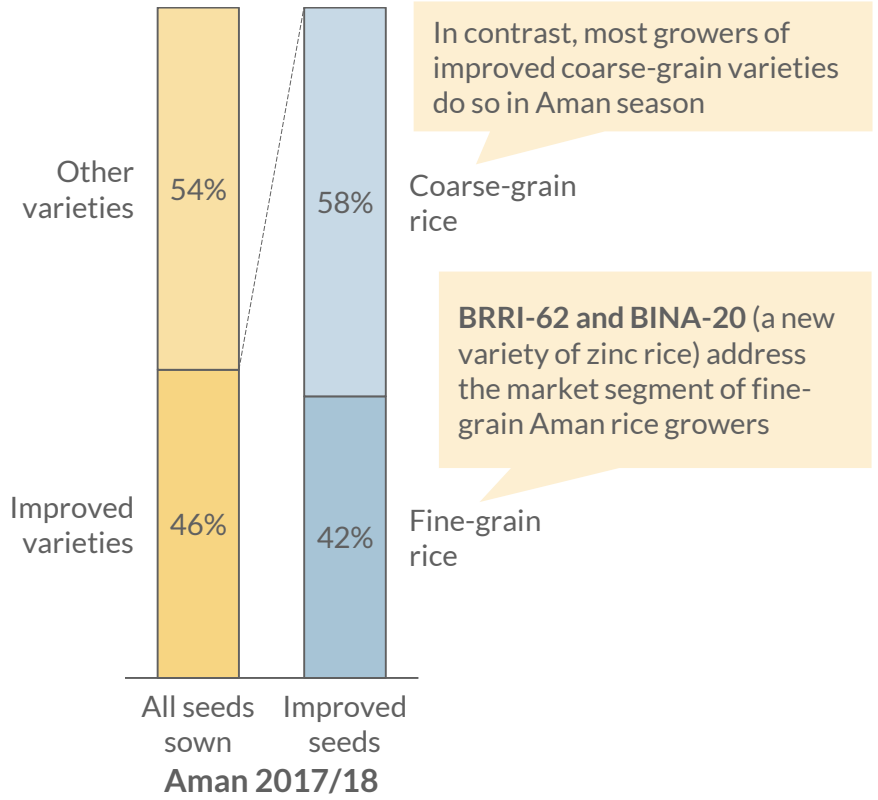
Among farmers who purchased improved seed in Boro season, nearly all preferred to purchase fine-grain rice…
% purchasing improved variety and type of rice, Boro 2017/18[1]



BRRI-74 is a Boro-season coarse grain variety, which is a type of seed that is infrequently purchased by farmers

Most improved rice seed purchased in Boro season is fine-grain (e.g., BRRI-28/29). **BRRI-84, a new variety of zinc rice, addresses this market segment**

…while about half of farmers in Aman season who purchased improved seed purchased a coarse-grain variety
% purchasing improved variety and type of rice, Aman 2017/18[1]



In contrast, most growers of improved coarse-grain varieties do so in Aman season

BRRI-62 and BINA-20 (a new variety of zinc rice) address the market segment of fine-grain Aman rice growers

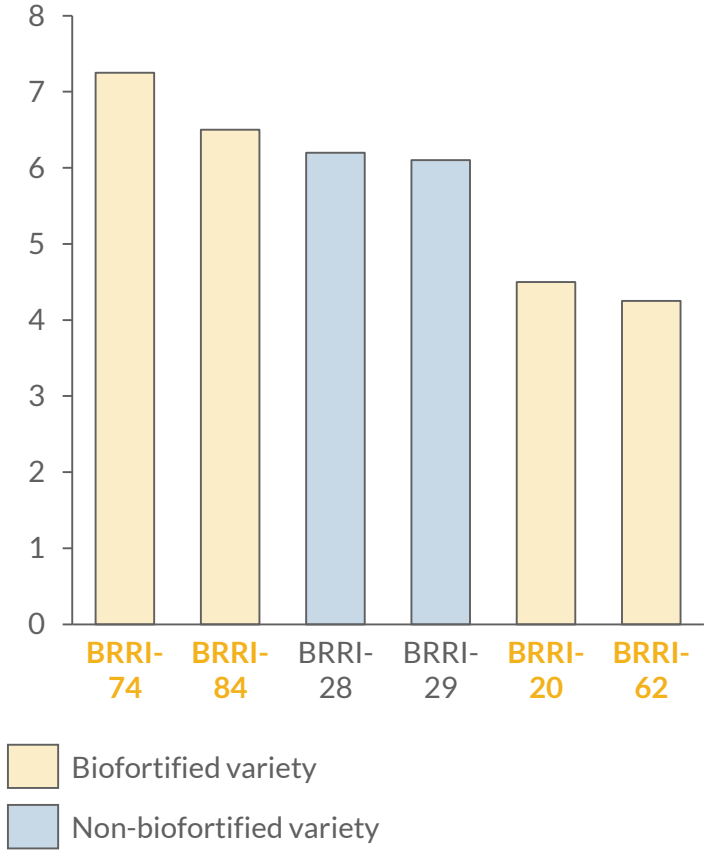
Farmers who purchase improved seeds in Boro season generally prefer to purchase fine-grained varieties, as they offer better expected revenue (Boro is the primary season for commercial rice sale). **Therefore, it may be difficult to scale production of BRRI-74, as the market for a coarse-grained Boro rice is very small relative to the overall market.**

Source: BRRI, "Data on rice adoption, 2017-18," 2018, Dalberg analysis

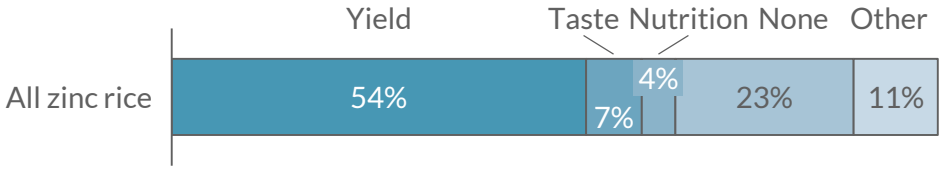
Agronomic competitiveness | Despite higher yield from some zinc rice varieties, less-preferred consumption traits restrict on-farm consumption

When producing for own consumption, farmers view yield and consumption characteristics as the most important traits. BRRI-74 and BRRI-84 offer competitive yield characteristics, but farmers may view consumption traits less favorably.[1,2]

Expected yield of rice varieties, in MT/ha



Zinc rice attribute most liked in first growing season, %



A significant minority of farmers liked neither the yield, the taste, or secondary characteristics of zinc rice varieties, indicating that there are key agronomic barriers to uptake for on-farm consumption

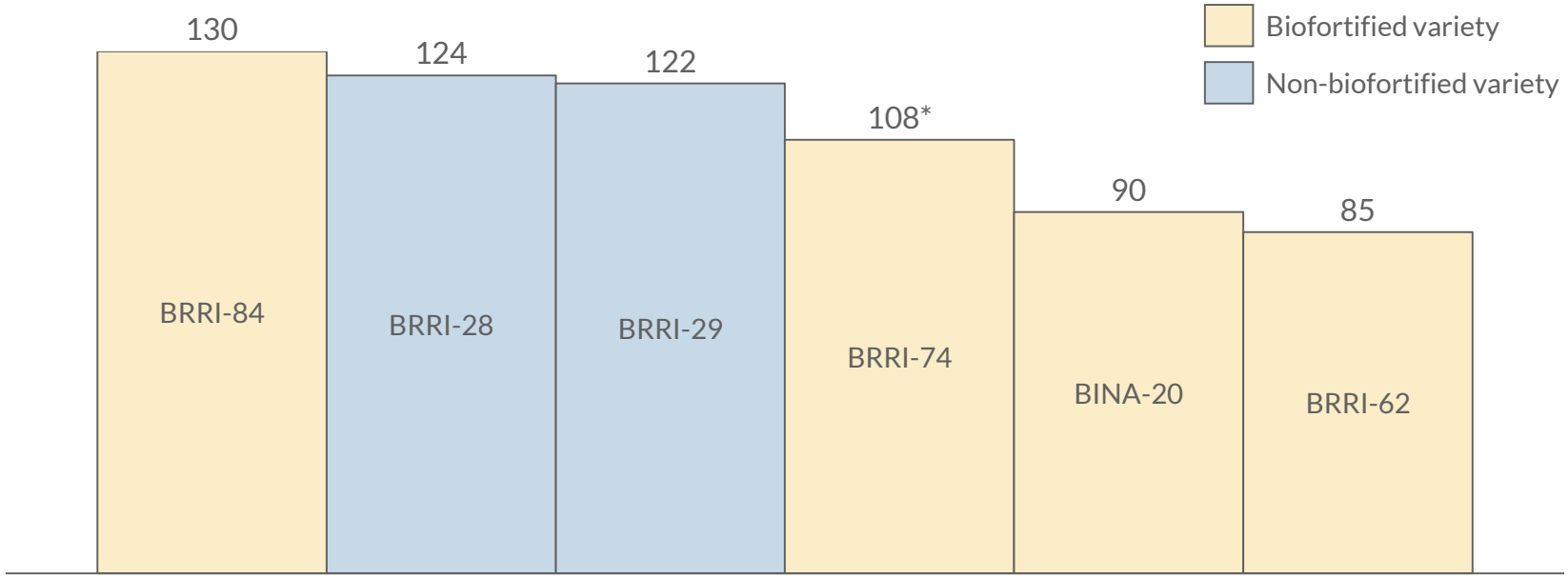
- Even given their relative satisfaction with the yield of certain zinc rice varieties (i.e., BRRI-74), 90% of farmers who try zinc rice do not grow it again.[1]
- If farmers do not choose to grow zinc rice again despite its competitive yield, **there are likely issues with its consumption traits.** In a survey of zinc rice farmers, processing and consumption traits for zinc rice are rated to be 70%-90% as good as the best varieties farmers have grown.[2]
- **Therefore, the overall combination of production and consumption traits for zinc rice varieties is likely not seen as competitive compared to other varieties.**

Source: (1) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012 (2) Bashar, et al. and aHarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019

Agronomic competitiveness | Most zinc rice varieties are less suited for sale because of lower market prices vs. non-fortified varieties

BRRI-84 is most competitive with BRRI-28 and BRRI-29 varieties. Other biofortified varieties have less expected revenue for farmers[1,2]

Expected farmer revenue for biofortified and leading improved varieties given Boro 2019 market prices, in BDT'000 per ha



(BRRI-84) is likely competitive with market-leading varieties for commercial production. However, it has just been launched in the market, so farmer opinion of its competitiveness has not yet been determined. The most popular zinc rice varieties, including (BRRI-74), have a lower expected revenue for farmers than other leading varieties and are therefore less competitive as a commercial crop[3]

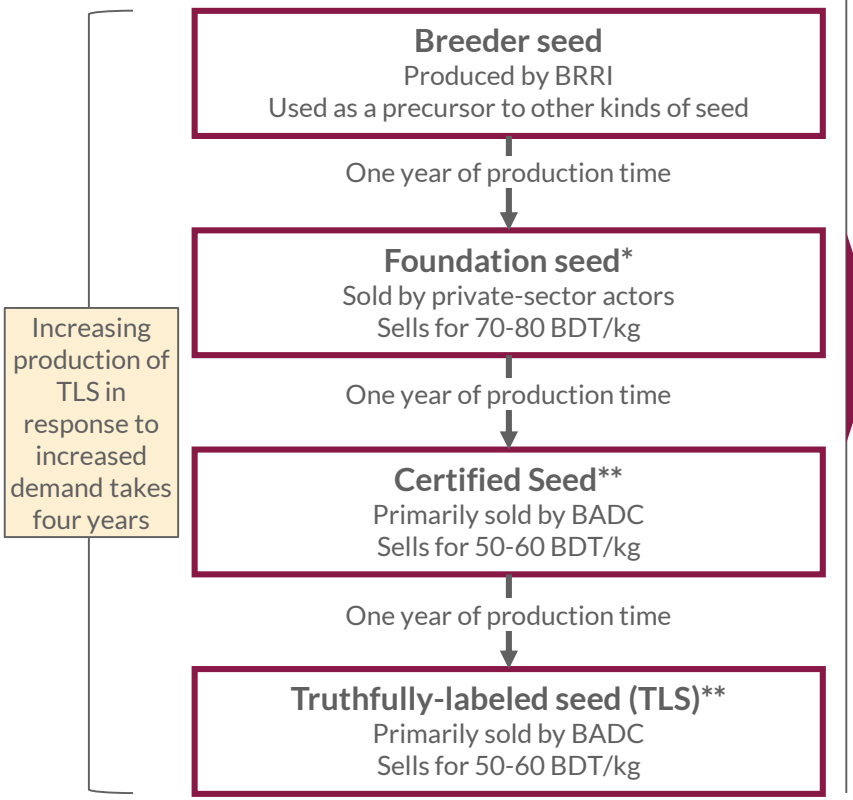
Without intensive marketing and behavior change interventions, varieties besides (BRRI-84) may struggle to build market share on the strength of their agronomic characteristics alone.

