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Commercialization assessment: Zinc wheat in Pakistan

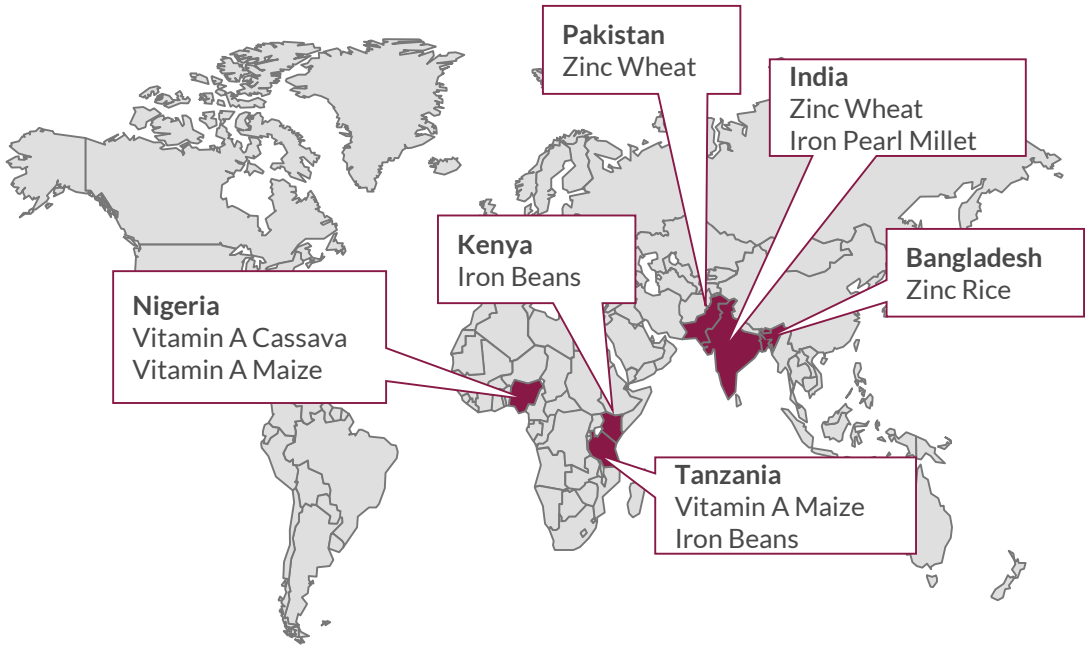
FINAL REPORT FOR GAIN AND HARVESTPLUS

DECEMBER 2019

Recap: Programme context

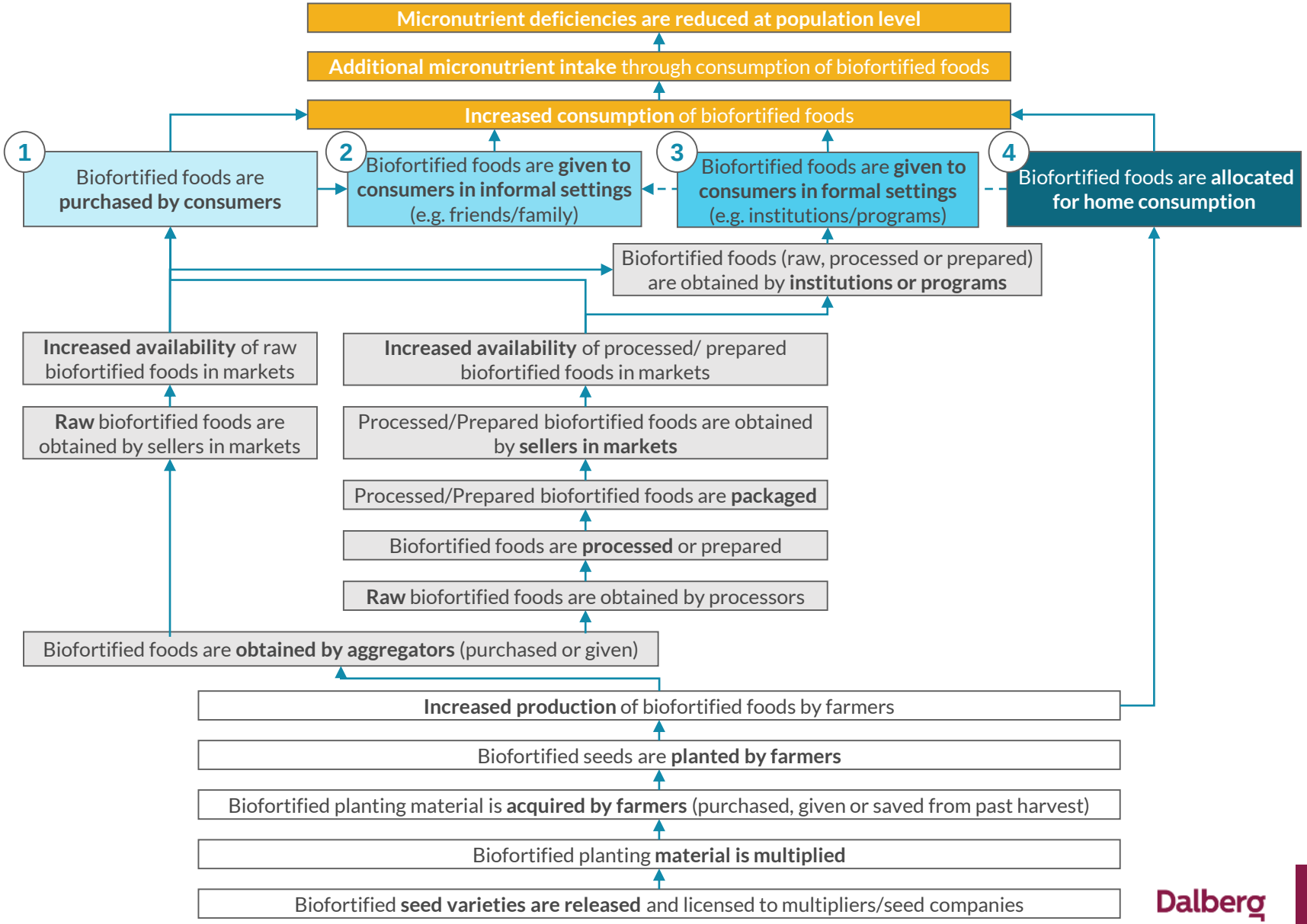
- GAIN and HarvestPlus share an ambition to expand coverage of biofortified nutrient dense foods to at least 200 million