Dalberg

Commercialization Assessment: Zinc Wheat in India

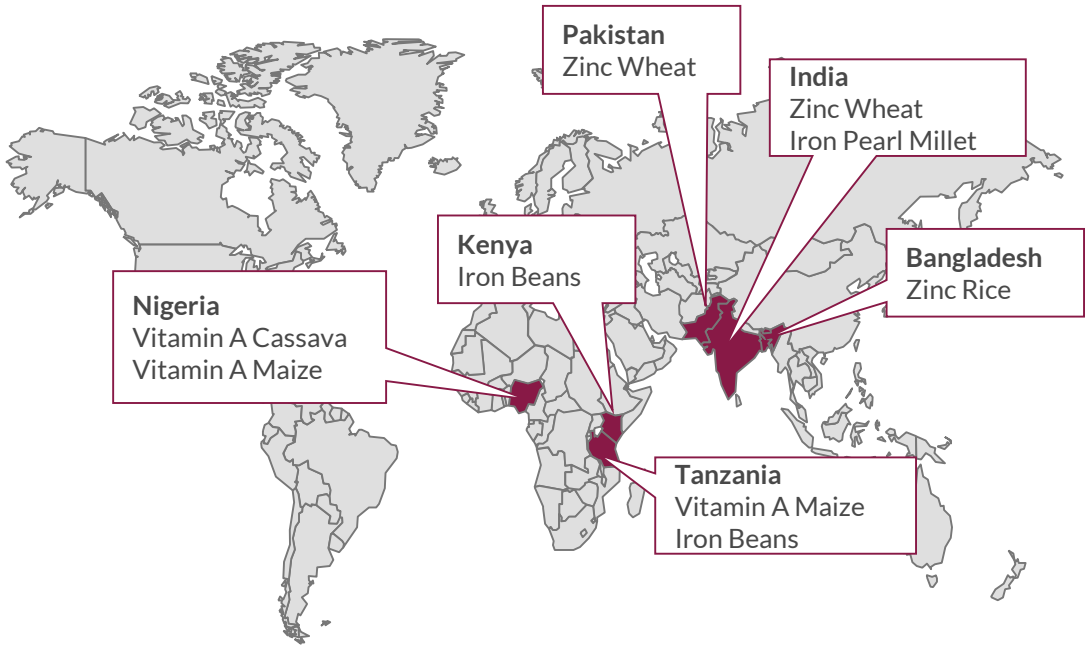
FINAL REPORT FOR GAIN AND HARVESTPLUS

DECEMBER 2019

Recap: Program context

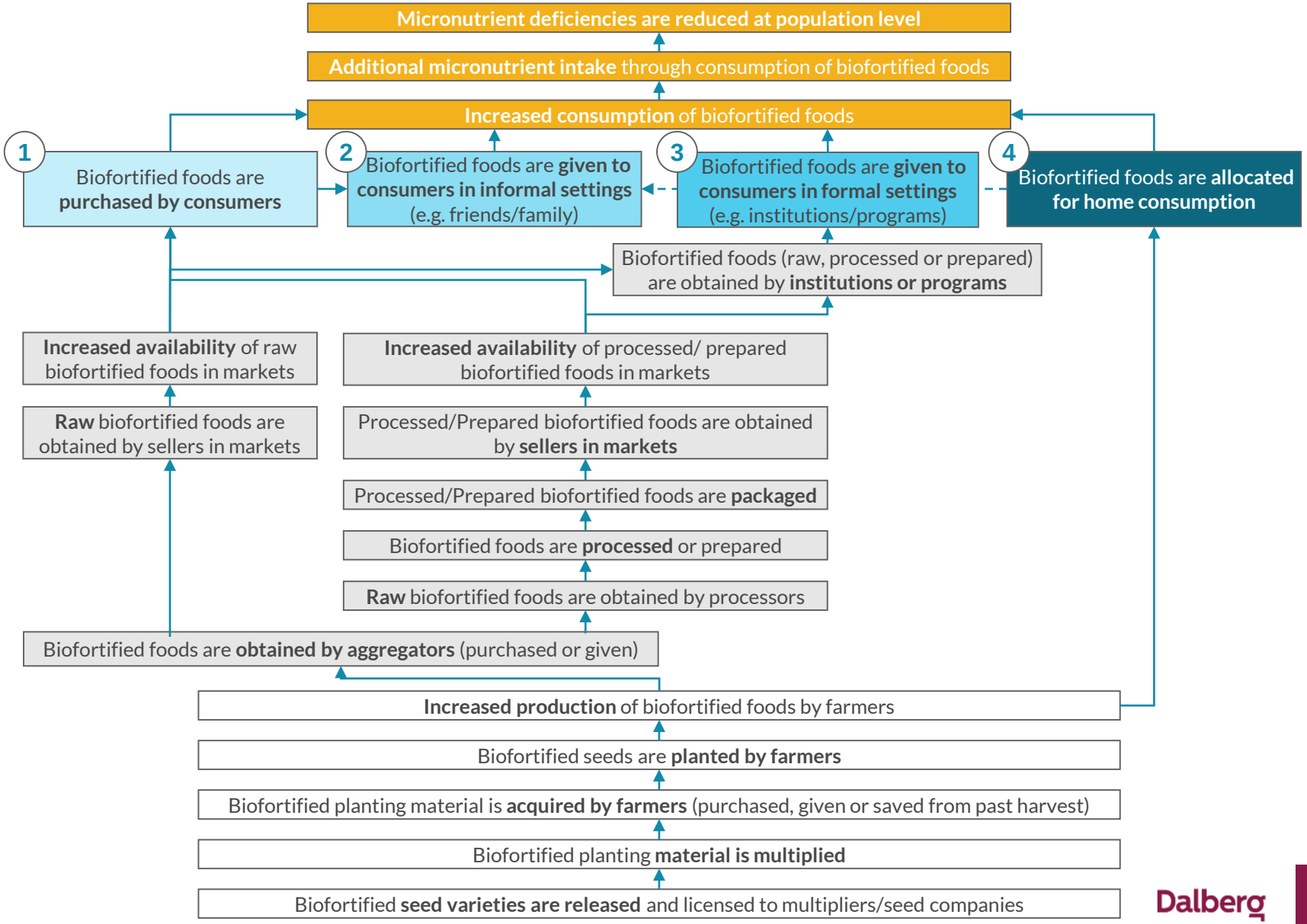
- GAIN and HarvestPlus share an ambition to expand coverage of biofortified nutrient dense foods to at least 200 million consumers. The overall vision of this program is to scale up the commercialization of biofortified foods. Zinc wheat in India is one of the nine selected crop/country combinations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

- 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 wheat in India 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 Program Impact Pathways in two ways
  - The potential routes to scale are codified in terms of the Program 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 program 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 a subset of the program Impact Pathways.** GAIN's definition, for this program, 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 program, 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".

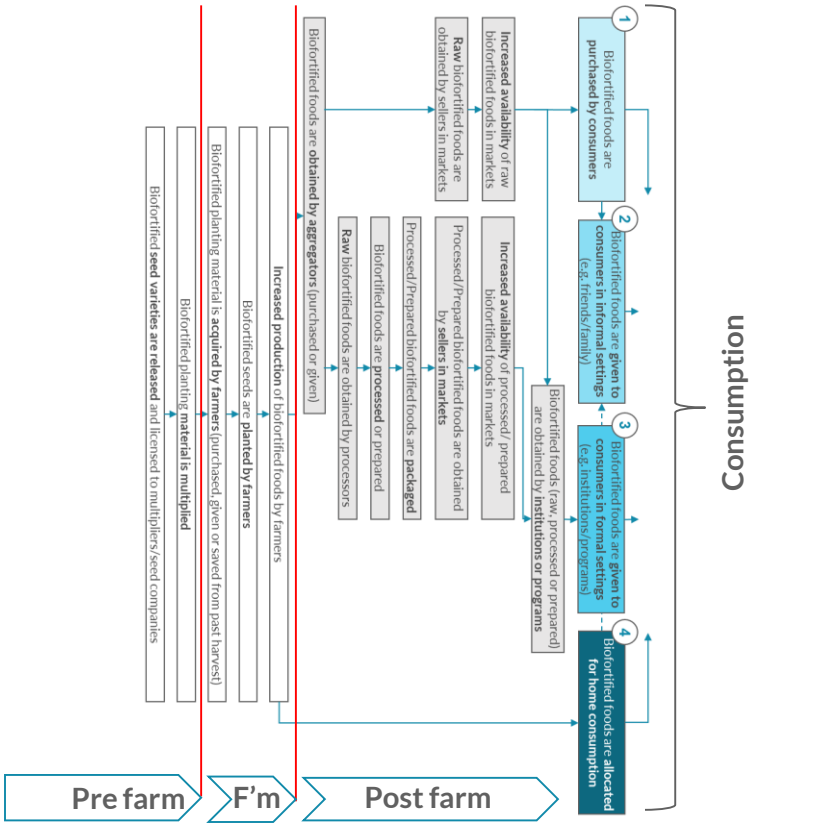
Alignment on the understanding of commercialization will potentially have significant impacts for scale that is feasible, programming, and resource allocation across the portfolio, amongst other things. On farm consumption and public procurement are significant parts of the value chains for a number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

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

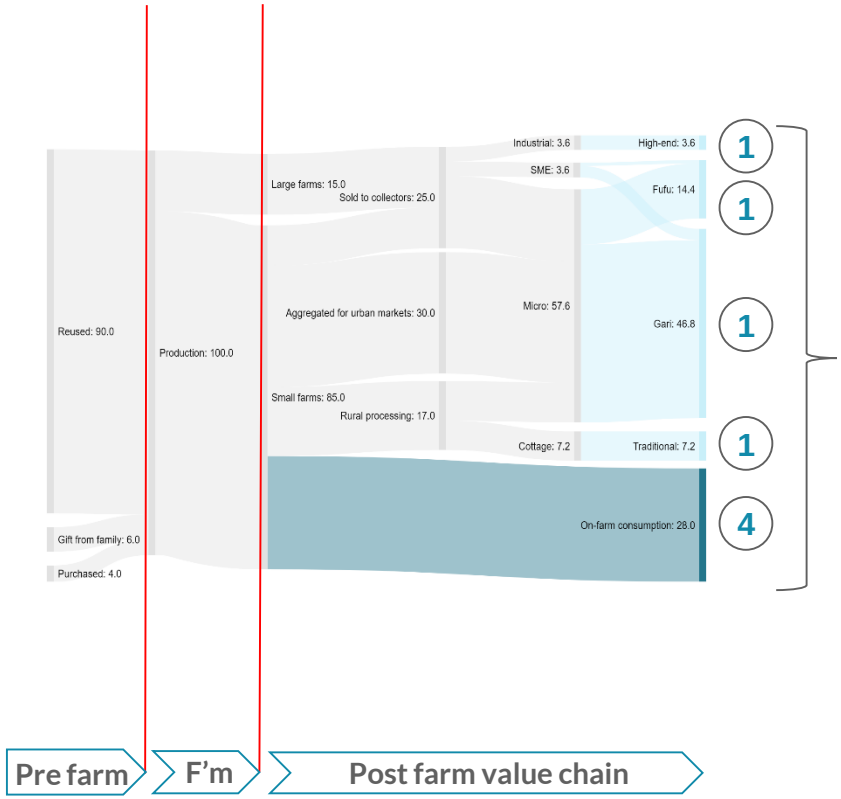
How to read this report (1/2)

This report assesses the potential for commercialization of the crops through the program Pathways. This page highlights how the pathways correspond to a crop value chain. Note below right that there may be >1 'channel' for each Pathway e.g. biofortified foods could be purchased through a number of value chains. Note also that not every Pathway might be material for each crop e.g. Pathways 2 and 3 are not listed below right.