Note: Because BRRI-74 is a coarse rice, it underperforms despite its higher yield because it receives a lower price in the market
Source: (1) Dalberg analysis, see annex for full calculation and sources. (2) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 ; (3) Focus group with zinc rice farmers in Sirajganj, 9/14/2019; focus group with millers in Bogra, 9/14/2019

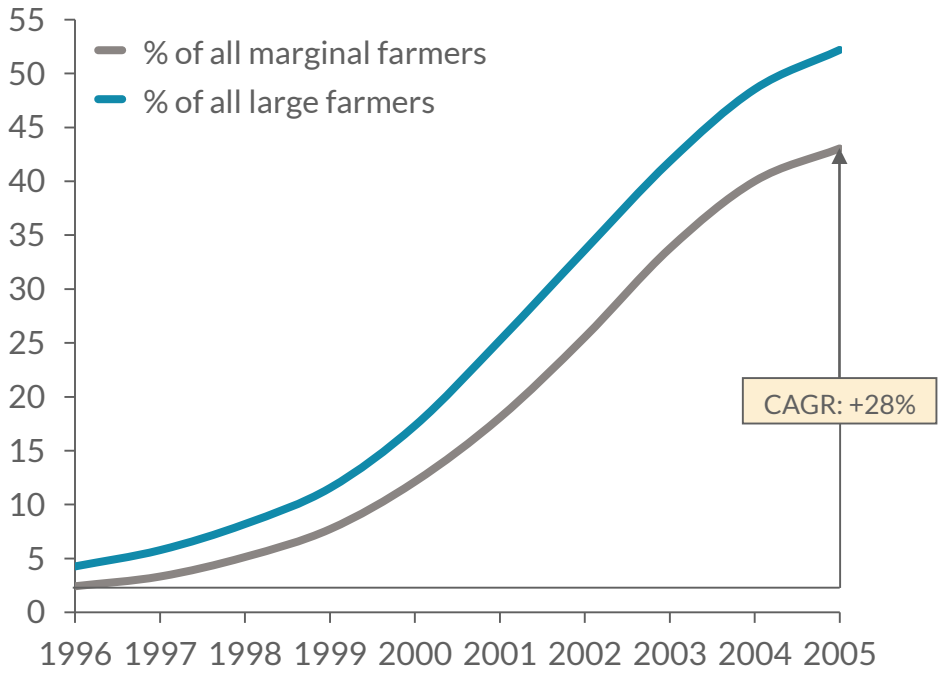
Dalberg

Time lag | Any significant increase in demand for zinc rice will likely take a long time to fill given long seed development timelines

Increasing seed production in response to perceived demand can take up to four years[1]
Structure of seed system in Bangladesh



Farmer uptake of megavarieties (e.g., BRRI-29) occurs over 10+ years and has little variation by farm size[2]
% of farmers using BRRI-29 by year and farm size, 1996-2005



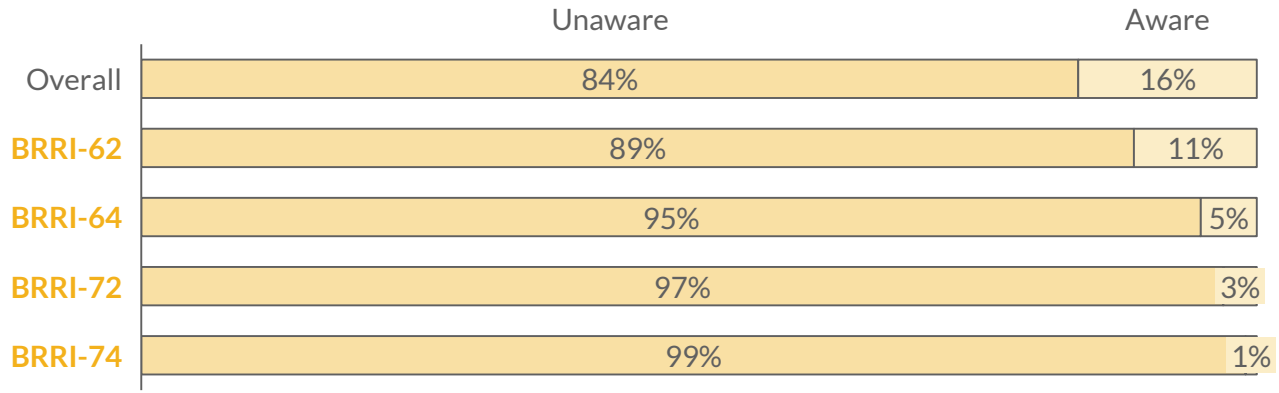
"It takes about 3-5 years to establish a new seed variety in the market" – *Mr. Masmun, Supreme Seed Co[3]*

Time lags in the seed system on both the supply and demand sides will likely serve as rate-limiting steps to scale. The historical experience with uptake of (BRRI-29) – which was strongly supported by the government and its extension workers – should be taken as a best-case scenario for the rate of scale of new varieties of rice.

Note: (*) Foundation seed represents around 20% of the overall Boro seed market. (**) Combined, certified and TLS represent 60% of the overall Boro seed market
Source: (1) Interview with HarvestPlus, 9/12/19. (2) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012 (3) Interview with Mohammad Masmun, CEO, Supreme Seed Co., 9/12/19

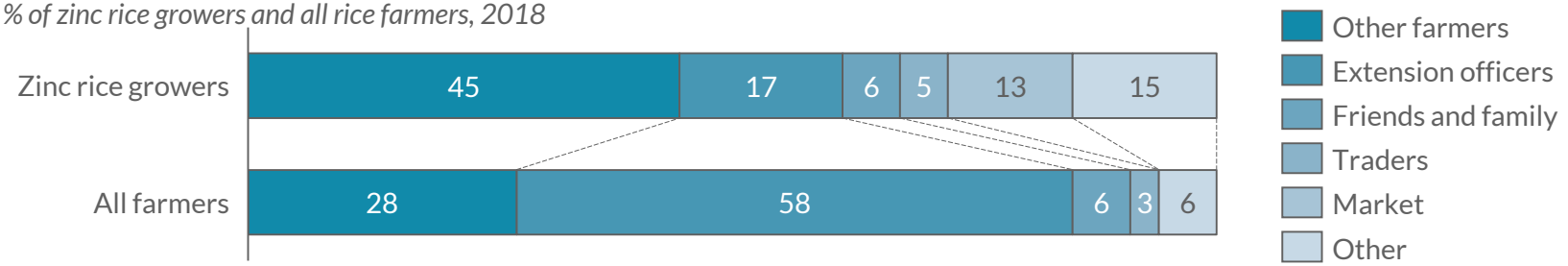
Farmer awareness | Farmers have low awareness about the value proposition and availability of zinc rice

Most farmers (>80%) are unaware of the zinc rice varieties currently on the market[1]
% of all rice farmers, 2018



Despite its high share of production (~50%), there is low overall awareness of BRRI-72

Compared to other improved varieties, farmers more frequently hear about zinc rice through informal networks than formal channels (e.g., extension officers)[1,2]
% of zinc rice growers and all rice farmers, 2018



Despite clear gains to date, there is still significant progress to be made on building farmer awareness of zinc rice and the health benefits it brings to farmers. Given the comparatively low amount of awareness built through formal extension channels, **continued engagement with DAE will likely be one key pathway to build awareness in the future.**

Source: (1) Bashar, et al. and HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 (2) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012

Dalberg

Key opportunity areas | Pre-farm and on-farm value chains

Key opportunity area	Description

Scaling production for on-farm consumption, particularly for coarse-rice growers[1]	• This opportunity area **is a quicker win that can likely be achieved in the medium-term.**
	• Interventions in this area will likely focus on building market share for BRRI-74 among existing coarse rice growers.
	  • **Developing farmer awareness** about the importance of zinc rice and its availability across new farmers and existing zinc rice farmers
	  • **Improving the agronomic competitiveness** of zinc rice varieties through targeted subsidies, awareness creation and new demand-generation partnerships to promote uptake.
	• Given the comparatively high amount of awareness built through formal extension channels for all farmers, **improving partnerships with DAE**[2] **will likely be one key pathway to build awareness in the future.**
	• **In the longer-term, efforts can be made to build market share among fine-rice growers with BRRI-84,** a new fine-grain variety that may be agronomically competitive.

Scaling production for market sale and retail consumption	• This is likely a longer-term focus area given that the key barrier – the lower expected farmer revenue from growing biofortified seeds versus other varieties – **can best be alleviated through shifting downstream consumer preferences or through a targeted subsidy for producers.** However, effectively shifting consumer preferences through interventions is likely a challenging exercise. • In the long run, new varieties could be developed that are more aligned with farmer preferences for market sale of their crop.

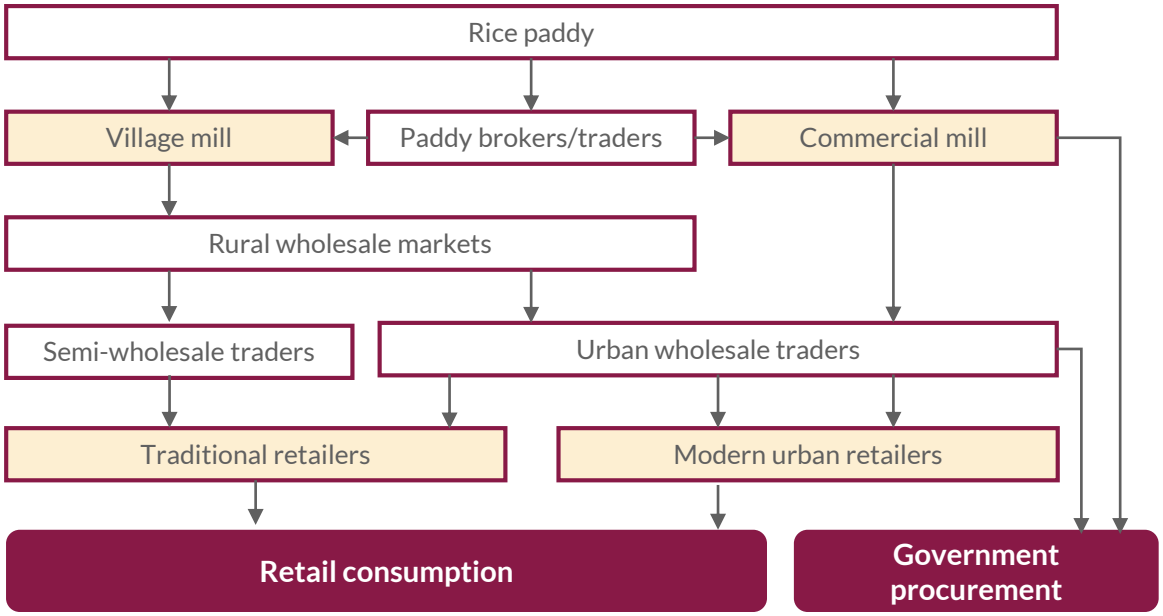
INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