consumers. The overall vision of this program is to scale up the commercialization of biofortified foods. zinc wheat in Pakistan is one of the nine selected crop/country combinations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

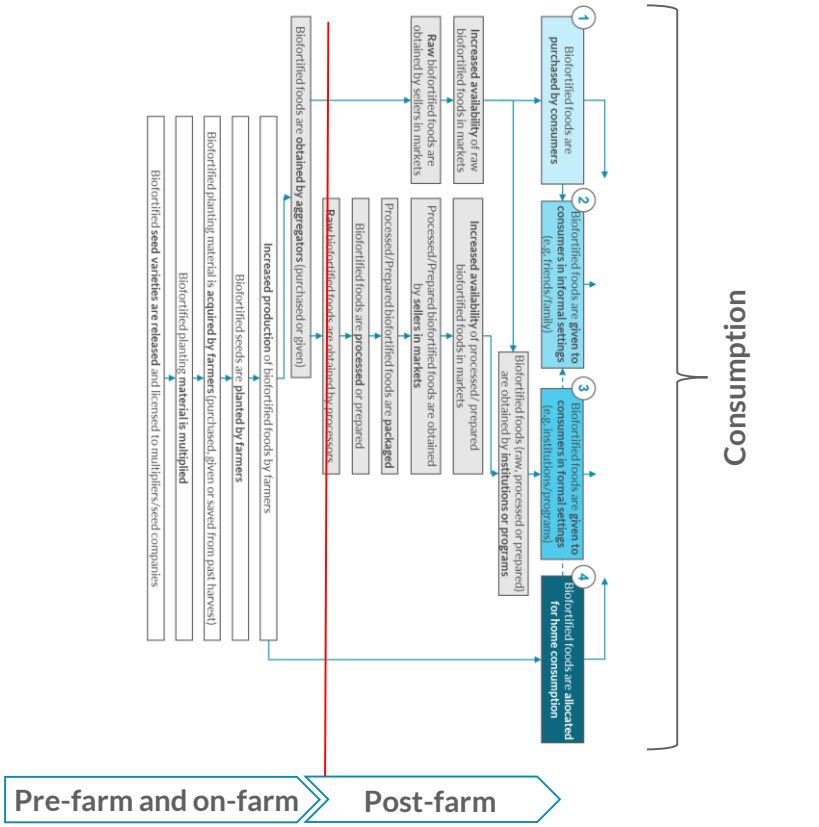
1. With the expectation that after the grant, no further subsidy is needed because the market failure is corrected