Conceptual outline of the value chain



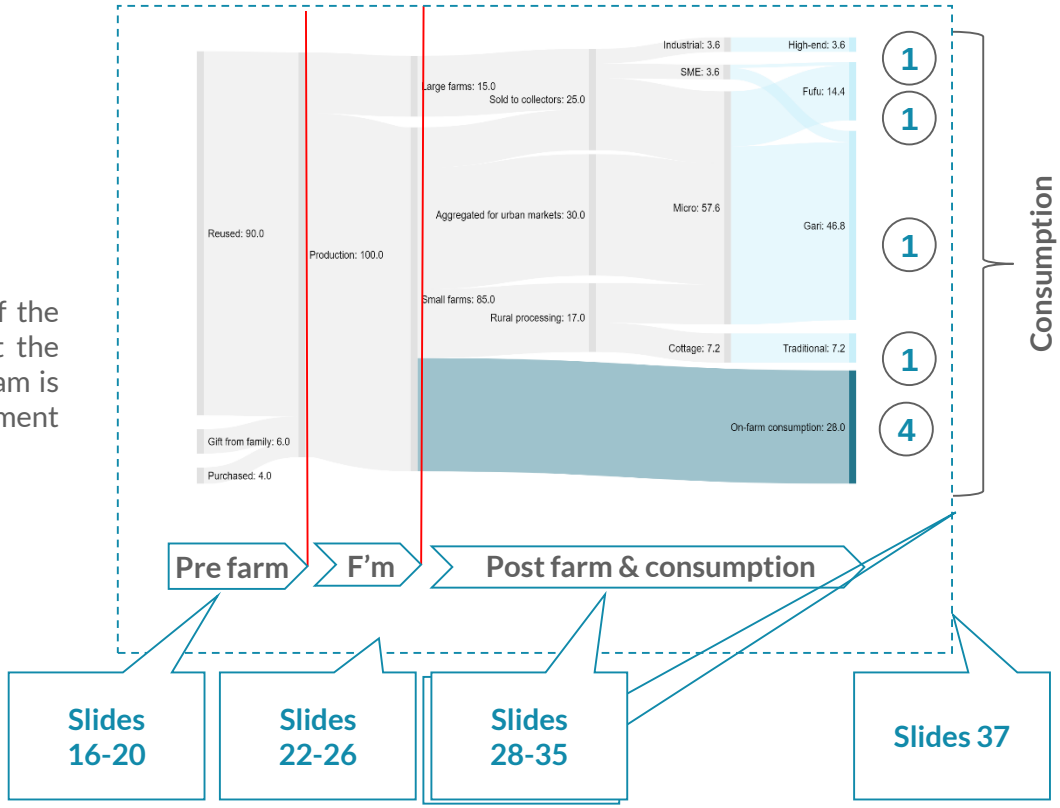
'Sankey diagram' showing relative flows through the value chain



How to read this report (2/2)

- This report is broken down into six sections:
  - Executive summary
  - Pre farm value chain
  - On farm
  - Post farm value chain and consumption
  - Cross cutting drivers of consumption
  - Policy

- 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



Executive Summary

Zinc wheat: Overview

Summary: *Farmers likely have high latent demand for zinc wheat because of its yield advantage. However, low farmer awareness and weak state seed companies slow adoption. GAIN and HarvestPlus should grow zinc wheat's market share by partnering with processed food companies to develop segregated supply chains for zinc wheat. Providing capacity building to seed companies and advocating for premium pricing in government procurement can grow market share further. Any commercial pathway must establish a reliable system for avoiding dilution of zinc wheat with analogue varieties – a major challenge.*

- **Zinc deficiency is associated with diminished immune function, stunting, diarrheal disease, and a host of other health challenges.** Approximately 300 million Indians are zinc deficient (22% of the population), including about 56 million of children under age five (or 44%). Zinc deficiency is a contributor to 6,000 children under the age of five dying of malnutrition each day[1].
- **Wheat, the primary staple crop in much of India, can be fortified with zinc, which would help eliminate zinc deficiency if consumed.** Throughout India, average daily wheat consumption is 43 kilograms (kg.) per year in rural areas and 43 kg per year in urban areas.[2] All in all, wheat is responsible for 20% of Indians daily caloric intake.[3] Outside of southern India, average consumption is even higher. Daily intake of zinc wheat can provide up to 50% of daily zinc needs.[4] Converting this consumption to biofortified varieties of wheat could significantly reduce the prevalence of zinc deficiency. HarvestPlus estimates that the share of the target population for zinc wheat is highest in Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, and Himachal Pradesh.[5]
- **While zinc wheat is a promising solution, production and consumption is currently small scale.** In 2018, an estimated 380,000 farming households produced and consumed zinc wheat[6]. Adoption is low despite some 2nd Wave varieties (such as SHD2769, WB02, BHU25, BHU31) achieving 5-10% higher yield than analogue varieties, with equivalent performance on hedonic factors at comparable prices.
- **To assess the potential for broader commercialization of zinc wheat, we focused our analysis on three market segments:** (i) on-farm consumption, which is 40-50% of the market, (ii) rural consumption, which is ~15% and (iii) urban consumption, which is ~7%. In addition to these consumer markets, ~25% of wheat produced is purchased by the government and stored as surplus stock. We did not consider this "segment," as stakeholders indicated much of the wheat procured is ultimately lost.

(1) Smith MR, et al. Inadequate Zinc Intake in India: Past, Present, and Future. Food and Nutrition Bulletin. 2019. (2) Funes, J., et al, "Subnational BPI – India," 2016 Jul. (3) Shewry, P. R. and Hey, S. P., "The contribution of wheat to human diet and health," *Food and Energy Security*, 2015 Oct. (4) HarvestPlus website, retrieved Sep 21 2019 (5) Funes Jose, Birol Ekin, Moursi Mourad and Manfred Zeller, "Subnational BPI – India" HarvestPlus, IFPRI, 2016 July. (6) GoI, 'Agricultural Statistics at a Glance, 2018', 2019

Zinc wheat: Barriers to commercialization

- **Even with the yield benefit of 2nd Wave varieties, penetrating these market segments could take years** if over-arching barriers are not addressed. One over-arching barrier is cross-cutting – inhibiting on-farm, rural, and urban consumption – and two are specific to rural and urban consumption. (On-farm consumption, though it may be out of GAIN and HarvestPlus's program scope, faces relatively fewer barriers due to its short supply chain.)

  Cross-cutting all the market segments:

  1. **Low capacity of state seed companies may delay their conversion to zinc wheat, despite farmers' latent demand for 2nd wave varieties potentially being substantial.** Accounting for 80% of the wheat seed sector, state seed companies have modest resources and capacity, and lack incentives to respond to market demand. Securing sufficient volumes of breeder seed is a challenge to multiplying new varieties. In addition, their on-the-ground promotion and education activities are limited. Without representatives of seed companies demonstrating the yield benefits of zinc wheat, farmers are likely to be slow to switch to a variety they have no experience with.

  Specific to *rural* and *urban consumption*:

  2. **The absence of a segregated supply chains to maintain the consistency of varieties of wheat reduces the nutritional impact of zinc wheat.** The operating model of informal aggregators and millers is to combine wheat from various sources into a single product. This practice leads to the dilution of zinc wheat with non-biofortified varieties. Diluting the flour lowers zinc wheat's nutritional impact on each individual consumer.
  3. **Absence of political will may deter potentially supportive procurement policies and regulations** (to be confirmed through further research). Some stakeholders indicated that government officials assign lower priority to promoting zinc than to other micro-nutrients. Perhaps evidence of this attitude is the recent government decision to fortify wheat in the midday meal scheme with six micronutrients, but not zinc. According to at least one government stakeholder, in the eyes of some public officials, the health case for zinc still needs to be made. Moreover, the vast number of farmers reliant on wheat for their livelihood may encourage caution on the part of policy-makers. Going forward, we will seek to gather additional input from government stakeholders to enable a more definitive perspective on the extent to which political will impedes commercialization. This will also require disseminating health research to policymakers to establish the health case for zinc and the impact of zinc deficiency on high-priority outcomes (e.g. infant mortality[1], stunting in children[2]).

(1) Ministry of Health and Family Welfare, 'National Health Policy – 2017', 2017; (2) NITI Aayog, 'Nourishing India – National Nutrition Strategy, Government of India', 2017

Zinc wheat: Recommended interventions (1/3)

- **As a first priority, we recommend GAIN and HarvestPlus work with major food processors to target upper-middle class health conscious consumers within the urban consumption segment.** The health conscious urban sub-segment is small – composed of approximately 90 million people – but commercially appealing. Consumers in this sub-segment that buy-into the zinc wheat value proposition can pay premium prices for branded health products, creating incentives for processors to build a segregated zinc wheat supply chain. In addition, the purchasing habits of this high end sub-segment may gradually trickle down to less affluent customers and help create a mass market for unbranded zinc wheat products.

  GAIN and HarvestPlus can support food processors by: (i) working with seed companies to produce sufficient volumes of zinc wheat varieties aligned with processors' needs, (ii) supporting farmers in producing consistent supply, and (iii) establishing a credible verification system that enables processors to stand behind their claims. A few processors, like ITC, are engaged in contract farming already. They may have the know-how to build a zinc wheat supply chain themselves, but potentially could use support in establishing a nutrition content verification system.

  This intervention would address Barrier 1 (through linkages with state seed companies, where appropriate) and Barrier 2 (through verification systems and other methods).

- **As a second priority[1], we recommend that GAIN and HarvestPlus provide a broad package of support to public seed companies**, including increasing the availability of breeder seed**.** This intervention can increase conversion to zinc wheat most dramatically through the on-farm consumption segment (though this segment may be out of program scope). It is the largest segment (at 45%) and is not affected by variety mixing by aggregators' and millers and the resulting dilution of zinc content. Conversion to zinc wheat is also possible through rural consumption (at 35% of the market) if adoption rates on neighboring farms is high.