Notes: (1) If considered as part of program scope (2) The Department of Agricultural Extension, a government agency

Post-farm value chain

Millers and retailers are key members of the value chain and are hard to influence as they primarily respond to consumer demand

Overview of the post-farm rice value chain[1]



Key actors in the post-farm value chain

- Millers have the most economic power because they capture the most margin in the value chain. Millers produce rice to fill perceived consumer demand
- Retailers capture the second-most margin and determine what products to sell to consumers based on their perception of consumer demand

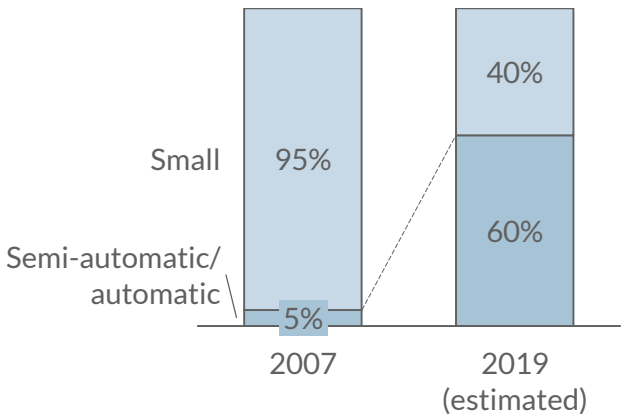
The post-farm value chain is primarily driven by consumer demand across consumer segments. For all segments of consumers, including coarse-rice consumers, **no single miller or retailer is large enough to have a meaningful influence on consumer preferences or consumer choice***; instead, value-chain actors work to fill perceived demand with products that match existing consumer preferences.[2] **However, groups of millers may be able to influence consumer preferences in localized areas.**[3]

Note: (*) With the possible exception of high-income urban consumers, who have recently begun to purchase premium branded rice products in supermarkets
Source: (1) Reardon, et al. "The Transformation of Rice Value Chains in Bangladesh and India: Implications for Food Security," 2013. (2) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013 (3) Conversation with Kazi Muinur Rahman, GAIN.

Market power is aggregated in large commercial millers; retailers remain fragmented

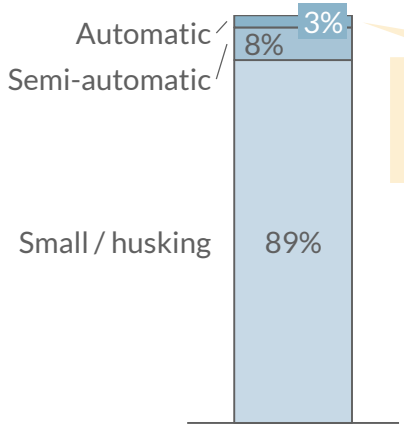
Commercialized semiautomatic and automatic rice mills are estimated to process more than half of all marketed rice…[1]

Source of processed rice by miller type, in % of total volume



… while constituting only ~10% of the market by number, demonstrating their importance as market actors[1]

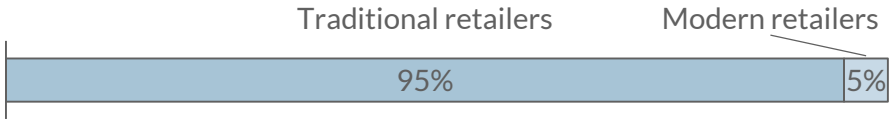
Number of mills in each market segment, Boro 2013



Leading automatic millers include ACI, PRAN Group, and City Group

Rice retailers are fragmented, with nearly all rice sold through small, traditional outlets.[1]

Breakdown of the retail market by type, in % of total volume



Most traditional retailers are small players in the market; at most, a traditional retailer does volume equal to the consumption needs of about 700 people each year

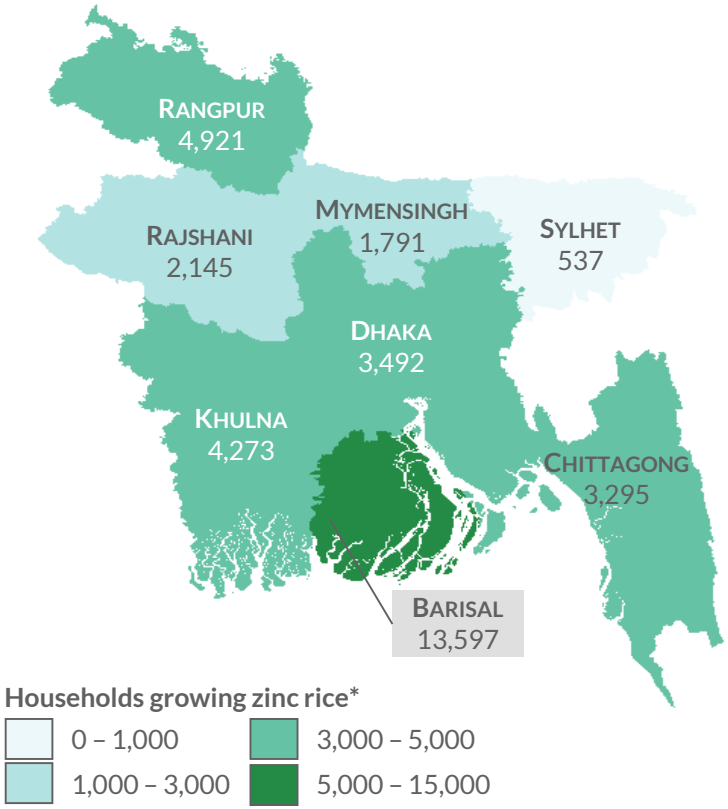
It will likely be more effective to engage leading millers (who control a meaningful amount of market share) to support zinc rice commercialization than multiple retailers, who individually control a small amount of market share.

Source: (1) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Current zinc rice production is weighted away from areas with high levels of commercialized processing capacity

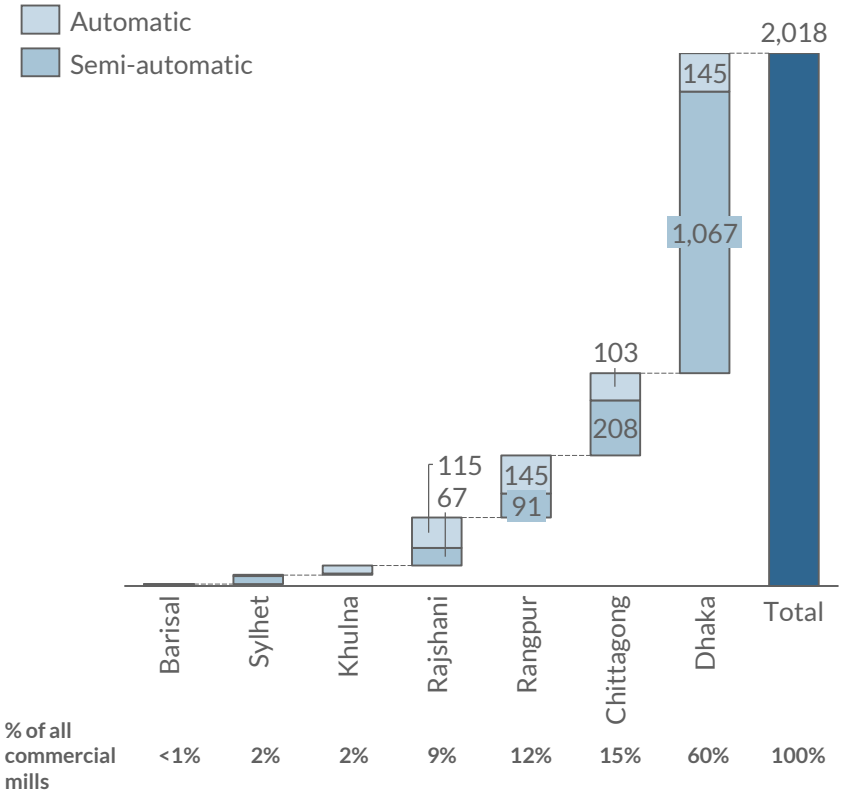
About half of all zinc rice growers are located in Barisal district in southern Bangladesh…[1]

Number of households growing zinc rice, Boro 2018



… but Barisal has almost no commercial milling capacity. Most commercial capacity is concentrated in four districts[2]

Number of semi-automatic and automatic mills by district



Source: (1) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 (2) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Four key barriers affect the uptake of zinc rice in the post-farm supply chain

Key barrier	Description	Relative priority†
Limited awareness	**Supply chain actors do not know zinc rice exists as a product**	**High**
No segregated supply chain	Farmers sell rice paddy in bulk by grade, rather than variety, **making it difficult for millers to purchase pure zinc rice**	**High**
Limited ability to influence consumer preferences	**No single value chain actor has enough market power to meaningfully change consumer preferences** to promote zinc rice adoption	**Medium**
Consumer preferences reduce zinc rice nutrition	**Consumers prefer highly-milled rice**, which tends to reduce the amount of zinc retained in processed zinc rice product	**Medium**

(†) These priorities are relative to the barriers being discussed on this slide

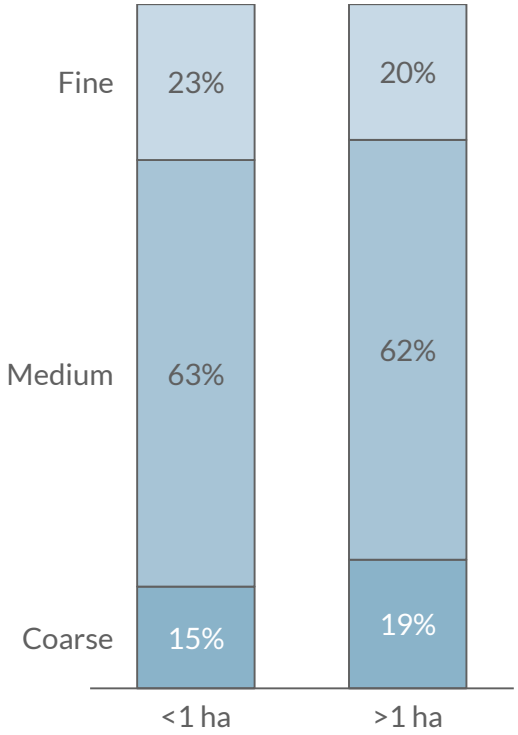
Awareness | There is likely very low awareness of zinc rice among key value chain actors

- **Village millers** sampled in our focus-group discussion (n=3) were aware of zinc rice because they purchased it as coarse rice directly from farmers and operated in a district in which zinc rice was grown (Sirajganj, Rajshashi division)
- All **automatic/semi-automatic millers sampled in our focus-group discussion** (n=5) **had not heard of zinc rice**, despite being based in a division in which zinc rice was grown (Sherpur, Bogra, Rajshashi division)
- We spoke to **one rice wholesaler, who had not heard of zinc rice**, despite being based in a division in which zinc rice was grown (Sherpur, Bogra, Rajshashi division)
- Farmers also reported that **no aggregators or millers specifically ask for zinc rice** when they sell it at market. Instead, it retails as low-grade coarse rice, for which millers and aggregators pay less than medium- and high-grade rice
- **PRAN**, one of the largest rice millers and processors in Bangladesh, **had not heard of zinc rice** (likely because of zinc rice's low market penetration and/or because it largely focused on producing fine grain rice) though it was interested in exploring the opportunity further through limited consumer trials.