(1) We consider this a second priority, not first, because the segment it would affects most directly is on-farm consumption

Zinc wheat: Recommended interventions (2/3)

State seed companies (limited to one per state) control 80% of the wheat seed market and shifting them to zinc wheat could have outsize impact on the market. For example, enhancing the capacity of the Bihar state seed company could result in 4.6 million (M) tons of zinc wheat (80% out of a total of 5.7 M tons produced in the state[1]); through the Uttar Pradesh state seed company, 25.5 M tons could be converted to zinc wheat (80% of 31.9M tons[2]).

GAIN and HarvestPlus could support state seed companies: by (i) increasing access to breeder seed, (ii) providing technical assistance on farmer promotion and education activities, and partnership building with local agri-extension agents, (iii) and offering marketing support. State seed companies, which are bound to execute the government's policy push for nutrient rich crop development, are likely to be receptive to partnering with GAIN and HarvestPlus even if they are not the most agile enterprises in the seed market.

To reduce the potential of selling a diluted product to rural consumers, GAIN and HarvestPlus should target circumscribed areas, potentially creating a geographic "brand" for zinc (e.g., as Madhya Pradesh enjoys for its varieties of wheat). Scaling up zinc wheat production in specific areas could reduce potential for dilution with non-zinc wheat varieties.

This intervention would directly address Barrier 1 (by strengthening state seed companies) and could address Barrier 2 (by concentrating adoption of zinc wheat in specific geographic areas).

- **In addition, we recommend GAIN and HarvestPlus advocate for and support implementation of premium pricing for zinc wheat within the government's Minimum Support Price (MSP) program[3].** The price farmers receive through the MSP is a driver of farmers' crop decisions. Establishing tiered pricing for wheat, with zinc wheat garnering a premium, would shift farmers' cost-benefit calculations and lead to rapid uptake. GAIN and HarvestPlus could facilitate inclusion of tiered pricing in the MSP by: (i) disseminating research to establish the health case for zinc wheat, (ii) lobbying the Ministry of Consumer Affairs for adapting the MSP, and (iii) supporting the Food Corporation of India in establishing a system for verifying zinc content.

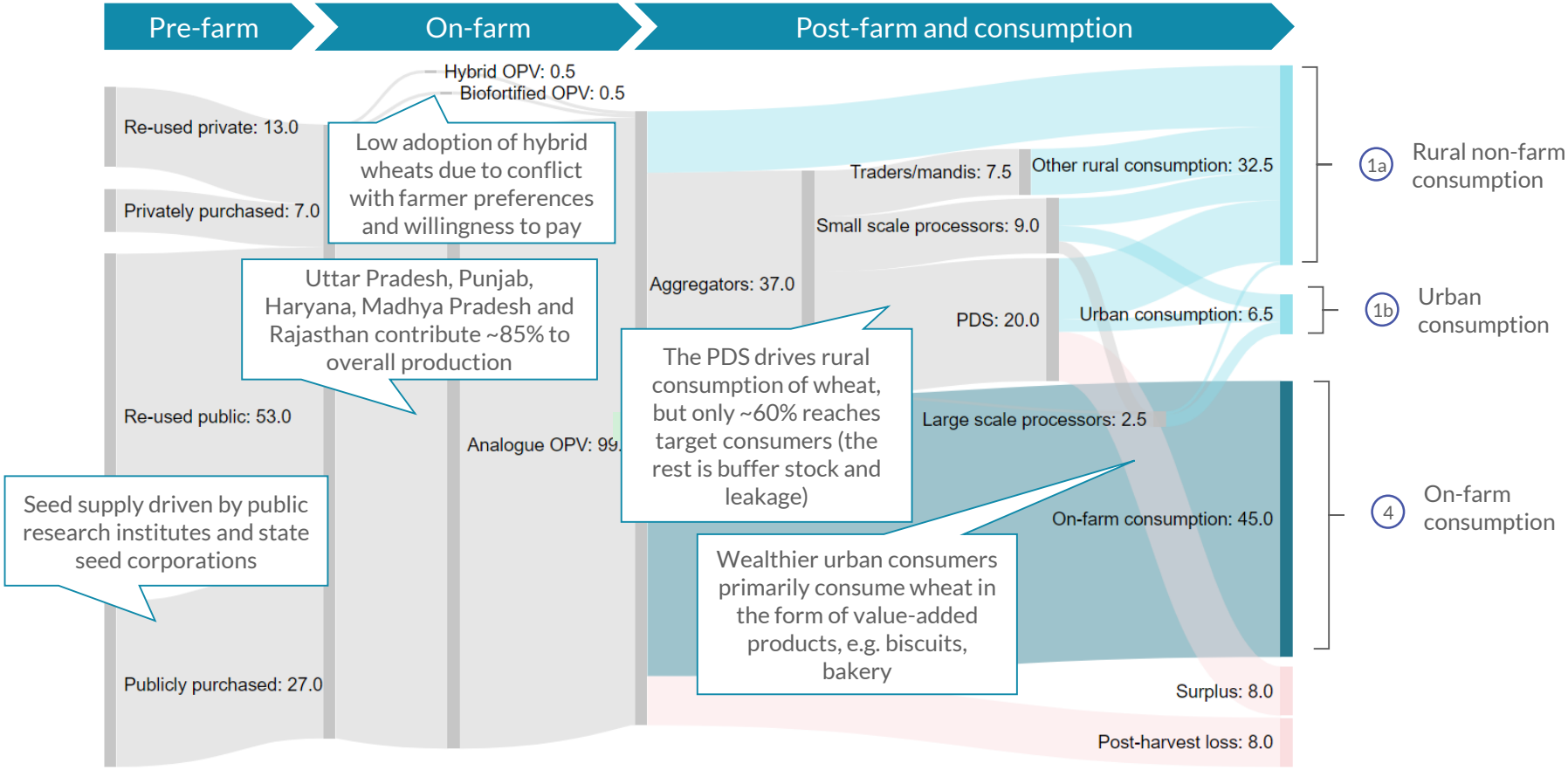
(1) Ministry of Agriculture and Farmer Welfare, 'Agricultural Statistics at a Glance, 2018', 2019. (2) Ibid; (3) 'Premium pricing' here refers only to the Minimum Support Price for zinc wheat, i.e. the price at which the government procures from farmers; this does not necessitate a higher price point for the end consumer, who may be cost-constrained

Zinc wheat: Recommended interventions (3/3)

- In a recent Department of Agriculture, Cooperating and Farmers Welfare meeting, a proposal to embed premium pricing for zinc wheat in the MSP was floated. The idea does not seem to have been pursued further. Still, the fact that the idea was a discussion point – however minor – indicates some potential for adopting what could be game-changing policy.
- This intervention would indirectly address Barrier 1 (by stimulating demand from farmers for zinc wheat seeds, which could spur state seed companies into action) and Barrier 3 (through lobbying of public officials).
- **Last, in the long term, we recommend advocating for minimum zinc content levels in the Public Distribution System (PDS).** The lack of a segregated supply chain and low levels of production seem to rule out consumption in the short term. Once a reliable supply has been established, GAIN and HarvestPlus can support including zinc wheat in the supply chain by: (i) disseminating research to establish the health case for zinc wheat, and (ii) partnering with the Food Corporation of India in building a reliable supply chain in targeted production districts and in verifying nutritional content.
- This intervention would indirectly address Barrier 1 (by stimulating demand from farmers for zinc wheat seeds, which could spur state seed companies into action) and Barrier 3 (through lobbying of public officials).

Wheat's commercial pathways are rural and urban consumption through public and private channels

Wheat, a staple for many of India's rural consumers, is considered a top national priority for food security, as evidenced by its inclusion in various national subsidy and supplemental nutrition programs. There is also is a growing segment of urban consumers who enjoy processed wheat products. Despite this, overall consumption has stagnated in recent years, particularly in urban markets, due to an increased focus on diet diversity and the greater availability of healthier alternatives.



Note(s): (1) Flow chart information with a +/- 5-10% margin of error; (2) values of <1% indicate negligible amounts
Source: S. Singh, "India – Grain and Feed Annual", 2019; PRS Legislative Research, 'Functioning of the Public Distribution System', 2013; National Sample Survey Organization, 'Household Consumption of Various Goods and Services', 2014, Indian Ministry of Agriculture, 'Status paper on wheat', 2015; Stakeholder consultations (Bihar Agriculture Growth and Reform Initiative (BAGRI), Bihar Rajya Beej Nigam, ICAR-IIWBR, JK Agri Genetics, Ma Annapurna FPO); Dalberg analyses

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GAIN and HarvestPlus should partner with processed food companies and provide capacity building to state seedcos

	Objective	Pathway(s)	Addressable market(s)	Illustrative GAIN and HarvestPlus activities
Short to medium term recommendations				
Partner with packaged food companies in substituting in zinc wheat	Capturing market share from analogues	1b Urban consump-tion	90M health conscious urban consumers	• Develop integrated supply chain with seedcos, farmers, and processors • Establish zinc content verification systems
Provide a broad package of support to public seed companies	Capturing market share from analogues	Cross-cutting	138M rural households	• Increase access to zinc wheat breeder seed • Provide technical assistance on farmer promotion
Advocate and support implementation of premium pricing for zinc wheat in MSP	Capturing market share from analogues	1a/b Consump-tion through PDS	44% of total households (rural and urban)	• Disseminate research to establish health case for zinc wheat • Lobby the Ministry of Consumer Affairs • Support the Food Corporation of India in verifying zinc content
Potential long term recommendations				
Advocate for minimum zinc content level in PDS (once reliable supply chains are in place)	Capturing market share from analogues	1a/b Consump-tion through PDS	44% of total households (rural and urban)	• Disseminate research to establish health case for zinc wheat • Partner with the Food Corporation of India in building a reliable supply chain in targeted districts and in verifying nutritional content

Pre-farm

Despite yields that can be 5-10% higher than analogues, zinc wheat seeds have captured less than 0.01% of wheat farm mkt.