Segregation | No segregated zinc rice supply chain exists

Farmers sell their paddy to traders and millers based on the quality of the rice, rather than by the variety itself. Varieties with similar grades (e.g., coarse, medium or fine) are mixed together after the farmgate when aggregated by traders and millers[1]

Total rice production disaggregated by grade and farm size, %, 2009



"We tend to process about four or five grades of rice – from coarse to katali [a superfine grade]. We buy paddy for these grades from traders"
– a large commercial miller, from miller FGD[2]

"We buy all kinds of rice from farmers, and pay them based on the quality of that rice. We process rice [of similar grades] together"
– a small village miller, Miller FGD[2]

"All varieties of rice get mixed up in the market. This is a significant challenge for zinc rice. To create a branded zinc rice product, a new, separate supply chain will be required"
– Dr. Khalequzzaman, BRRI[3]

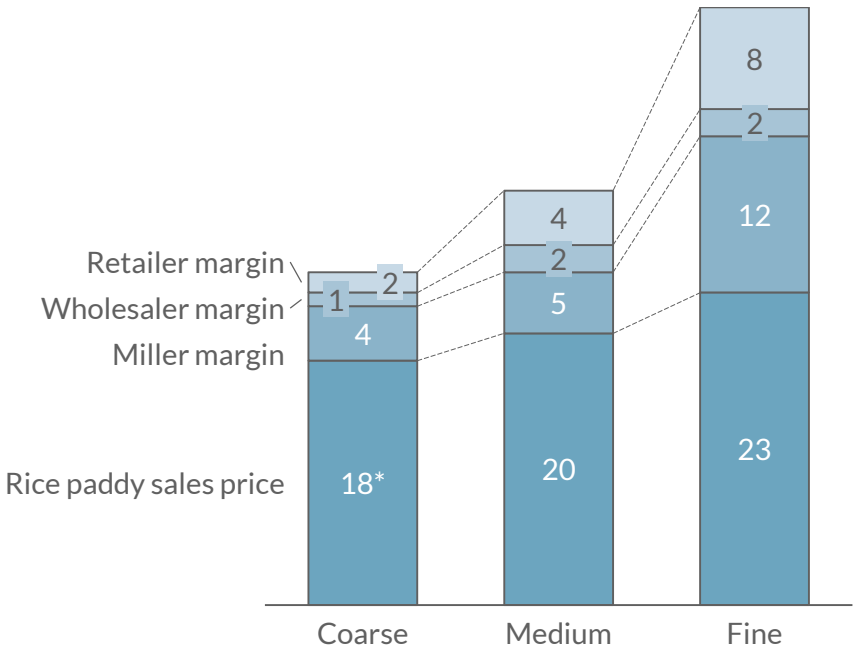
Zinc rice has not been established as a product, so no segregated supply chain currently exists to support its processing and distribution. Aggregation is a challenge because zinc rice paddy is currently sold mixed in with other varieties of rice of similar grade, making it impossible for millers to procure pure zinc rice without setting up a contract farming system.

Source: (1) Reardon, et al. "The quiet revolution in staple food value chains: enter the dragon, the elephant, and the tiger," 2012. (2) Miller FGD, Sherpur, Bogra, 14/09/19. (3) Interview with Dr. Khalequzzaman, 15/9.19

Consumer influence | In a commoditized market with slim margins, millers have limited ability to influence consumer preferences

While the millers and retailers have the most economic power in the post-farm supply chain because they have the greatest margin[1]…

Decomposition of margin in final sales price, BDT/kg, 2009



… the margin and their market share is not big enough to be able to influence the preferences of price-conscious consumers.

- The margins for all actors across the post-farm rice value chain are thin
- Millers currently indicate that they make sourcing decisions based on the price they think they can get for specific grades of rice based on consumer preferences
- Value chain actors are quite fragmented, with no single actor having a significant market share
- However, milling industry experts indicate that a limited set of commercial mills may eventually capture enough market share so as to be able to influence both the price of rice and fundamental consumer preferences for rice
- If this happens, market leaders will have a greater ability to "push" zinc rice through targeted marketing with specific segments of consumers

Given the current structure of the post-farm value chain market, it is unlikely that millers will be able to implement a "supply push"-type of market entry strategy for zinc rice in the short- and medium-terms. However, this might be possible to achieve in the future, once the milling industry becomes more efficient and consolidates further.

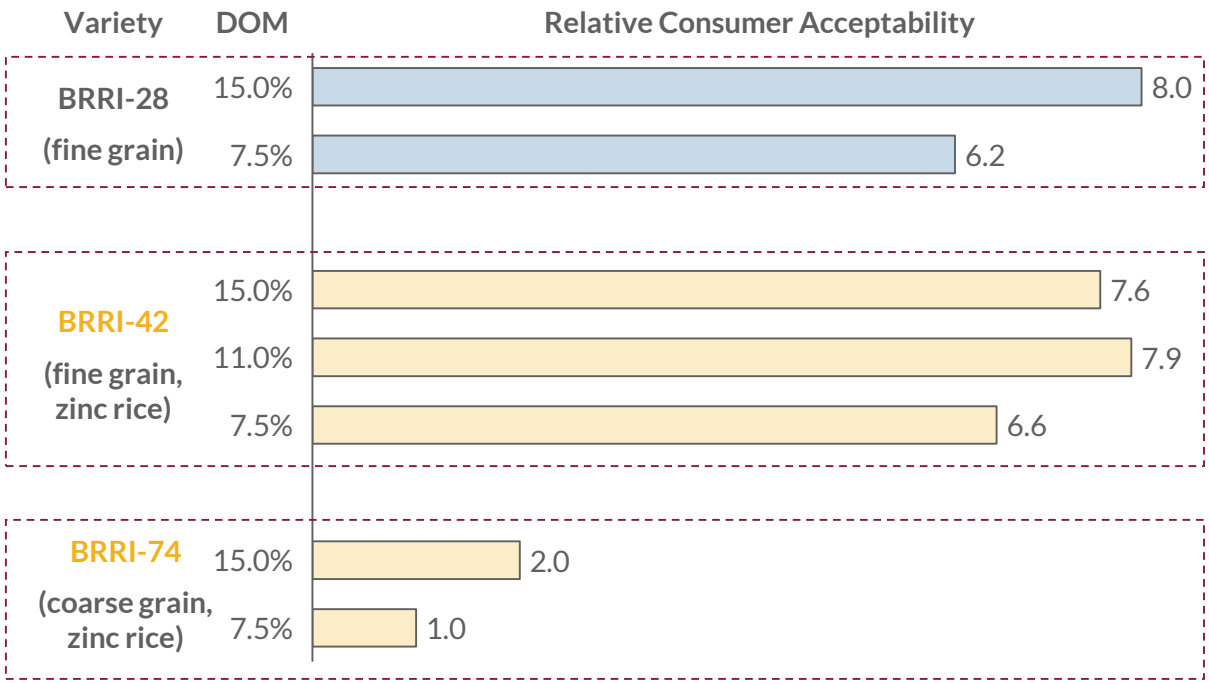
Note: (*) At the time this study was done, coarse rice had a higher sales price than in Boro 2018 (estimated to be 15 BDT/kg)
Source: (1) Minten, et al. "Food quality changes and implications: evidence from the rice value chain in Bangladesh, 2012. (2) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Dalberg

Nutrition | Consumer preferences for polished rice may make processed zinc rice less nutritious, limiting uptake of most impactful products

HarvestPlus recommends a 7.5% degree of milling ("DOM") for optimal nutrition in zinc rice. However, consumers tend to prefer more highly-milled rice in head-to-head trials (in addition to preferring fine rice to coarse rice)[1]

Normalized consumer acceptability (10 is highest) by variety and degree of milling (%), n=576 consumers in Dinajpur and Satkhira, 2018



Highly-milled (BRRI-28) is more preferred by consumers than zinc rice

Highly-milled zinc rice is more preferred than the nutritional optimum

Consumers prefer fine-grain alternatives to coarse-grain zinc rice*

Given consumer preferences, millers would be likely to overmill any zinc rice product, reducing the nutritional impact of the intervention. While the exact degree of zinc loss from overmilling is not yet known, it will be important to incentivize millers to sell undermilled product in order to maximize the ability of commercial products to deliver nutrition for consumers.†

Note: (*) There is no data on direct head-to-head comparisons for (BRRI-74) against coarse rice varieties, so the data on this slide should not be interpreted as showing the market acceptability of BRRI-74 (beyond the general preference for fine-grain rice) (†) Modifying milling practices are not without risk. The lack of consistent oversight and quality control in the country could pose a problem for ensuring the quality of nutritious rice produced. The Ministry of Industries has no effective control over how rice mills operate. The Bangladesh Standards and Testing Institute (BSTI) developed a set of quality standards for milled rice in 1981, but these guidelines are voluntary rather than mandatory[2]

Source: (1) Taleon, Victor, "Preliminary findings from the Bangladesh zinc rice consumer acceptance study," private correspondence, 2019; (2) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Dalberg

Key opportunity areas | Post-farm value chain

Key opportunity area*	Description
Retail consumption of zinc rice through market development – address barriers around access and awareness	• Partner with a large miller to create a packaged zinc rice product aimed at upper-income consumer segments who are willing to pay a premium for nutrition. This will help setup a differentiated supply chain for zinc rice. • Incentivize millers to substitute a percentage of their total rice production with zinc rice. This may work best with coarse rice production, given that (BRRI-74), a coarse-rice variety, is currently the most commonly-produced zinc rice variety". • In the long-term, millers could create a separate branded rice product aimed at middle-income consumers coupled with intensive marketing and behavior-change efforts (similar to how the current "miniket" rice has been branded and packaged).

INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

*Post-farm value chain has limited control on influencing the government consumption. Millers and aggregators usually react to a policy intervention and thus government consumption opportunities are covered in the next section.

Consumption

The vast majority of rice in Bangladesh is consumed on-farm or by retail consumers; zinc rice has a very small market presence

Three main grades of rice are consumed in Bangladesh[1]

Coarse	Medium	Fine
Short and bold-grain rice *(17% of overall consumption)*	Long and slender-grain rice *(62% of overall consumption)*	Premium rice (e.g., katali) *(22% of overall consumption)*

These grades of rice cater to three main demand segments[2]

On-farm consumption	Government procurement	Retail consumption
Farmers reserve a portion of their crop for self-consumption *(40% of overall consumption)*	Government purchases rice for feeding programs and price support *(4% of overall consumption)*	Consumers purchase rice through retail outlets *(55% of overall consumption)*

Key context on the status of zinc rice

- Of the total rice market, **the market share for zinc rice is less than 1%.**
- The majority of zinc rice consumption occurs through the on-farm consumption pathway.
- Because zinc rice is mixed in with other rice varieties after the farmgate (where rice is sold by grade, not variety), **we don't know who's currently consuming (mixed) zinc rice through retail consumption or government procurement.**

Note: (*) More coarse rice is consumed in the southern divisions (e.g., Barisal)
Sources: (1) Minten, et al. "Food quality changes and implications: evidence from the rice value chain of Bangladesh," 2012 (2) Dalberg analysis, see Slide 7 for sources (3) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Rice consumers have highly specific preferences, which are vary by the demand segment

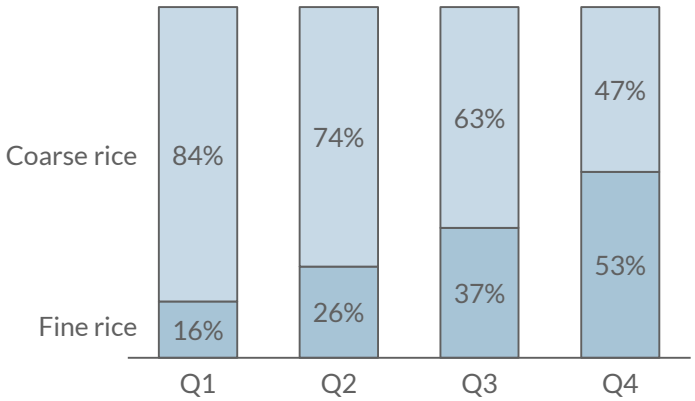
	Key consumption preferences[3]
On-farm consumption	• Preferred varieties offer the best blend of yield and consumption characteristics. • Long- and fine-grain rice is preferred, although there is some regional variation.* • Farmers value nutrition significantly less than yield and other production traits (e.g., pest resistance).
Government procurement	• The government generally procures the cheapest rice (of minimum quality) for its programs. This conventionally means that it preferentially procures coarse rice. • The government is only starting to procure nutritious rice for some of its programs.
Retail consumption	• Consumers have a strong preference for long- and fine-grain rice that is highly polished. • Consumers are unlikely to pay a premium for nutrition.