	Zinc Wheat
Delivery stage	3rd wave varieties in the introduction stage
Number of varieties released	6 zinc varieties released by HarvestPlus (2 officially released by government, 4 commercialized)
Household reach	380,000 farming households were expected by end of 2018
Volumes	Total wheat production of ~103M mt over 30M hectares Analogue OPVs (99%+) dominate the market; analogue hybrids and biofortified OPVs have low penetration (both <1%)
Agronomic characteristics	• Consistent seed and grain quality • 5-10% higher yield for select varieties • Taste and texture aligns with hedonic preferences
Other characteristics	• 40% higher zinc content (8-12 ppm in Wave 2 varieties, 12+ ppm in Wave 3 varieties) • 90% zinc retention rate, 15% absorption rate

Biofortified market composition

- Seed development currently being driven by public research institutes (e.g. ICAR) and partner NGOs (e.g. HarvestPlus, SHDA, etc.)
- Limited participation from private sector players in the upstream value chain
- Limited drivership from private sector players (e.g. Britannia) outside of local/regional pilots (e.g. by ITC, Big Basket)

Biofortified characteristics compared to analogues

- Wave 2 and 3 biofortified varieties are equal to or advantageous to analogue varieties on all key parameters
  - ✓ Greater consistency in crop size and quality
  - ✓ 5-10% higher crop yield for select varieties (including WB02, BHU25, BHU31)
  - ✓ Potential benefits in longer shelf life, though this needs validation via additional testing
  - ✓ New varieties may be 8-12+ ppm (66-100%+) richer in zinc content (e.g., PPM level in WB 02 is 42 PPM)

Future releases

- New varieties, such as PBZ01, are under testing and are expecting to add value on yield and quality
- Benares Hindu University (BHU) is driving development of multiple new varieties, including BHU25 and BHU31, are in various stages of the regulatory/pre-release process

Source: Dept. of Agriculture Cooperation & Farmers' Welfare, 'Commodity Profile for Wheat', 2019; B. Ramaswami, "Biofortified Crops and Biotechnology: A Political Economy Landscape for India", 2007; HarvestPlus, 'Biofortification Progress Briefs', 2014;" "Indian Ministry of Agriculture, 'Status Paper on Wheat' , 2015; Department of Agriculture, Cooperation & Farmers Welfare, 'Annual Report 2017-18', 2018;Yadava, D.K., et al "Biofortified Varieties: Sustainable Ways to Alleviate Malnurtion," Indian Council of Agricultural Research, 2017; Stakeholder consultations (BAGRI, Bihar State Seed Corporation, HarvestPlus, JK Agri Genetics, NIDAN)

While development of varieties is strong, production and promotion is weakened by the large role of public seedcos

	Research and development	Production and approval	Agricultural Supply
	Innovative R&D by public seed developers has produced competitive zinc wheat varieties …	*… but regulatory bottlenecks for public seedcos slow production...*	*…and their low capacity to promote new seeds to farmers reduces adoption of those varieties that are available*
Features	**Strong R&D capacities** • Variety development has driven YoY yield improvements of 1-5% • At least 6 biofortified varieties in circulation[1] • Yield advantageous 3rd wave varieties in the introduction phase	**Lag between innovation and adoption** • Publicly developed varieties must go through 2-5 years of certification processes for release at the state and central level, respectively • Delay of 4-6 years between variety release and commercial adoption	**Low promotional capacities limit adoption** • Farmers do not regularly replace varieties under cultivation with new varieties (5-8% VRR) • Conversion of farmers requires clear communication of a yield-based value proposition by seed suppliers
Actors	**Public institutes and SAUs drive development of new varieties** • Driven (95%) by public bodies, e.g. SAUs and research institutes, in collaboration from HarvestPlus and ICRISAT • Low private sector involvement at the R&D stage	**Production by public seedcos** • State seedcos and local NGOs engage farmers for seed production of publicly developed varieties • Production of proprietary wheat varieties is minimal	**Outside public seedcos, efforts in pilot mode** • State seedcos and farmer coops (e.g. NAFED) drive 80% of sales, both directly and through intermediaries • NGOs run localized pilots for new varieties with support from SHGs and other community organizations
Economics	**R&D efforts by public institutions not commercially motivated** • Seed developers are not profit seeking • Often weak linkages with seed producers	**High volume, low value market** • Farmers tend to re-use seeds (67%) more often than making purchases • Private suppliers see low ROI due to monopoly of established varieties, e.g. HD2967, and thus maintain a small presence in the market	**Missing incentives** • Farmers do not regularly replace varieties under cultivation with new varieties (5-8% VRR) • Wheat seeds are subsidized at 50%; however no differentiated subsidies offered based on nutritional content

[1]Based on understanding from stakeholder consultations, this only includes HarvestPlus released varieties; other biofortified varieties may be available;
Source: R. Singh, 'Varietal Replacements Among Field Crops: current status, constraints, impact, challenges and opportunities in the Indian seed industry', 2015; S. McCarthy, "Value Chain Analysis Of Wheat And Rice In Uttar Pradesh, India", 2008; Stakeholder consultations

Barriers: Public seed suppliers struggle to access the breeder seeds needed to scale zinc wheat seed production

Barrier summary

Insufficient quantities of breeder seeds creates a bottleneck in seed suppliers' distribution of zinc wheat seeds

Constraining factors

Capacity constraints	• Research institutes and State Agricultural Universities (SAUs) lack the capacity to produce sufficient quantities of breeder seeds to enable production and distribution beyond localized pilots
Regulatory constraints	• Regulatory requirements lead to a high time and resource investment to ensure genetic and physical purity, multiple rounds of seed cultivation, roguing and grading are often needed as a result
Importance to quality control	• Public seed suppliers need publicly certified breeder seeds before they are able to multiply and distribute seeds of guaranteed quality and consistency, potentially compromising adoption efforts

Enabling factors

Low variety replacement ratio	• Breeder seed shortage projects to be a short-term constraint; once seeds have been sufficiently multiplied and successfully distributed and adopted, farmers will likely continue using the same varieties for multiple successive cycles, as evidenced by a low variety replacement ratio (5-8%)

Implications

Barrier will have moderate impact in the short-term

The above-mentioned barriers will likely rate limit production of new biofortified varieties in the introductory phase, but will be less of a constraint as varieties enter mainstream circulation and production gradually moves towards greater scale

Source: R. Singh, 'Varietal Replacements Among Field Crops: current status, constraints, impact, challenges and opportunities in the Indian seed industry', 2015, Seednet India Portal, "Seed Production Systems"; Stakeholder consultations (Bihar State Department of Agriculture, Bihar State Seed Corporation, JK Agri Genetics, ICAR-IIWBR, NIDAN, Sustainable Human Development Association)

Barriers: Even when breeder seeds are available, adoption is weakened by public suppliers low capacity for seed promotion

Barrier summary

Seed suppliers face capacity constraints that prevent them from either effectively engaging farmers on the value proposition of zinc wheat, or effectively scaling their engagement beyond pilot areas

Constraining factors

Public suppliers' technical constraints	• Public suppliers, including state seed corporations, SAUs and research institutes, often lack capacity to train and sensitize farmers to the required level of quality
Lack of incentives for public suppliers	• Public suppliers lack incentives to convert latent demand for zinc wheat varieties into actual demand
NGOs' coverage constraints	• Partner NGOs often do not have the organizational capacity to scale beyond localized pilots and limited production capacity (100-300T), and may not have the ability to scale

Enabling factors

Receptive farmers	• If properly sensitized that new varieties meet their agronomical and hedonic preferences, farmers are typically receptive to at least sampling them on part of their land
Availability of last mile linkages	• Farmer producer organizations (FPOs), farmer cooperatives and self help groups provide linkages to farmers and communities and can be mobilized to help drive adoption at scale

Implications

Barrier will have high impact

Failure to address capacity issues, particularly among public seed suppliers who own 80% of all distribution, will compromise the program's ability to bridge the information gap with farmers and drive adoption at meaningful scale

Source: Stakeholder consultations (Bihar State Department of Agriculture, Bihar State Seed Corporation, JK Agri Genetics, ICAR-IIWBR, Ma Annapurna FPO, NIDAN, Sustainable Human Development Association)

Opportunities: Building the capacity of public sector suppliers and/or linking them with partners can help overcome these barriers

Opportunity	Description	Importance
Increase availability of breeder seeds	• Increasing the access to breeder seeds would strengthen the capacity of public suppliers, particularly state seed companies, to engage farmers through demo plots and multiply seeds at greater scale • GAIN and HarvestPlus can provide technical assistance to augment public seed developers' breeder seed production and distribution capacities	*High*
Provide a package of support to state seed companies and other public seed suppliers	• GAIN and HarvestPlus can offer technical assistance on farmer promotion and education activities with public suppliers, who may be more amenable to partnering with organizations aligned with central and state governments' push for nutrient rich crop development • Offering marketing support to state seed companies, e.g. by subsidizing the procurement of seeds via tender, can incentivize adoption by these suppliers	*High*
Build partnerships with local agri-extension agents and community organizations	• GAIN and HarvestPlus can facilitate partnerships between public seed suppliers and local agri-extension agents, including partner NGOs, FPOs, and self-help groups, to not only augment outreach and promotional capacities, but also create a more robust system of last mile linkages. • As a longer term exploration area, GAIN and HarvestPlus can incentivize private sector participation through knowledge sharing and access to germplasm and breeder seeds, thus augmenting public sector capacities and expertise	*Medium*

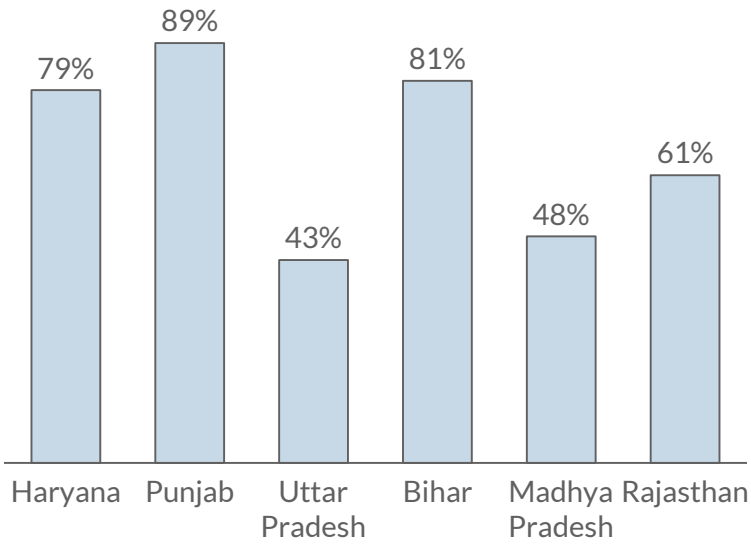
INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

Notes: (1) The Department of Agricultural Extension, a government agency

On farm

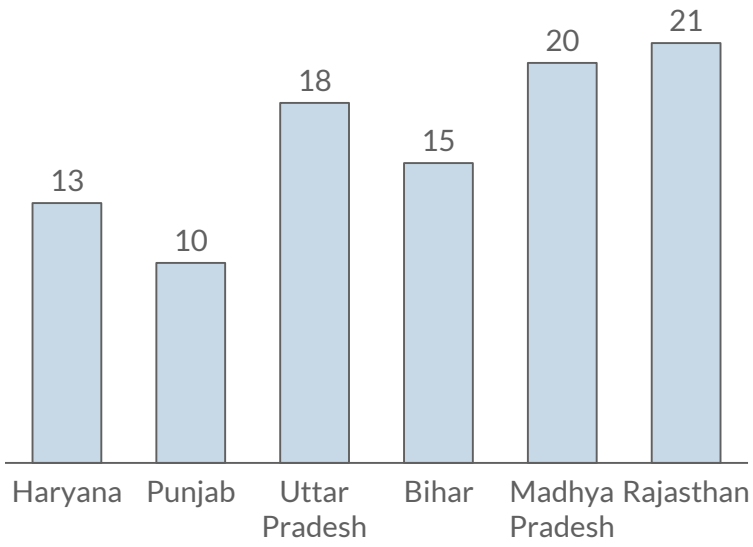
In general, wheat farmers are slow to adopt new varieties; seed selection is driven by tradition and what is popular locally

Percent area under cultivation of top five varieties in select states



A small number of seed varieties dominate seed markets in many states, despite the National Agricultural Research System releasing about 40 new varieties every five years…

Average age of top five varieties in select states (years since official release)



…and farmers are often slow to adopt to new varieties, even though most new varieties outperform older varieties on yield, vulnerability to disease, and stress tolerance

While no specific behavior change is required for farming zinc wheat varieties, the tradition of recycling the same seeds year after year is a high barrier to adoption of any new seed variety

Source: Pavithra, S. "Spatial and Temoral Diversity in Adoption of Modern Wheat Varieties in India," *Agricultural Economics Research Review*. Vol. 30, 2017 Jan-Jun

Yet, attitudes toward change are not uniform; wheat farmers may be segmented into archetypes based on levels of openness

1 Early adopters *(~16%)*

Farmer characteristics

- Rural community leaders, may be "lead farmers" in farmer groups; maintain large social networks
- May be first to join contract farming schemes and bring other farmers on to them
- ~1-2% of output consumed on-farm

Decision drivers

- Most prioritize profit potential
- Are the least risk averse and price sensitive
- Have most access to finance
- May be influenced by seed suppliers and NGOs

2 Majority adopters *(~68%)*

Farmer characteristics

- Small and marginal farmers
- Often re-use traditional seeds year-after year
- ~40% of output consumed on farm

Decision drivers

- Prioritize hedonic qualities of wheat, as it accounts for much of their consumption
- Are price sensitive but can afford high quality wheat seeds (given their low price)
- Moderately risk averse and traditional
- May be influenced by seed suppliers, NGOs, and early adopters

3 Laggards *(~16%)*

Farmer characteristics

- Small and marginal farmers
- Often re-use traditional seeds year-after year
- ~50-60% of output consumed on farm

Decision drivers

- Most prioritize hedonic qualities of wheat, as it accounts for much of their consumption
- Are price sensitive but can afford high quality wheat seeds (given their low prices)
- Risk averse and traditional
- Challenging to influence before achieving broad community acceptance

Source: Stakeholder consultations (Bihar State Seed Corporation, JK Agri Genetics, Ma Annapurna FPO)

1

Early adopters are most open to new ag technology; they can be targeted as allies in awareness building efforts

Early adopters are willing to trial new varieties provided yield advantages and alignment with cultural and hedonic preferences present a compelling business case for adoption

- Early adopters farmers are primarily concerned with maximizing yield per hectare
- These farmers are typically more open to adopting new varieties due to possessing a relatively higher level of information about new technologies and market dynamics
- While these farmers are relatively self-informed, they do rely on outreach from seed suppliers

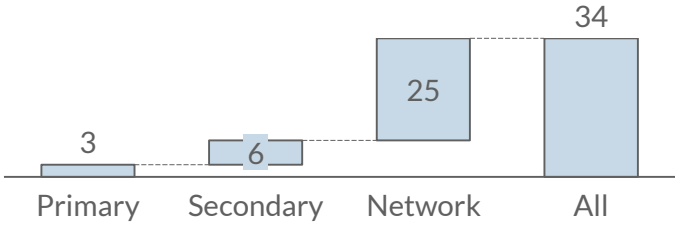
Building awareness among early adopters can trickle down to early majority farmers

- Early adopters are often the first point of engagement for seed suppliers, often through distribution of discounted or free samples
- As respected community leaders, these farmers often work with village-level organizations (e.g. Gram Panchayats, village committees), Farmer Production Organizations (FPOs) and local NGOs to build awareness and deliver technical training among farmers in their communities, sometimes assuming as much as a 50-60% burden in capacity building activities
- Early adopters may also distribute samples to small and marginal farmers in their communities, causing the impact of these awareness campaigns to filter down

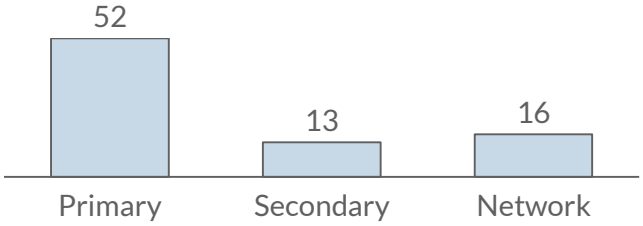
Awareness building efforts by Krishi Vigyan Kendras (KVKs), Agricultural Science Centers demonstrate the influence a few early adopters can have on a farming community

- Primary beneficiaries were provided sensitization on the wheat variety HD-2967; secondary beneficiaries visited the primary beneficiaries' farms and spoke with them; network beneficiaries spoke with the primary and secondary beneficiaries

"Frontline demonstration" beneficiaries (% farmers in villages of study)



Increase in adoption rates compared to non-beneficiaries (%)



Source: Varshney, D., et. Al, "Direct and Spillover Effects of Agricultural Advisory Services," IFPRI Discussion Paper 01850, 2019, June; Stakeholder consultations (Bihar State Seed Corporation, JK Agri Genetics, Ma Annapurna FPO)

Majority farmers are more cautious but, unlike *laggards*, can be influenced by trusted sources; they may be addressable

Hedonic and cultural preferences influence seed purchasing decisions for both segments, but are unlikely to drive their decision on whether to purchase zinc wheat

- Laggard farmers tend to retain a higher percentage of their land for on-farm consumption than majority farmers
- As a result, they are more likely to take into account factors like taste, texture, and consistency of quality
- Hedonic qualities are unlikely to deter adoption of zinc wheat because zinc wheat performs well on hedonic qualities

Similarly, both segments typically are more price sensitive than early adopters; again, this factor is unlikely to be a major factor deterring or supporting zinc wheat adoption

- Majority adopters and laggards are willing to pay a premium for seeds certified by State Seed Certification Agencies or well-established seed companies, such as Bayer, Pioneer, and Shaktiman Agro

On the other hand, majority farmers place more trust in information from seed companies and early adopters, and exhibit higher tolerance for risk; as a result, they are the more reachable segment for zinc wheat adoption in the short to medium term

- Majority farmers tend to be in farmer cooperatives and farmer producer organizations (FPOs); they are likely to trust advice from early adopters (often in their role as lead farmers)
- Laggards have lower community linkages and trust more in tradition and prevailing customs

Whereas zinc wheat's yield advantage alone may shift early adopters' behavior, majority farmers may require a combination of awareness building and social proof (e.g., testimonies by early adopters)

Source: Stakeholder consultations (Bihar State Seed Corporation, JK Agri Genetics, Ma Annapurna FPO)

Opportunities: Interventions may leverage early adopters' influence to build wide awareness of zinc wheat's benefits

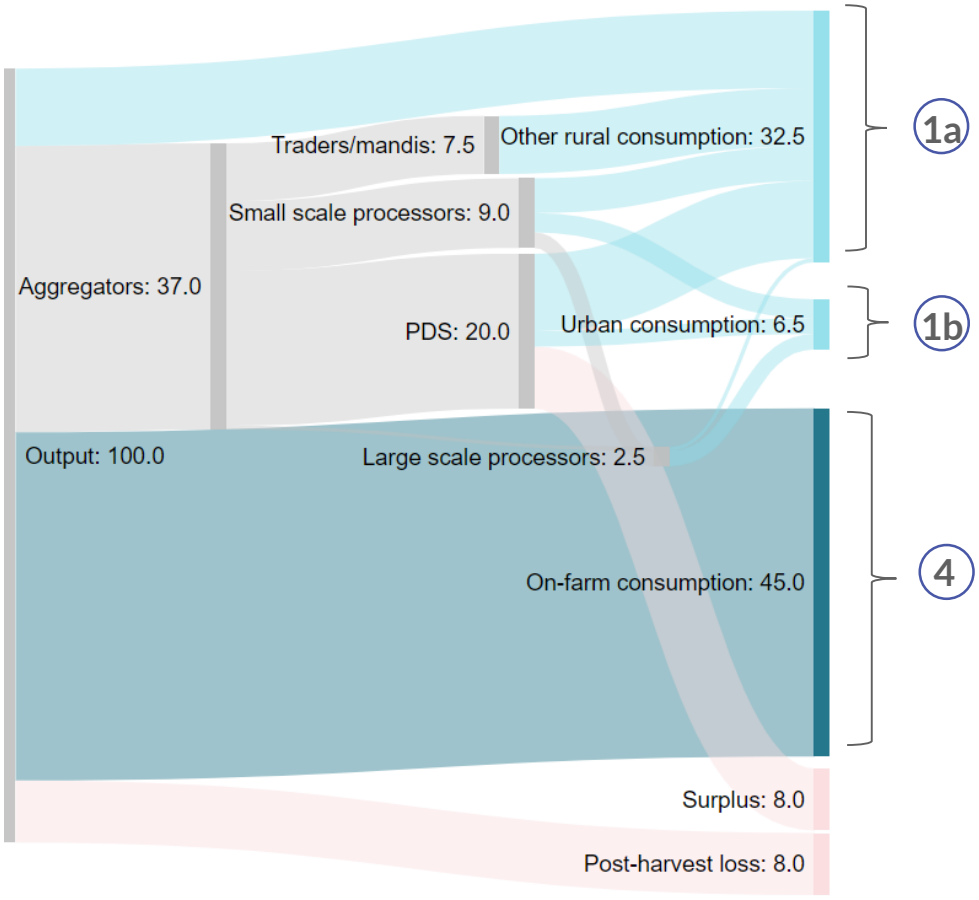
Intervention area	Description	Importance
Partner with seed companies on farmer promotion activities, leveraging early adopters as influencers	• GAIN and HarvestPlus can provide technical assistance on farmer promotion and education activities to public seed suppliers • Public seed companies are unlikely to contribute financial resources to this work, diminishing its potential for sustainability; however, farmers who converted to zinc wheat are likely to continue to use the variety year after year given its improved yield	*High* *Linked with pre-farm recommendation to provide TA to public seed suppliers*
Partner with major food processors on contract farming schemes, leveraging early adopters as influences	• GAIN and HarvestPlus can partner with major food processors in contract farming or "contract-farming like" schemes (the latter is an informal agreement for farmers to supply processors without a contract) • This may transition to a truly commercial approach as GAIN and HarvestPlus transfer knowledge on working with farmers to processors • Contract farmer (and similar schemes) are not widespread in India but are run by a few large processors, such as ITC • Farmers already supplying processors could be converted to zinc wheat – with the only main change being the variety produced	*Medium* *Linked with post-farm recommendation to partner with private processors*