Note: (*) More coarse rice is consumed in the southern divisions (e.g., Barisal)
Sources: (1) Minten, et al. "Food quality changes and implications: evidence from the rice value chain of Bangladesh," 2012 (2) Dalberg analysis, see Slide 7 for sources (3) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Coarse rice is seen as an "inferior" good; consumers switch to medium and fine rice as incomes increase

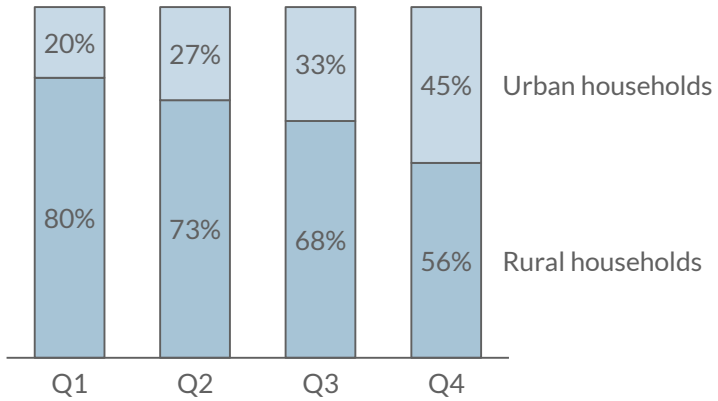
While coarse rice consumption varies by income, it is present across all income quartiles[1]

% of total rice expenditure by income quartile, 2009[1]



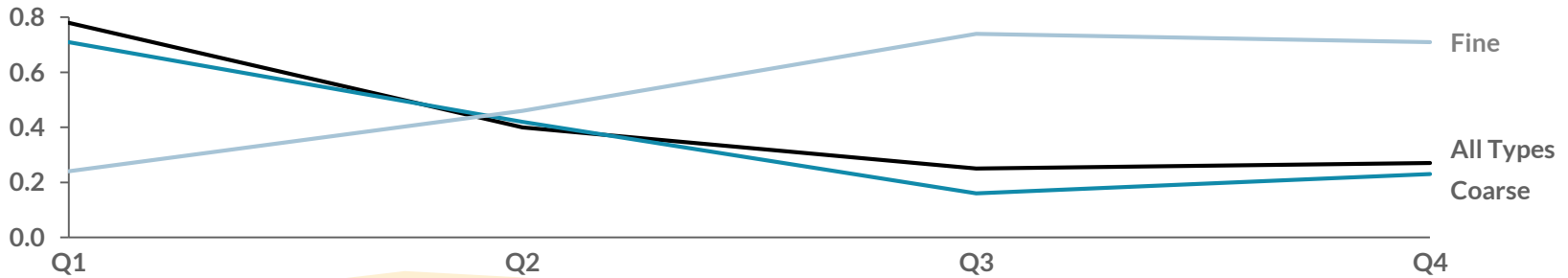
Coarse rice is likely consumed most frequently in rural areas and least frequently in urban areas[1]

Geographic distribution by income quartile, %, 2002



As consumer income increases, purchase and consumption of coarse rice consumption decreases[2]

Income elasticity of expenditure by income quartile and type of rice, 2010



Low-income consumers prioritize increasing their total consumption of rice as their incomes increase by preferentially buying cheaper coarse rice. In contrast, **higher-income consumers buy less and higher-quality rice as their incomes increase**, shifting their consumption to other food products (e.g., meat, vegetables)

Source: (1) Hossain, et al., "Adoption and diffusion of modern rice varieties in Bangladesh and Eastern India," 2012 (2) Mottaleb and Mishra, "Rice consumption and grain-type preference by household: a Bangladesh case," 2016,

Dalberg

Two key barriers affect zinc rice consumption: (i) consumers don't know about it; (ii) Of the few who do know about it don't prefer it

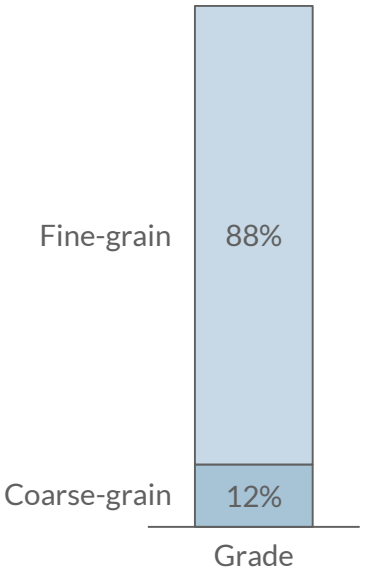
Key barrier	Description	Relative priority†
Some zinc rice varieties are misaligned with current consumer preferences	The most agronomically popular variety of zinc rice **(BRRI-74) is a coarse rice, which is not valued by retail consumers.** **Additionally, nearly all consumers have very little willingness to pay for improved nutrition,** providing no margin to support specialized zinc rice products	**High**
Limited consumer awareness	**Nearly all consumers are unaware of zinc rice as a product**	**High**

(†) These priorities are relative to the barriers being discussed on this slide

Consumer preferences | Popular zinc rice varieties are mostly coarse, and therefore misaligned with consumer preferences

Bangladeshi consumers strongly prefer to eat fine-grain rice…[1]

*Rice type preferred by consumers, % of total, n=1250**



… but the most widely-grown variety of zinc rice is a coarse-grained rice[2]

	BRRI-74	BRRI-62	BRRI-64
Release year	2015	2013	2014
Season	Boro	Aman	Boro
Grain type	Coarse	Fine	Fine
Grain quality	Medium bold	Long slender	Medium slender
% of total production	**50**	**35**	**11**

- Given the strength of consumer preferences, **it is unlikely that BRRI-74 is a strong candidate for any commercialization program that relies on an increased consumer willingness to pay for a zinc rice product.** However, it may be a good fit for commercialization programs in the coarse-rice market (as long as those programs do not rely on increased consumer WTP).
- **Low-income consumers prioritize increasing their total consumption of rice as their incomes increase** by preferentially buying cheaper coarse rice.
- In contrast**, higher-income consumers preferentially buy less and higher-quality rice as their incomes increase**, shifting their consumption to other food products (e.g., meat, vegetables).[3]

Note: (*) While this data on consumer demand is from 2013, it is in line with other estimates of consumer preferences. Studies of administrative data have found that consumer preferences shifted towards fine-grain rice from coarse-grain rice from 2000-2010 as incomes rose, and so has likely increased further since then as incomes have risen[3]

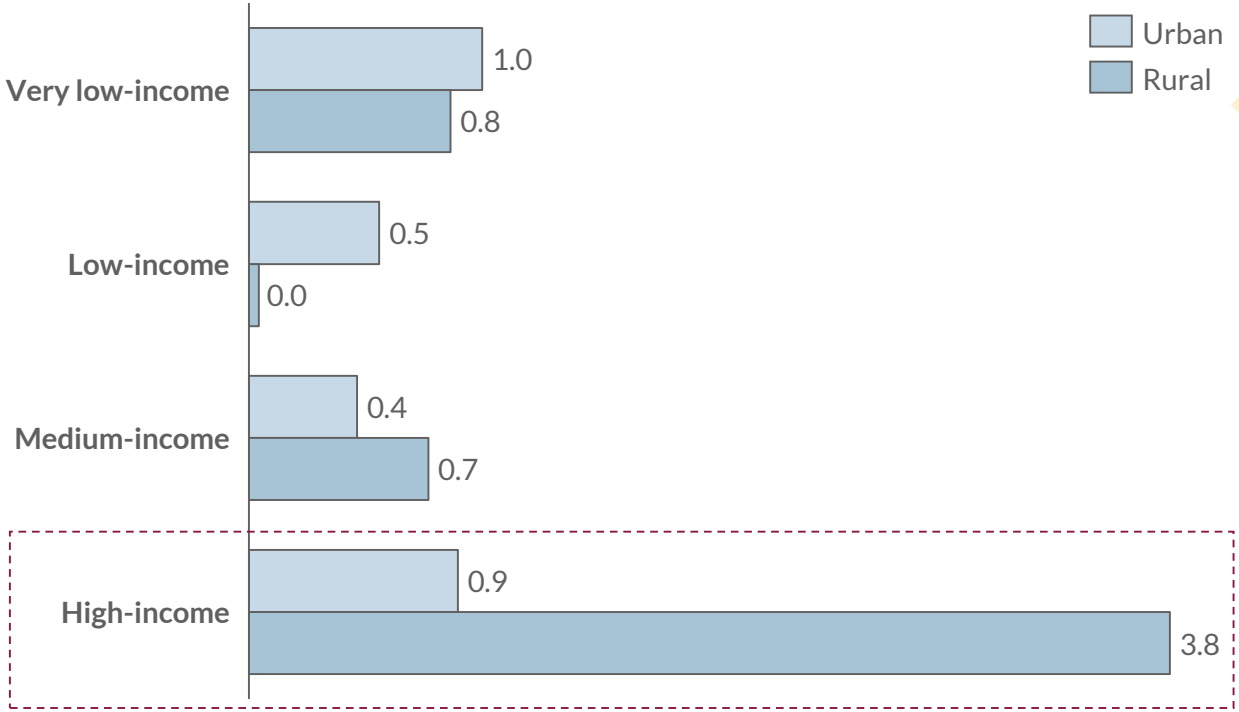
Source: (1) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013 (2) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019. (3) Mottaleb and Mishra, "Rice consumption and grain-type preference by household: a Bangladesh case," 2016,

Dalberg

Consumer preferences | Low WTP for zinc rice will hinder uptake among low- and medium-income consumers

Estimated consumer willingness to pay ("WTP") for nutrition across most income quartiles is <1 BDT/kg of rice; only high-income rural consumers demonstrate significant WTP for nutrition[1]

Survey of rice consumers (n = 1250) sampled pre- nutrition awareness-building interventions, in BDT/kg, 2013



Consumers across income segments are generally price-sensitive and have low additional WTP for more nutritious rice

High-income rural consumers **have significant WTP for nutrition** but are **unlikely to receive significant additional benefits** from consuming zinc rice given their diversified diet

Given likely low additional WTP for nutritious rice, **there is little existing incentive for upstream value-chain actors to create zinc rice products to capture this small margin** without demand-creation efforts to boost consumer WTP. **This low WTP significantly restricts the business case for millers to introduce zinc rice products**, as it is unlikely that they will be able to market the product at a higher price to recoup the additional costs associated with creating such a product (e.g., contract farming zinc rice, maintaining and verifying a segregated supply chain, branding and marketing)

Source: (1) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Consumer awareness | While some awareness of the value of nutrition exists in consumers, not many are likely aware of zinc rice

Our focus group discussions in areas with zinc rice production revealed very little consumer awareness about zinc rice and its value proposition[1]

	Urban FGD	Rural FGD
Location	Mirpur, Dhaka	Sherpur, Bogra
Size	N = 15 *(F = 8, M = 7)*	N = 14 *(F = 5, M = 9)*
Number of participants who had heard of zinc rice	0	1
What qualities do you look for in rice?	Price most important Strongly prefer thin and fine rice Taste secondary	Price most important Want "good looking" rice – e.g., fine and thin rice
Where do you buy your rice?	Local shop (in bulk) Some buy packaged rice from supermarket	Local shop (in bulk)

However, some consumers do consider nutrition in their purchase of rice, although it is a secondary preference[2]
*Top five ranked qualities of cooked rice for consumers, consumer survey (n = 1250), 2013**

Rank	Characteristic
1	Taste
2	Cleanliness
3	Smell
4	Nutrition
5	Keeping time

In a consumer survey, just over one-third of consumers ranked nutrition within their top three most important factors for cooked rice, indicating some baseline awareness to support a nutrition intervention

Note: (*) These survey results are in line with other general assessments of preferences of consumption traits, including Hossain, et al. and HarvestPlus's primary research on zinc rice adoption.
Source: (1) Consumer FGDs, 15/09/19 (2) GAIN and Dalberg, "Embedding Nutrition in the Rice Value Chain in Bangladesh: A review and assessment of intervention opportunities, 2013

Key opportunity areas | Consumption

Key opportunity area	Description
On-farm*	• **Work on creating short-term financial incentives / subsidies, awareness creation and new partnerships for demand-generation to address barriers around awareness and agronomic competitiveness.** Given a high risk-aversion, farmer seed preferences are "sticky" and take several years of trialing to switch their production to a new variety. Thus, to increase uptake, it may be effective to create awareness about zinc rice and offer subsidized seeds to farmers in the short-term. It might be possible to remove the subsidy in the medium-term once farmers have switched to primarily producing zinc rice for own consumption. Given low awareness amongst farmers, any economic subsidy should be coupled with demand generation activities. For example, HarvestPlus and GAIN could forge a deeper partnership with the Department of Agricultural Extension to promote and market zinc rice varieties more widely
Government	• **Collaborate with the government on a partnership to integrate zinc rice into their social-security programs, which could be an effective method of reaching key populations and developing the supply chain while addressing barriers related to consumer preferences.** While these programs are small as a share of overall demand (<5% of the rice market), they could provide a stable source of demand for zinc rice growers year-over-year, helping create a separate supply chain which can also be utilized when end consumer demand fructifies. A key benefit of government programs is that they reach key demographics such as children and women in low-income households.
Retail	• **Collaborate with the government and leading millers and agroprocessors on a large-scale awareness and demand-generation campaign to build demand for zinc rice among consumers** (given current estimates of consumer willingness to pay for nutritious rice, this would likely only be effective among the wealthier demographic segments in the near / medium term). However, such a campaign would likely be significantly resource-intensive with uncertain efficacy, given entrenched consumer preferences for rice.

INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

Note: (*) If included in program scope

Policy and financing

The rice value chain is situated within a wider ecosystem: here we focus on policy and finance as cross-cutting issues

Beyond the specific value chain for zinc rice there are a number of factors that could support or hinder ability to commercialize. In this analysis we focus on two: policy, and access to finance. Given the timeframe of the programme the current analysis focuses on early interpretation of policy and dome suggested ideas for finance that GAIN and HarvestPlus could leverage:[1]

- Interpretation of existing policy, rather than creation of new policies/changes to existing policies.
- Access to finance for value chain actors (rather than consumers).

In terms of 'policy', the analysis considers two types of policy: norms and standards. For zinc rice, we see two main barriers in policy:

Government support for zinc rice

While not blocking uptake, government could do much more to accelerate zinc rice adoption

Zinc rice standard-setting

There are currently no standards for "zinc rice" or zinc rice products in the market

(1) Beyond traditional pillars of [written] policy, and finance, there are deeper, often cross cutting issues that will impact on the ability of the biofortified crop to reach commercial pathways to scale:

1. Policy coherence – Do different decisionmakers have clear and aligned visions for how a biofortified system should work?
2. Institutional incentives – Is biofortification a priority or not?
3. Effective coordination – Are the different actors talking with one another? Are there clear platforms for alignment?
4. Capacity & agency – Do the different actors in the system have awareness as well as the technical capacity or general capabilities to scale biofortification?

Often these issues are very hard to influence, and outside the remit of GAIN/HarvestPlus to intervene in. However, they are important to note and track, especially where they are crucial to a given pathway e.g. Government capability as crucial to a public procurement led pathway

While the government has expressed support for nutrition programming, there is no current push to accelerate zinc rice adoption

- **Addressing "hidden hunger" and achieving nutritional requirements is a priority for the current government, where with guidance from the Institute of Public Health Nutrition (IPHN) different ministries have started collaborating on common goals.**
- **Overall, the Government of Bangladesh takes a supportive policy stance towards biofortification**. Biofortification has been included in major national plans, but **it is unclear how these policies have been implemented**. These policy documents include:
    - National Plan of Action for Nutrition (2016 2025): plans to "promote" the adoption of zinc rice
    - National Strategy on Prevention and Control of Micronutrient Deficiencies (2015 2024): promises to support research on and M&E of zinc rice's effectiveness
    - Second Country Investment Plan in Nutrition Sensitive Food Systems (2016 2020): biofortification will be "considered" as an intervention option
    - General Economics Division 7 th Five Year Plan (2016 2020): biofortification will be "explored"
- **Currently, promotion of zinc rice does not seem to be a significant priority for the Govt of Bangladesh.**
- **However, there are significant areas of policy overlap between government goals and potential interventions to advance the uptake of zinc rice.** Fighting malnutrition is a significant priority for government policymakers; zinc rice presents the opportunity to provide zinc micronutrient nutrition at scale.
- **Additionally, many barriers to scale can be addressed through government intervention.** The Government of Bangladesh has existing systems – e.g., the Department of Agricultural Extension – through which it can reach farmers at scale to promote the uptake of biofortified seeds for production for both on-farm consumption (if included in program scope) and market sale. Additionally, it is also well-positioned to take the lead on consumer awareness-building and demand-creation for zinc rice products.
- **The government rice procurement program offers another good opportunity to support uptake of zinc rice consumption**. The government programs cater to the lowest-income quartiles in the country and usually offers the cheapest available rice options. This could be a small but significant vehicle to reach the consumers who likely need the necessary support to reach nutritional requirements.
- **Therefore, targeted advocacy is critical**, particularly to key ministries and policymakers, to push higher zinc rice adoption

There are currently no standards for zinc rice as a product, increasing risk for value chain actors entering the market

- **There are no common standards for zinc rice paddy or zinc rice products.** Millers, retailers and consumers have no way to ensure that the products they are purchasing are genuinely zinc rice, or that they have a high enough zinc content to be effective nutrition interventions.
- **Additionally, the government generally does not set quality standards for value-chain actors;** it lacks an effective testing and enforcement mechanism for any key standards for zinc rice products that are enacted.
- **Because of this, there is a significant risk of zinc rice counterfeiting or other perverse incentives that could confound potential interventions.** Any potential interventions that aim to alter the unit economics of zinc rice production (e.g., subsidies) will face significant challenges in verifying that millers and other value chain actors are creating zinc rice products to GAIN and HarvestPlus's expected specifications

Opportunity | Policy

Key opportunity area	Description
On-farm	• Work with the Department of Agricultural Extension to improve farmer awareness.
Government	• Work with policymakers designing public food distribution programs to preferentially buy zinc rice as a part of government procurement.
Retail	• Work with ministry of health to include zinc rice in their mass-media nutrition campaigns. • Set clear standards for zinc rice and zinc rice products • Create blanket requirements for minimum zinc levels in packaged rice products.

INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

Financing interventions could be used to support value chain interventions highlighted in previous sections

Illustrative financing interventions potentially funded by development sector actors and / or Government of Bangladesh – *for discussion*		
Instrument	*Target beneficiaries*	*Description*
Cash incentives / Conditional cash transfers	• Farmers • Millers	• Cash incentives or discounts could be provided to farmers to reduce effective cost of zinc rice seeds, improving their agronomic competitiveness – relevant especially for new / upcoming zinc rice varieties expected to be competitive with other popular varieties • Conditional cash transfers could be provided to millers or farmers who produce or process verified zinc rice / paddy – funding could be provided on a per ton basis
Lending incentives	• Farmers • Millers	• Blended agri-finance instruments could be developed to provide lower cost debt to farmers or millers who produce or process verified zinc rice • Zinc rice producers / processors could be provided with preferential credit terms via commercial banks with the policy support of finance ministry and the central bank
Direct policy incentives	• Millers	• Government of Bangladesh could provide structural incentives (e.g., tax benefits) to millers who process verified zinc rice paddy as a certain % of their output
Programmatic financial support – typically grants	NA	• For pure public-good type interventions, like awareness, financing partnerships could be developed between the government and development sector to pilot innovative methods and roll out at scale

Essential to provide financial incentives only for the ramp up / increase in adoption phase – incentives can ramp down once consumer preferences evolve in favor of zinc rice and a critical mass of dedicated consumers is developed

Open questions to explore in further research

1. How feasible are interventions in each of our potential opportunity areas? Do they align with GAIN/HarvestPlus capabilities and resources? What key partners could be engaged to collaborate on these interventions?

2. What is the potential scale unlocked through interventions in each of our potential opportunity areas?

3. Who are the key actors in the agri-financing landscape in Bangladesh by group (e.g., DFIs, donors, national banks)? What are their:
    1. Preferred instruments
    2. Key focus
    3. Total volume

4. What is the potential market impact of new / future varieties of zinc rice (e.g., BRRI-84)? Are they better fit for scale than varieties that have existing market share (e.g., BRRI-74)

Annex

Unlocking these pathways for commercialization of zinc rice would require focusing on interventions cutting across the demand segments

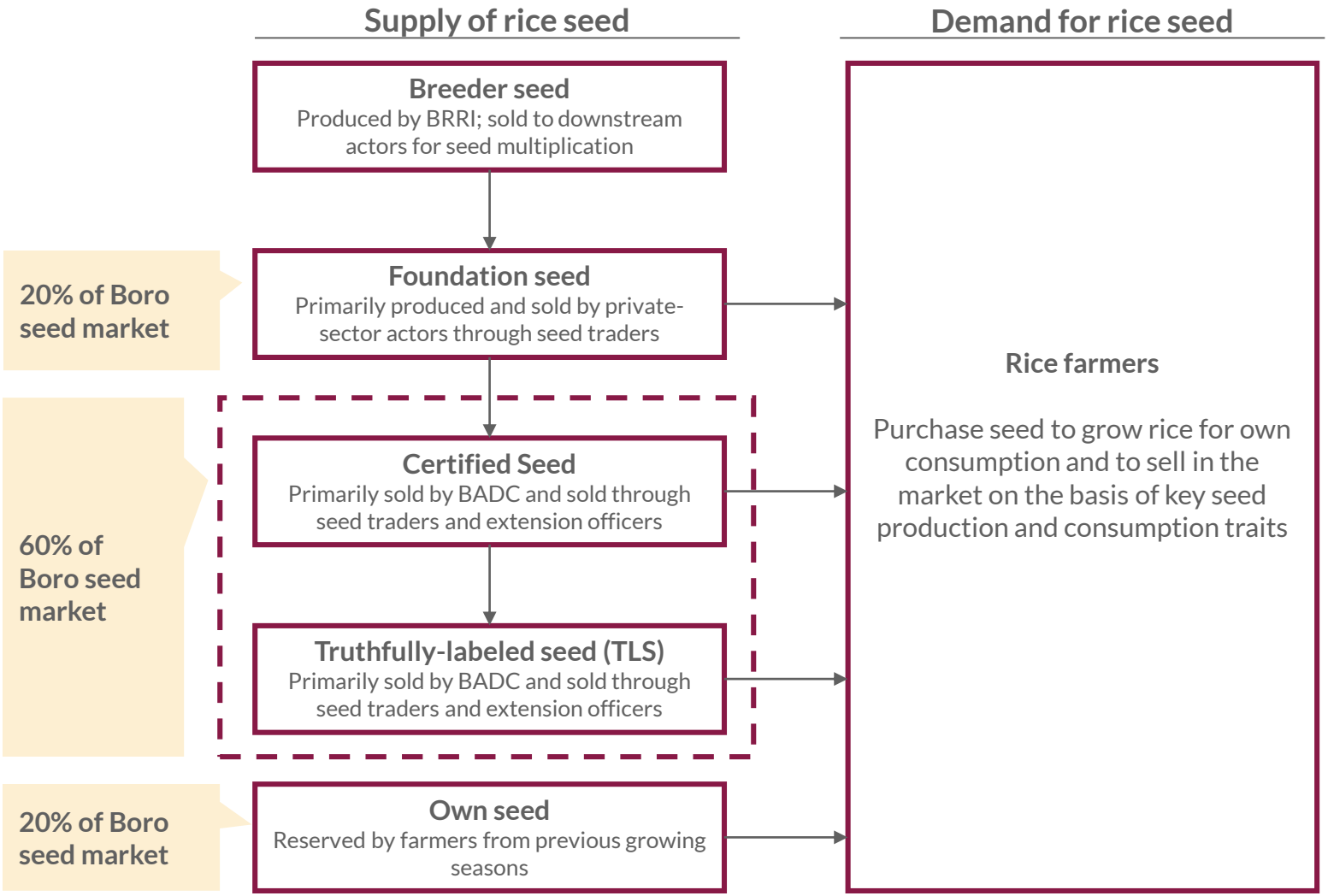
To assess the path to commercialize zinc rice, **we have segregated the rice produced in Bangladesh into three demand based segments**: (i) on-farm consumption by farmers (if that is within program scope), (ii) government procurement, and (iii) retail consumption. **Initial hypotheses around potential interventions to accelerate commercialization through each of these pathways are presented below**