INITIAL HYPOTHESES FOR DISCUSSION DURING DUBAI WORKSHOP

Source: Stakeholder interviews; Dalberg analyses

Post-farm value chain and consumption

Wheat consumption occurs through three pathways



De-prioritized segments

1a

Rural consumption

- Rural consumers procure wheat, either as unprocessed grain or as unbranded processed flour, from a combination of farmgate, government distribution systems, and intermediary traders

1b **Urban consumption**

- Majority of market consists of unbranded processed flour, unbranded packaged products, and baked products
- Niche market consists of wheat processed into branded value added products

4

On-farm consumption (potentially outside of program scope)

- Wheat produced and stored by farmers for self-consumption

Production surplus and post-harvest losses

- A combination of buffer stock and surplus inventories collected through public procurement, as well as post-harvest losses throughout the value chain
- A portion of spoiled inventory is repurposed as animal feed

Source: S. Singh, "India – Grain and Feed Annual", 2019; PRS Legislative Research, 'Functioning of the Public Distribution System', 2013; National Sample Survey Organization, 'Household Consumption of Various Goods and Services', 2014, Indian Ministry of Agriculture, 'Status paper on wheat', 2015; Stakeholder consultations (Bihar Agriculture Growth and Reform Initiative (BAGRI), Bihar Rajya Beej Nigam, ICAR-IIWBR, JK Agri Genetics, Ma Annapurna FPO); Dalberg analyses

Rural millers and urban processors are high potential pathways; on-farm consumption may be a non-commercial route to scale

High potential pathways

1A Rural consumption

Pathway 1: Local Millers

Used by consumers of all income levels

- ✓ Better commercial opportunity compared to PDS
- × High level of effort involved in segregating supply chains and building in quality control

~~Pathway 2: PDS~~

Used mostly by low-income consumer

- ✓ Wide network and caters to significant population
- ✓ Reaches most vulnerable sections and, therefore, high nutritional impact
- × Low political will to disrupt the supply chain for a crop that is central to farmer livelihoods and food security

1B Urban consumption

Pathway 1: Private Processors

Used mostly by middle to high-income consumers

- ✓ Purely commercial channel
- ✓ Can fill existing demand for value-added wheat based product
- ✓ Can facilitate supply chain improvements that add trickle-down value to other pathways
- × Competition from other product categories marketing towards the same consumer segment
- × Small accessible market
- × Low nutritional need

Pathway 2: PDS

Same considerations as Rural PDS

Pathway 3: Local Millers

Used by consumers of all income levels

- ~ Weaker commercial opportunity compared to Pathway 1 but better than PDS

Remaining considerations same as in case of rural consumption

4 Rural consumption

Pathway 1: On-Farm Consumption

Used by wheat farmers

- ✓ Largest consumption channel
- ✓ Zinc wheat dilution challenge not applicable
- × No commercial opportunity

We do not deep-dive into urban PDS as interventions for rural and urban PDS will be the same; Within the urban segment, private processors provide a potentially more impactful opportunity for GAIN and HarvestPlus to intervene

Source: Stakeholder consultations

1a

Converting some rural consumption to zinc wheat is possible, but only if dilution can be avoided – a major challenge

Current consumption (on average)	Potential addressable market
37% of output / ~37M metric tons per annum	138M rural households, particularly the ~35% of rural households engaged solely in non-farm activity

The majority of rural consumers purchase wheat through traders and Fair Price Shops (retail outlets for the PDS); flour from different wheat varieties is mixed together in the aggregation and milling process

- Due to limited available quantity of any one variety, aggregators mix varieties, creating scope for dilution of micronutrient content and reducing nutritional impact
- Inability to differentiate between analogue and biofortified varieties, compounded with a lack of segregated supply chain mechanisms, creates challenges in verifying which crops are biofortified and which are not

Opportunities

Intervention area	Description	Importance
Implement upstream interventions in circumscribed areas	• GAIN and HarvestPlus can work with community organizations (e.g., self-help groups), farmer cooperatives and FPOs, partner NGOs, and seed companies to concentrate awareness building areas in specific areas. High share of zinc wheat in one area can diminish the risk of variety dilution • Development of strong regional reputations for wheat quality (such as that enjoyed by Madhya Pradesh) could eventually lead to greater consistency in supply • Given the yield advantage of zinc wheat, once farmers adopt zinc wheat they are likely to continue using it – even if without consumer demand specific to the variety • Benefits of this approach will be hard to assess; post-farm gate the path the zinc wheat takes will be hard to track	*Medium*

Source: PRS Legislative Research, 'Functioning of the Public Distribution System', 2013; National Sample Survey Organization, 'Household Consumption of Various Goods and Services', 2014 S. McCarthy, "Value Chain Analysis Of Wheat And Rice In Uttar Pradesh, India", 2008; Stakeholder consultations (BAGRI, ICAR-IIWBR, JK Agri Genetics, Ma Annapurna FPO, National Institute of Nutrition), Dalberg analyses,

1a/1b

The PDS pathway could hypothetically reach large volumes of rural and urban consumers, but may be politically infeasible (1/2)

Current consumption (on average)	Potential addressable market
12% of output / ~12M metric tons per annum *(not including buffer stock and leakages from PDS)*	Up to 44% of rural and urban households procuring wheat through PDS

Wheat is procured heavily through public distribution channels in both urban (30-40% of households) and rural (40-50% of households) settings, indicating a pathway to scale

- The share of PDS in wheat consumption figures to grow, as the central government continues to view wheat as vital to food security and farmer livelihoods
- Wheat also features heavily in flagship nutrition program, including the Integrated Child Development Services (ICDS); ICDS covers more 70M pregnant women, lactating mothers, and children in India

In terms of pure coverage, the PDS represents the most significant single route to accessing demand; however, central- and state-level policymakers may not be willing to disrupt the wheat market at scale through introduction of zinc wheat varieties

- While policymakers have articulated support for driving the biofortification agenda, some stakeholders indicated that disrupting the public value chain for wheat is considered a political risk; the crop is central to rural consumers' diets and there is a significant cost burden to storing and managing a growing public surplus (currently estimated at ~8% of all wheat output)
- Central and state government agencies may be prioritize other micronutrients over zinc; evidence of low prioritization is the Ministry of Women and Child Development's decision to mandate in the Mid-Day Meals program fortification of wheat with six micronutrients, but not zinc

Moreover, the PDS is likely to suffer the same dilution challenges as other pathways

- The Food Corporation of India sources wheat grains through informal markets
- For the PDS to distribute zinc wheat with the recommended level of nutrition content, a new system would need to be devised to assure varietal consistency as individual consumers, meaning that there would be no assurance the PDS distributes non-diluted wheat flour with the recommended level of zinc

Nevertheless, given the potential scale the PDS can achieve, exploring potential for inclusion seems like a relatively inexpensive investment in advocacy with a possibility for high return

Source: Agricultural Census of India, 2011; PRS Legislative Research, 'Functioning of the Public Distribution System', 2013; Government of India, "Evaluation Study on Role of Public Distribution System in Shaping Household and Nutritional Security India", 2016; National Sample Survey Organization, 'Household Consumption of Various Goods and Services', 2014; S. McCarthy, "Value Chain Analysis Of Wheat And Rice In Uttar Pradesh, India", 2008; Stakeholder consultations (BAGRI, ICAR-IIWBR, JK Agri Genetics, Ma Annapurna FPO, National Institute of Nutrition), Dalberg analyses,

The PDS pathway could hypothetically reach large volumes of rural and urban consumers, but may be politically infeasible (2/2)

Current consumption (on average)	Potential addressable market
12% of output / ~12M metric tons per annum *(not including buffer stock and leakages from PDS)*	Up to 44% of rural and urban households procuring wheat through PDS

Immediate opportunity Long-term opportunity

Opportunities

Intervention area	Description	Importance
Advocate for a tiered minimum support price in the PDS	• GAIN and HarvestPlus can advocate for the introduction of a higher minimum support price (MSP) for zinc biofortified wheat, incentivizing adoption among farmers • While this would likely increase farmer production of zinc wheat and rural consumption through the PDS, it would not address dilution issues • Moreover, already 40% of wheat purchased through the PDS ends up as surplus stock or post-harvest loss • Increasing the MSP for zinc wheat would increase outlay on an inefficient program • Most importantly, political will to increase zinc levels and disrupt the wheat value chain may be lacking, meaning the idea could be a non-starter	*High*
Advocate for the inclusion of zinc wheat in PDS	• GAIN and HarvestPlus can advocate for inclusion of zinc wheat in the PDS • Inclusion in the PDS would face the same challenges as tiered MSP pricing – no assurance of zinc content, a high loss rate, and low political will • Moreover, the PDS operates at massive scale and sourcing from the small number of zinc wheat farmers may be an obstacle to implementation in the short to medium term	*Low*

Source: PRS Legislative Research, 'Functioning of the Public Distribution System', 2013; Dalberg analyses

1b

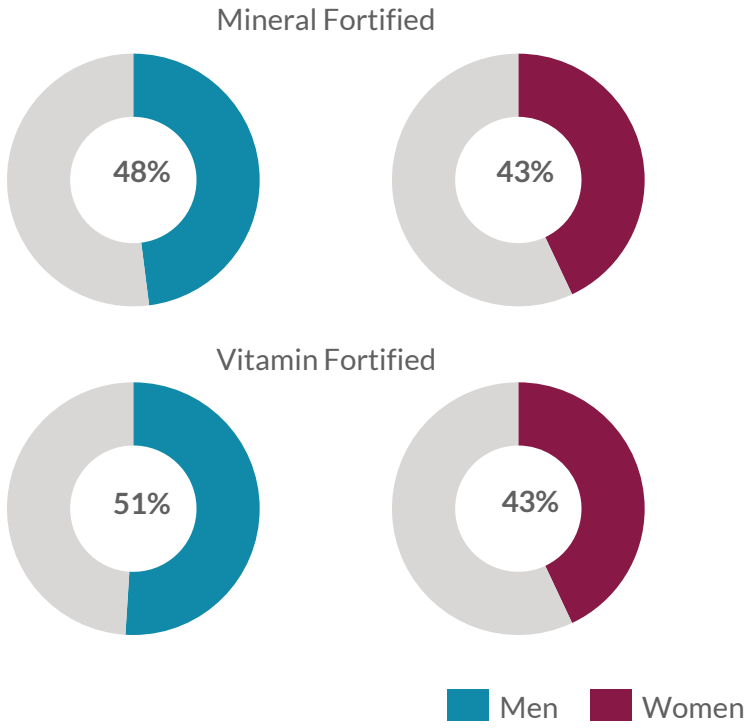
In the urban segment, affluent health-conscious consumers offer the best pathway to commercialization (2/2)