IDEATION GRID

Opportunity	Demand generation pathways		
	On-farm consumption	Government programs and procurement	Retail consumption
	Short- medium term		*Long term*
Agronomically competitive zinc rice seeds to activate the **pre-farm and on-farm** parts of the rice value chains	Incentive for farmers to buy zinc rice seeds for their own-consumption		
Differentiated supply chain to enable **post-farm** distribution of zinc rice as a product		Partnering with the government on their welfare programs	Partnering with millers
Awareness about availability of zinc rice and its value proposition for **consumption** uptake	Increasing farmer reach through agri extension partnerships or through existing farmers growing zinc rice using programs like refer-a-friend. Creating awareness about the availability of zinc rice seeds in the market and the benefits associated with consuming zinc rice.		Influencing rice consumers' preference towards making conscious choices of nutritional products by running educational programs about the importance of nutrition when choosing rice.

INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

The rice seed system in Bangladesh supplies three grades of seed to farmers; famers also reuse seed from previous seasons



Source: (1) Interview with HarvestPlus

Zinc rice seeds are produced by BRRI and private seed producers (ASI, Supreme Seed Co.) and marketed to farmers through HarvestPlus and other extension programs

	Seed R&D	Seed production	Seed sale and distribution
Features	• Eight varieties of zinc rice released • BRRI dhan-62 and BRRI dhan-74 most popular • BRRI dhan-84 and BINA dhan-20 newly released, may have scale potential	• BRRI produces breeder seeds and released them to seed multipliers based on assessed market demand • Private seed multipliers produce foundation seed one year after receiving breeder seed • BADC produces certified, and truthfully-labeled seed two years after receiving breeder seed	• The formal rice seed market accounts for around 80% of the total seed market[1] • 60% of the seed market is comprised of certified/TLS seed, while ~20% of the seed market is comprised of foundation seed
Actors	• BRRI leads the development of new varieties in coordination with HarvestPlus; BRRI produces all breeder seed • BINA has begun to develop new varieties of zinc rice (e.g., BINA dhan-20)	• BRRI produces breeder seed and allocates it to private sector actors and BADC (~50% of seed market)[1] • Several large seed companies (ASI, Supreme Seed, BRAC) and more than 1,000 other smaller companies multiply seeds[3]	• 18,000 registered seed dealers in Bangladesh[3]
Economics	• BRRI produces 140 tons of breeder seed for Boro varieties and 60 tons of breeder seed for Aman varieties • Last year, across both seasons, around 20 tons of zinc rice breeder seed was produced[2]	• Breeder seed is sold for ~300 BDT/kg to seed multipliers • Private seed multipliers realize a margin of 10-20 BDT/kg[1]	• ~160,000 MT of seed is sold each year • Foundation seeds retail for 70-80 BDT/kg while certified/TLS seeds retail for 50-60 BDT/kg[1]

Source: (1) Interview with HarvestPlus, (2) interview with Dr. Khalequzzaman, BRRI, (3) Sohol Parvez, "Seed market grows, led by private firms," *The Daily Star*, 2014.

Major barriers to scaling the production of biofortified seeds include agronomic competitiveness and time lag for seed production

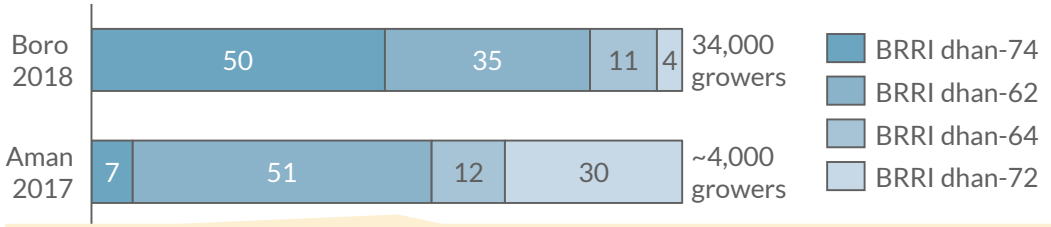
	Research and development	Seed production	Seed marketing
Features	• Eight varieties of zinc rice released • BRRI dhan-62 and BRRI dhan-74 most popular • BRRI dhan-84 and BINA dhan-20 newly released, may have scale potential	***Barrier 1*** **Time lag for demand and uptake** It takes several years for value chain actors to produce seed in response to perceived market demand and for uptake to grow for new varieties	• The formal rice seed market accounts for around 80% of the total seed market[1] as farmers tend to re-use seeds from previous seasons or collect from friends and family • 60% of the seed market is comprised of certified/TLS seed, while ~20% of the seed market is comprised of foundation seed
Actors	• BRRI leads the development of new varieties in coordination with HarvestPlus; BRRI produces all breeder seed • BINA has begun to develop new varieties of zinc rice (e.g., BINA dhan-20)	• BRRI produces breeder seed and allocates it to private sector actors and BADC (~50% of seed market)[1] • Several large seed companies (ASI, Supreme Seed, BRAC) and more than 1,000 other smaller companies multiply seeds[3]	• 18,000 registered seed dealers in Bangladesh[3]
Economics	• BRRI produces 140 tons of breeder seed for Boro varieties and 60 tons of breeder seed for Aman varieties • Last year, across both seasons, around 20 tons of zinc rice breeder seed was produced[2]	• Breeder seed is sold for ~300 BDT/kg to seed multipliers • Private seed multipliers realize a margin of 10-20 BDT/kg[1]	***Barrier 2*** **Agronomic competitiveness** Existing zinc rice varieties may not be able to directly compete with the most popular rice varieties

Currently, eight varieties of zinc rice are available in the market where BRRI dhan-74 is most widely adopted while BRRI dhan-84 may have high scale potential

Zinc Rice	
Delivery stage	Saturation
Number of varieties released	**First wave:** *BRRI dhan-62, BRRI dhan-64* **Second wave:** *BRRI dhan-72, BRRI dhan-74, BU Hybrid Rice 1, BU dhan-2* **Third wave:** *BRRI dhan-84, BINA dhan-20*[1]
Household reach	Cumulative reach of ~500,000 households; yearly reach of ~120,000+ households[2]
Volumes	~135,000 MT[2]
Agronomic characteristics	**BRRI dhan-74** (most prevalent variety): coarse grained, 7.0-7.5 MT/ha yield, 145-147 day life cycle
Nutritional characteristics	**BRRI dhan-74**: 22.7 mg Zn/kg (+6.5 mg/kg over reference variety)

Market composition of zinc rice seed purchasers[1]

Aman and Boro seasons, 2017-18, % of zinc rice seed purchasers



BRRI dhan-74 is the most popular variety of rice overall and is largely grown in Boro season, when most farmers purchase seed; BRRI dhan-62, while traditionally an Aman variety, has significant market share in both seasons

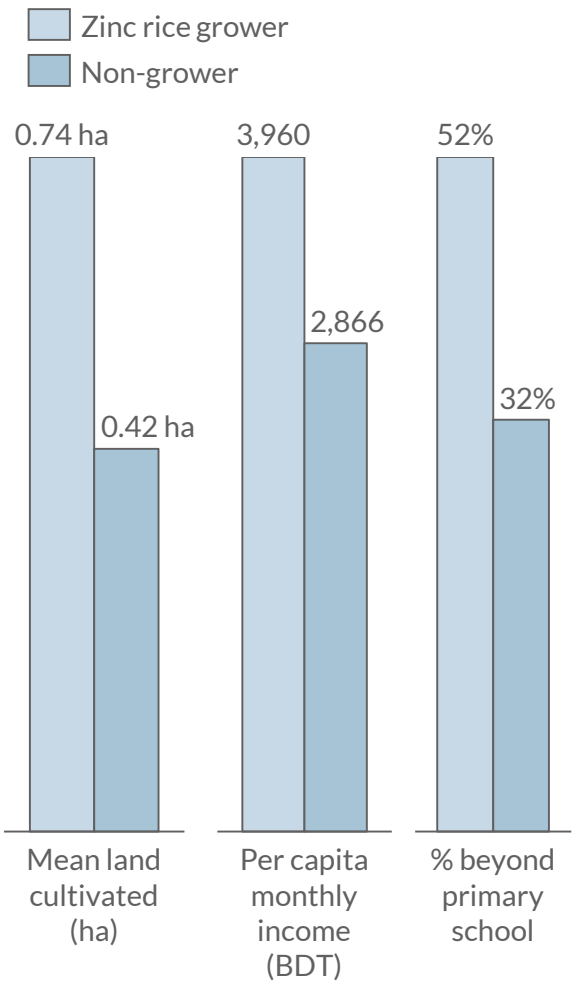
	BRRI-74	BRRI-62	BRRI-84	BINA-20
Release year	2015	2013	2017	2017
Season	Boro	Aman	Boro	Aman
Grain type	Medium bold	Long slender	Medium slender	Long slender
Yield (MT/ha)	7.0-7.5	4.0-4.5	6.5	4.5-7
Grain market price (BDT/kg)[3]	15	20	20	20
Estimated revenue (BDT '000/ha)	108	85	130	90

BRRI dhan-74 has highest yield, but fetches a lower market price because it is a coarse rice. BRRI 84, while it has lower yield, may be more attractive to farmers because it is a fine rice and retails for a higher price.