Current consumption (on average)	Potential addressable market
2% of output / ~2M metric tons per annum	~90M health conscious individuals through health foods market

Urban consumers' food preferences are increasingly shaped by health considerations

Factors considered when purchasing food items	% of Rank-1 *Urban consumers, Chandigarh*
Compare nutritional content of similar products	25%
Check for better quality food items	14%
Prefer regularly purchased brand	13%
Check for added vitamins/minerals	10%
Compare prices of similar products	4%
Well-known brand	3%
Go with kid's preference	2%

Percentage of Indian adults replying "very important" to the question "How important are the following health attributes in influence your purchase"



Note: *the total amount of percentages in the table is 73%, so percentages should be higher or other factors are not addressed
Source: (1) HarvestPlus, "Usage & Attitude cum Concept & Product Test for Zinc Bio-fortified Atta Findings," 2015.; (2) Nielsen, "India Acquires A Taste For Health And Wellness," 2019

1b

In the urban segment, affluent health-conscious consumers offer the best pathway to commercialization (2/2)

Current consumption (on average)	Potential addressable market
2% of output / ~2M metric tons per annum	~90M health conscious individuals through health foods market

Consumption of processed wheat flour and value-added products is primarily driven by the urban markets

- Health and wellness foods segment, which targets consumers willing to pay premium prices for healthier food choices, is a USD 1.4 bn+ market and has a ~10% growth rate in India
- Growth of this segment is likely to be driven by rising disposable income (~10% in 2018-19), greater access to information, and a higher willingness to pay for nutrition-rich products (25% of Indians would pay more for snacks with greater nutrition)
- Although this sub-segment is likely to benefit less from the nutrition benefits of zinc wheat, its purchasing habits could trickle down to other consumers
- This segment includes a sub-segment of health conscious urban consumers that can be captured through deliberate marketing of the additional nutritional benefit of biofortified wheat products vs. fortified or analogue wheat products
- Most of this market is captured by large food processing brands, including Britannia, Parle, Marico

Processed wheat products are already a major category in urban markets, and large processors have expressed interest in substituting zinc wheat flour into their products

- One major wheat processor indicated that zinc wheat could improve revenue per product; for some products, fortification leads to price premiums of three times the price for the non-fortified product
- A few large processors are already engaged in contract farming in the wheat value chain; an integrated supply chain approach would be the most effective means of avoiding variety mixing and dilution

Opportunities

Intervention area	Description	Importance

Partner with food processors to develop zinc wheat products for the niche urban health market	• GAIN and HarvestPlus can support large food processors by developing an integrated supply chain:
	  ○ Linking with seed companies to produce sufficient volumes of zinc wheat varieties aligned with processors' specific needs around taste, nutritional content
	  ○ Facilitating partnership with local agri-extension agents trusted by farmers
	  ○ Serving as a broker with farmer groups and processors in contract or contract-like farming schemes
	• In addition, GAIN and HarvestPlus can work with processors to implement a zinc content verification system that touches various points in the supply chain
		High

Source: NIELSEN, 'India Acquires A Taste For Health And Wellness', 2019; FICCI, 'The changing landscape of the retail food service industry', 2018; Redseer, 'Indian Habit Of Being Healthy', 2018 Stakeholder consultations (Britannia, JK Agri Genetics, ICAR-IIWBR, GAIN/HarvestPlus), Mintel Press Office, 'Health living tops Indian consumers' list of goals and aspirations', 2017; Dalberg analyses,

Dalberg

4

On-farm consumption represents a significant pathway to scale, but may not represent a route to genuine commercialization

Current consumption (on average)	Potential addressable market
45% of output / ~45M metric tons per annum	100% of wheat farmers in India

The "market" for on farm consumption is large – and so are the nutritional needs

- Majority of Indian farmers are small or marginal actors who grow crops largely for subsistence purposes
- 45% of wheat production is consumed on-farm by humans (wheat is rarely used for fodder)
- As a result of the role of wheat and other cereals in farmers' diets, they are prone to high rates of nutritional deficiency, including zinc deficiency

Farmers may initially be reticent to consume zinc wheat

- Crops grown for on-farm consumption typically maintained as separate plots grown without use of fertilizers or chemical additives
- Some farmers prefer crops avoid crops raised "unnaturally" – it is not clear if zinc wheat would fall into this category in farmers' minds

Farmers producing zinc wheat are likely to consume pure, non-diluted zinc wheat

- Farmers usually mill their own wheat – or have a local miller their wheat – and return the resulting flour
- As a result, the risk of dilution with other wheat varieties is low for on-farm consumption

On farm consumption is inherently a non-commercial pathway, and thus may be slow to scale

- Without a commercial market create demand for zinc wheat, motivating farmers to switch to a new variety simply is likely to be challenging
- On the other hand, given the yield benefit of zinc wheat, if farmers trial the variety, it seems likely they will convert to it

Source: Stakeholder consultations (Bihar State Seed Corporation, JK Agri Genetics, ICAR-IIWBR, Ma Annapurna FPO, GAIN/HarvestPlus), Dalberg analyses

Policy

Current policies and programs indicate zinc consumption is not a major priority, nor is wheat a priority as a source of nutrition

Government prioritization of wheat for its economic benefits

- The government views wheat as a major lever in improving domestic farmers' livelihoods – as evidenced by steep import duties of 40% on foreign wheat – and may therefore prioritize policy measures that improve farmer income rather than nutrition outcomes
- Crop insurance and loan schemes, such as Pradhan Mantri Fasal Bima Yojana (PMFBY) are designed to incentivize higher yield, rather than nutritional content and crop quality
- Many regional and local initiatives, such as Bring Green Revolution to Eastern India (BGREI) are specifically focused on driving yield improvements
- Procurement of wheat seeds by farmers is heavily subsidized at 50%, irrespective of nutritional content

Policy preferences for alternatives to both zinc and wheat

- The Mid-Day Meals program, a potential pathway for zinc wheat adoption, recently mandated that wheat served to beneficiaries must be fortified with six micronutrients, but not zinc
- Central government schemes, such as the Integrated Child Development Services, promote diet diversity and the consumption of horticultural crops and other grains as alternatives to wheat

While government procurement and distribution could accelerate adoption, advocacy efforts for zinc wheat may be ineffectual in the short to medium term

Source: Stakeholder consultations (BAGRI, ICAR-IIWBR, National Institute of Nutrition, PCI Global)

Annex

Policy: Numerous national-, state- and local-level actors are involved in setting policies across the agricultural value chain

	Pre-farm	On farm	Post farm value chain	Consumption
National	• Ministry of Agriculture's Central Seed Certification Board sets standards for seed production • The Central Sub-Committee on crop standards determine status of biofortified seed varieties	• 'Pradhan Mantri Fasal Bima Yojana' (PMFBY) protects farmers through a crop insurance scheme to encourage new technologies for increased production	• Commission of Agricultural Costs and Prices (CACP) sets minimum set prices (MSPs) for each crop based on cost of production	• Ministry of Agriculture's Food Corporation of India (FCI) handles inclusion of crops into the public distribution system (e.g. mid-day meal schemes at school)
State	• State agricultural universities help develop seed varieties or push research	• NFSM monitors nutri-farm implementation through visits, meetings, and contingencies	• Centre of Excellence (CoE) by NFSM to train entrepreneurs for the creation of nutri-rich products	• State Department of Agriculture publicizes NFSM through mass media for awareness of consumption of nutri-rich crop varieties • CoE to train entrepreneurs for commercialisation of nutri-rich products
Local	• District Programme Management Groups (PMG) for NFSM provide farmers critical inputs for nutri-rich varieties	• NFSM targets malnourished districts with technology to increase output of nutri-rich crops	• PMGs provide food processing and value addition technologies for nutri-rich harvests	• NFSM scheme provides training to entrepreneurs for the creation of nutri-rich related products

Source: Tripathi, Amarnath & Mishra, Ashok.. "The Wheat Sector in India: Production, Policies and Food Security." 2017.; Government of India, "Guidelines for Establishment of Nutri-farms Scheme", 2014.

Policy Landscape: Food fortification in India began in the 1950s; progress has been slow

1950-99 — FIRST FORAYS INTO FOOD FORTIFICATION IN INDIA

- **1953** — GoI mandates fortification of Vanaspati with Vitamin A
- **1962** — GoI bans sale of non-iodised edible salt in goitre-endemic regions under National Goitre Control Programme
- **1997** — GoI bans sale of non-iodised edible salt across country under Prevention of Food Adulteration Act 1954, which is **de facto mandatory iodization of salt**

2000-15 — FRAGMENTED REGIONAL PILOTS and GOV SCHEME-SPECIFIC INITIATIVES

- **2000** — West Bengal initiates first pilot for wheat flour fortification in Darjeeling district
- **2004** — Double Fortified Salt is produced by Tamil Nadu Salt Corporation and introduced in state's MDM scheme. DFS is now available in all districts of TN through PDS, MDM and ICDS
- **2006** — Government of Gujarat mandates fortification of edible oil
- **2008** — Cargill India Pvt. Ltd. is first provider to fortify edible oil in India
- **2010** — PATH implements first pilot for rice fortification in India through Andhra Pradesh MDM scheme. But since then, only 2-3 districts in AP implementing in their programmes
- **2011** — GAIN helps pilot edible oil fortification in Rajasthan, where Fortified Edible Oil is now available in all districts through PDS, MDM and ICDS
- **Jun-Jul 2011** — MoWCD and MoHRD issue directives mandating DFS in ICDS and MDM schemes
- **2014** — Higher quality pre-mix for DFS developed using encapsulated Ferrous Fumarate
- **2015** — Tata Salt Plus is launched as India's first national brand of packaged DFS

This period also witnessed some policy missteps: In 2000, GoI lifted ban on non-iodised edible salt post-backlash from industry, but re-introduced ban in 2005/6 when 50% HH already consuming

Nearly 60 years gap between global introduction of rice and wheat fortification and first pilots of Fortified Rice and Wheat in India

Oil · Salt · Rice · Wheat · Key cross-cutting events

Notes: GoI: Govt. of India; MDM: Mid-day Meal; DFS: Double Fortified Salt; TN: Tamil Nadu; PDS: Public Distribution System; ICDS: Integrated Child Development Services; MoWCD: Min. of Women and Children Development; MoHRD: Min of Human Resource Development
Source: FSSAI, Large Scale Food Fortification (Oct 2017); FFRC, Brochure (May 2019); Expert Interviews, Dalberg Research

Policy Landscape: Momentum has increased nationally only in the last 3 years owing to FSSAI advocacy and the set-up of FFRC; however, FF still lacks a unified policy framework

2016-Current | **FOOD FORTIFICATION ENTERS THE NATIONAL AGENDA**

2016	FSSAI lays down standards for fortification of all staples, the F+ logo is introduced
Dec 2016	MoCA,F&PD issues circular directing states to only use Fortified Wheat Flour in their PDS schemes
2016	General Mills is first provider to fortify wheat flour in India
2017	DCP Foods Pvt. Ltd. launches "Asbah" Fortified Rice in open market
Jul-Aug17	MoWCD and MoHRD extend mandate use Fortified Edible Oil and Fortified Wheat Flour in ICDS and MDM
Mar 2018	The Prime Minister's Office launches the National Nutrition Mission (NNM), or "Poshan Abhiyaan," which cites food fortification as an intervention to address malnutrition in India. However, little focus on FF within NNM, indicating **FF still lacks a comprehensive national policy framework**
Aug 2018	FSSAI sets up Food Fortification Resource Center (FFRC) with financial assistance from Tata Trusts
Aug 2018	Food Safety and Standards Regulations for fortified staples are notified in the Gazette of India
Oct 2018	MoCA,F&PD issues an advisory urging states to publicize the benefits of Fortified Edible Oil
Feb 2019	MoWCD issues an order mandating use of Fortified Rice in ICDS and SABLA schemes
Mar 2019	The GoI announces a pilot for the distribution of Fortified Rice in 15 districts across India (15 states x 1 district) for 3 years through the PDS

India moved from fragmented pilots to key national policies only in the last 3 years due to:

- ***Limited government consensus*** *and* ***political will*** *to drive fortification agenda forward*
- *Contention between policymakers/ activists as to whether food fortification ought to be* ***mandatory or voluntary****. This debate persists even today.*

Rice fortification *entered the national policy landscape only in 2019,* ***much later*** *than the fortification of other key commodities.*

Oil | Salt | Rice | Wheat | Key cross-cutting events

Biofortification (BFF) is yet to achieve attention similar to food fortification at the national stage; while government has been discussing the idea, a policy or framework is yet to materialize

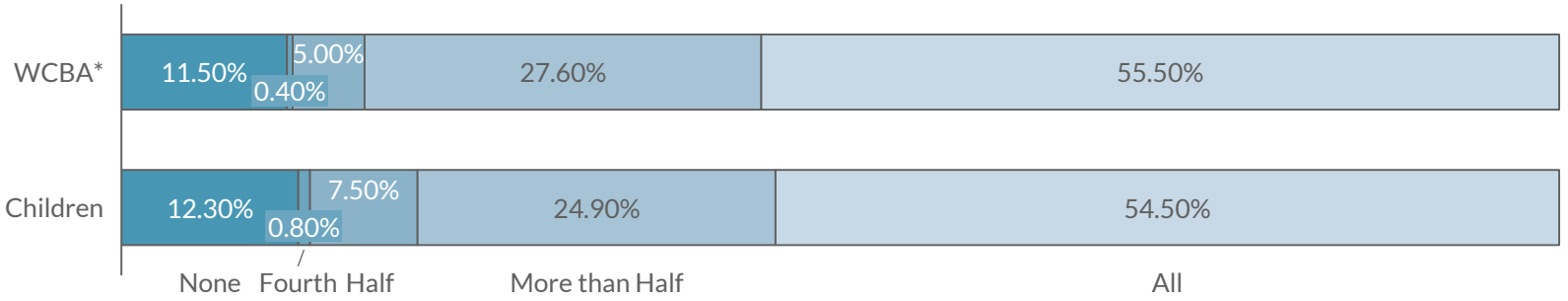
Notes: FSSAI: Food Safety and Standards Authority of India; MoCA,F&PD: Ministry of Consumer Affairs, Food and Public Distribution Department of Food & PD; FF: Food Fortification;
Source: Large Scale Food Fortification (Oct 2017); Expert Interviews; Down To Earth, Making Food Fortification Mandatory is Illegal (2018), Dalberg Research

Field research We conducted interviews with 13 stakeholders

				Topics covered				
#	Org. Name	Org type	Expert Name	Pre-farm	On farm	Post farm VC	Consump-tion	Policy & financing
1	National Institute of Nutrition (NIN)	Public sector	Dr. Sesikeran	✓				
2	National Institute of Nutrition (NIN)	Public sector	Dr. Radhika Madhari					
3	PCI Global	Civil Society	Basanta Kumar Kar					✓
4	BAGRI	Civil Society	Rajendra Kumar	✓		✓		✓
5	Bihar Rajya Beej Nigam (Bihar State Seed Corporations)	Government	RK Verma	✓	✓			
6	Department of Agriculture – Bihar	Government	Anil Jha			✓		✓
7	Britannia	Food processor	Dr. Dhruti Bal			✓		
8	Britannia	Food Processor	Sudhir Nema		✓	✓	✓	
9	ICAR - Indian Institute of Wheat and Barley Research (IIWBR)	Research Organization	Dr. AK Singh	✓	✓		✓	✓
10	JK Agri Genetics	Seed company	RSS Gurjar	✓	✓	✓		
11	Maa Annapurna FPO	Commercial VC actor	Nilesh Kumar		✓	✓		
12	NIDAN	Civil Society	Ranjan Kumar	✓	✓			✓
13	Sustainable Human Development Association (SHDA)	Civil Society	BM Tripathi	✓	✓		✓	

Evidence of efficacy: Consumption of zinc wheat led to a 25% decrease in zinc deficiency among treatment groups

Compliance of biofortified wheat flour, by daily share of recommended intake



Treatment	Group	Zinc Deficient (<70 µg/dL)		
		Baseline	After 6 months	Change
High Zinc wheat flour (30 ppm daily)	WCBA	85.5%	75.8%	-21%
	Children	85.8%	69.6%	-27.2%
Low Zinc wheat flour (20 ppm daily)	WCBA	87.5%	75.1%	-22.4%
	Children	84.7%	69.3%	-26.7%

Women of Child Bearing Age and children are one of the demographics most at risk due to zinc deficiency, and their rapid response rate to intervention shows a potential for targeted impact

Note: WCBA* Women of Child Bearing Age
Source: S. Sazawal, et al. 'Efficacy of high zinc biofortified wheat in improvement of micronutrient status, and prevention of morbidity among preschool children and women', 2018

Dalberg

We have conducted a rapid scan of tech-enabled farmer solutions that can be considered for driving interventions (1/2)

NON-EXHAUSTIVE

Platform Name	Description
Digital Farmers	• A mobile application that connects different agriculture ecosystem actors and supports with knowledge dissemination • Farmers, input dealers, merchants etc. can connect with each other using the app • Information on government schemes for farmers, ogranic farming practices, latest market prices etc., and optimal farming practices are shared using the app • SMS as well as call center services are used to communicate with farmers
BigHaat	• An online digital platforms for farmers to purchase quality inputs such as seeds, fertilizers, pesticides, nutrition supplements, farm machinery from a variety of brands • It also provides doorstep delivery facilities as well as knowledge services through the website and call services
Ekutir	• A one-stop-shop that offers an online and mobile-based platform to connect marginal farmers with stakeholders across the value chain such as soil-testing labs, suppliers of seeds and fertilizers, banks, exporters, food-processing units, and branded retailers • Field partners also train farmers to use their application
Blooom	• An integrated soil-to-shelf digital platform for smallholder farmers that supports sustainable food supply value chains • Services include access to information, finance, sustainable inputs, agri services, and markets

ITC E-Choupal	• An assisted platform that has village internet kiosks managed by farmers - called sanchalaks
	• Kiosks support the agriculture community with:
	  ○ access-ready information in their local language on the weather & market price
	  ○ knowledge on scientific farm practices & risk management
	  ○ sale of farm inputs, and
	  ○ purchase of farm produce from the farmers' doorsteps

Source: Organization websites

We have conducted a rapid scan of tech-enabled farmer solutions that can be considered for driving interventions (2/2)

NON-EXHAUSTIVE

Platform Name	Description
Kisan Network	• A tech-enabled supply chain platform for farmers in India • It enables small and marginal farmers to sell their fresh produce directly to businesses across the country, using their smartphone • It takes cares of the complete PAN-India supply chain from the farm directly to the buyer's doorstep
KrishiYog	• KrishiYog is a platform that supports farmers with multiple touchpoints such as productivity improvement, market linkages, and finance • It has the extension service platform to support farmers with production practices • It also has the ERP platform that helps farmer producer companies and farmer cooperatives to manage their operations • KrishiYog has a credit rating platform to support NBFCs and banks assess credibility of the borrower and lend at optimal interest
Ergos	• Ergos provides warehousing solutions to farmers as well as food processing units by acting as an intermediary for storing the produce • The farmers can sell the produce to Ergos at the local micro warehouses, where the quality and quantity is checked and approved before sale of the produce • Based on the quality and quantity data, prices are negotiated with food processing companies • Food processing companies can then buy the produce through Ergos, helping them save on the brick and mortar costs of warehouses • The entire model is supported using technology platform, which includes a mobile app for the farmers to connect with Ergos, and the tech platform for monitoring the entire operations

Source: Organization websites

Financing: All levels of the Indian government actively finance the agriculture industry across the supply chain

TO BE DEVELOPED FURTHER POST-DUBAI

	Pre-farm	On farm	Post farm value chain	Consumption
National	• National Bank for Agriculture and Rural Development (NABARD) serves as a refinancer to other banks and provides financial assistance with a focus on rural communities	• PMFBY provides crop insurance if farmers pay 2% premium for *kharif* crops and 1.5% for *rabi* crops (5% for annual commercial crops)	• Trader credit helps middlemen traders make transactions on a wholesale scale	• Agriculture is designated as a priority sector for banks to reach a target coverage in lending. In 2011, banks exceeded the Rs. 37.5 million target by over 20%
State	• State Cooperative Banks (SCBs) primarily provide short and medium-term agricultural credit	• NFSM allocates Rs.15000 per cluster for all crops for food processing and value addition in products.	• Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP) established 300 post-harvesting unites to supply raw materials for value-added products	• Regional Rural Banks (RRBs) mostly mobilize financial resources for small farmers, but also other agricultural laborers
Local	• NFSM allocates Rs 200 crores for establishing nutri-farms in districts most affected by malnutrition	• NFSM offers Rs.2 lakh per district to review meetings and monitor implementation	• NFSM provides Rs.15000 per district for food processing and value addition of bio-fortified crops	• NFSM provides Rs.1.00 lakh per district for media purposes to raise awareness for consumption of nutri-rich products

Source: Government of India, "Guidelines for Establishment of Nutri-farms Scheme", 2014.; Kumar, Raj, "Workshop on Enhancing Exports' Competitiveness Through Value Chain Finance", 2012.