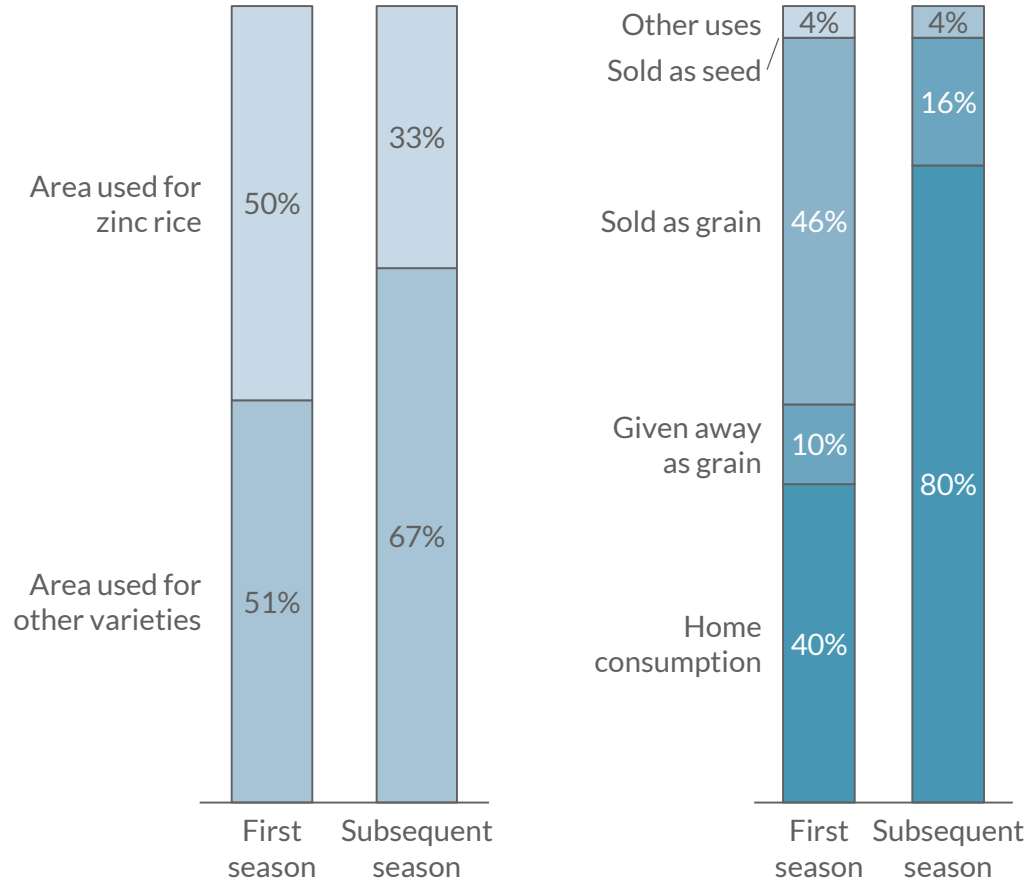
Source: (1) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 ; (2) Technoserve, "HarvestPlus Bangladesh Final Report," 2018. (3) Focus groups with farmers and millers in Sherpur, Bogra
Notes: (*) Compared to a reference amount of 16 mg/kg

Existing zinc rice farmers are slightly wealthier marginal farmers who grow smaller amounts for household consumption

Current zinc wealth farmers are wealthier and more well-educated than non-growers[1]
Zinc rice growers compared to non-growers



Repeat growers of zinc rice tend to grow smaller amounts of it for their own consumption rather than selling it into the market[1]
Segmentation of farm households by cultivated area, %



Source: (1) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019

Revenue calculation for biofortified seed varieties

Seed	Expected yield (MT/ha)[1,2]	Expected grain sales price (BDT/kg)[3]	Expected revenue (BDT'000/ha)
BRRI-84	6.5	20	130
BRRI-28	6.2	20	124
BRRI-29	6.1	20	122
BRRI-74	7.25	15	109
BINA-20	4.5	20	90
BRRI-62	4.25	20	85

Procedure

- Grain sales price is multiplied by 1,000 to convert to BDT/MT
- Expected yield is multiplied by expected sales price to create expected revenue

Key assumptions

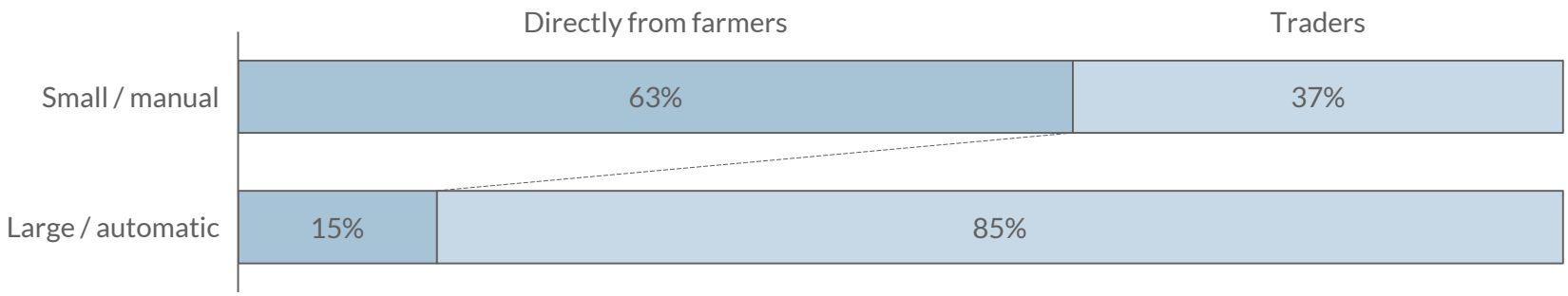
- BRRI-84 will be sold to millers at the fine-grain sales price (20 BDT/kg) rather than the coarse grain sales price (15 BDT/kg)
- The expected yield of all varieties is the midpoint of the estimated range of their yield (e.g., the expected yield of a variety estimated at 7.0-7.5 MT/ha is 7.25 MT/ha)
- This does not take growing time into account

Source: (1) HarvestPlus, "Results from the Bangladesh High Zinc Rice Adoption Study," 2019 ; (2) Technoserve, "HarvestPlus Bangladesh Final Report," 2018, (3) Interview with National Agricare and farmer and miller focus groups

Large millers do not procure directly from farmers, making it difficult to create segregated supply chains for zinc rice

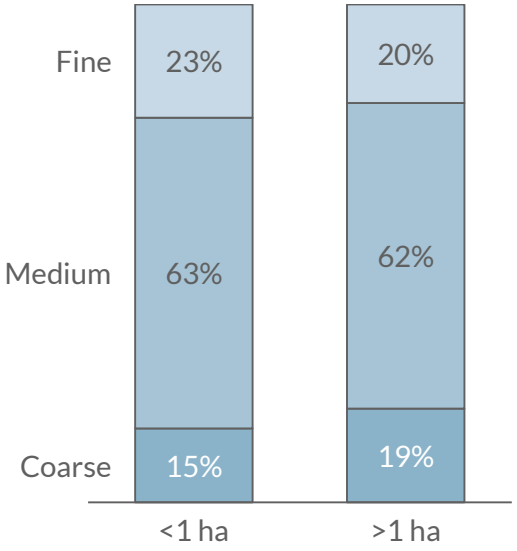
Large millers, who have the capacity to produce differentiated products, procure nearly all of their rice paddy from traders[1]

Source of rice paddy as a % of all rice paddy purchased, 2009



Farmers sell their paddy to aggregators based on the quality of the rice, rather than by the variety itself. Varieties with similar grades (e.g., coarse, medium or fine) are mixed together after the farmgate when aggregated by traders and millers[1]

Total rice production disaggregated by grade and farm size, %, 2009



"We tend to process about four or five grades of rice – from coarse to katali [a superfine grade]. We buy paddy for these grades from traders" – *a large commercial miller, from miller FGD[2]*

"We buy all kinds of rice from farmers, and pay them based on the rice's quality. We process rice [of similar grades] together" – *a small village miller, Miller FGD[2]*

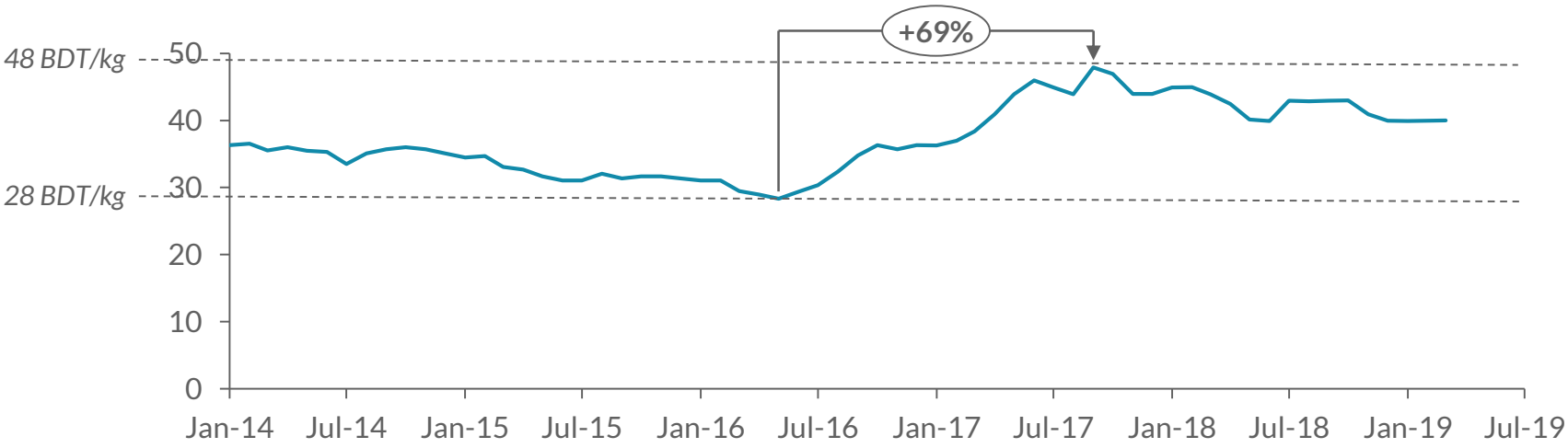
"All varieties of rice get mixed up in the market. This is a significant challenge for zinc rice. To create a branded zinc rice product, a new, separate supply chain will be required" – *Dr. Khalequzzaman, BRRI[3]*

Source: (1) Reardon, et al. "The quiet revolution in staple food value chains: enter the dragon, the elephant, and the tiger," 2012. (2) Miller FGD, Sherpur, Bogra, 14/09/19. (3) Interview with Dr. Khalequzzaman, 15/9.19

Over the last five years, the price of coarse rice in Bangladesh has fluctuated significantly for a staple good

While rice prices remain relatively stable from month-to-month over the last five years, there has been significant overall variance in the spot price of coarse rice for consumers [1]

Average monthly price for coarse rice (in BDT/kg), 2014-2019



Year	Price Range (BDT/kg)				
	Min	*25%*	*50%*	*75%*	*Max*
2014	33.52	35.25	35.62	36.01	36.55
2015	31.04	31.35	31.66	32.77	34.69
2016	28.32	29.46	31.04	35	36.32
2017	36.27	40.29	43.92	45.18	47.88
2018	39.90	40.73	42.89	43.21	44.98
Total	**28.32**	**32.51**	**36.01**	**41.68**	**47.88**

Source: (1) Department of Agricultural Marketing and Trading

The government serves as an end consumer of rice through price stabilization and food distribution programs

Government intervention in rice markets[1]		
	Price stabilization	**Public food distribution programs**
Description	The government buys rice immediately post-harvest from farmers, millers and wholesalers and sells it into the market over time to maintain a price floor for farmers and to stabilize the price of rice for consumers. This process occurs in both Boro and Aman seasons.	The government purchases rice from millers and wholesalers for use in its social safety net systems (e.g., food-for-work, school feeding programs)
Amount of rice procured / used (% of total harvest)	Generally ~3%, although this varies year-over-year depending on market conditions	Generally <5%
Impact on consumer demand	Stabilizes rice prices both within and across years for price-sensitive consumers	Fills some of the demand for rice from the poorest and most vulnerable populations

While price stabilization programs are unlikely to be a meaningful source of demand for zinc rice, **there is a strong impact case for working with government to preferentially integrate zinc rice into public food distribution programs,** which provide consistent demand

Source: (1) Dorosh and Shahabuddin, "Rice Price Stabilization in Bangladesh: An Analysis of Policy Options," 2002.