Prologue

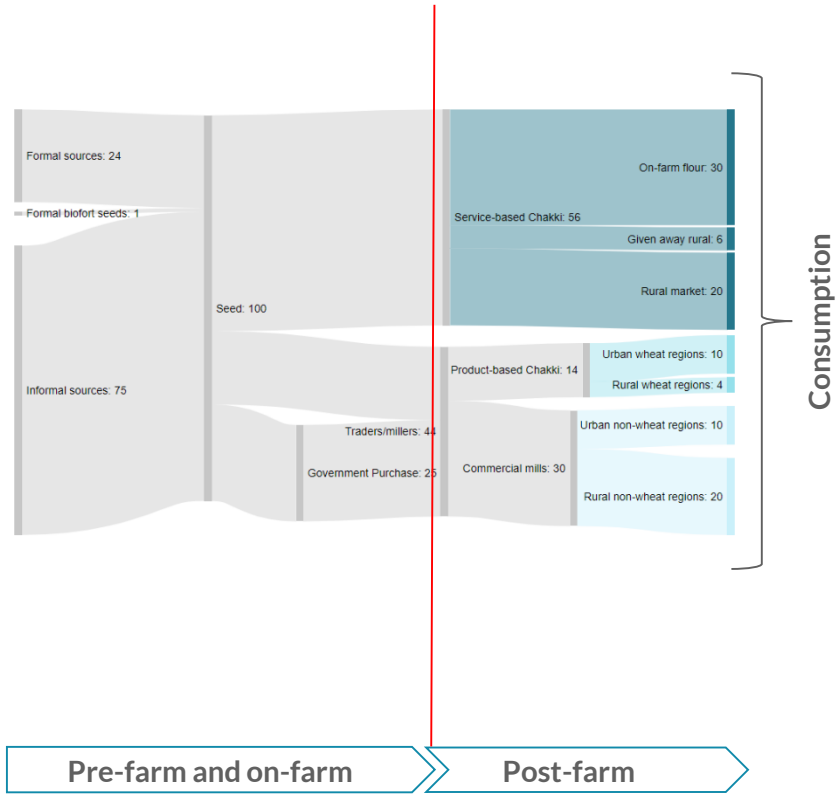
How to read this report (1/2)

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 wheat in Pakistan.

Conceptual outline of the value chain



'Sankey diagram' showing relative flows through the value chain



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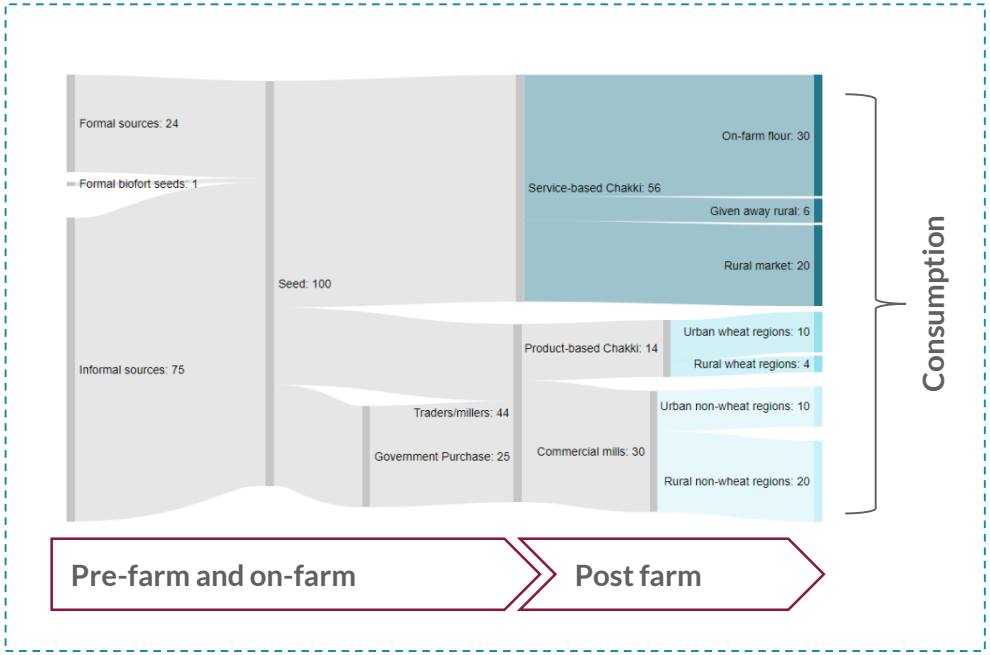
How to read this report (2/2)

- This report is broken down into five sections:
  - Executive summary
  - Pre-farm and on-farm
  - Post-farm and consumers
  - 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 13-25

Slides 25-41

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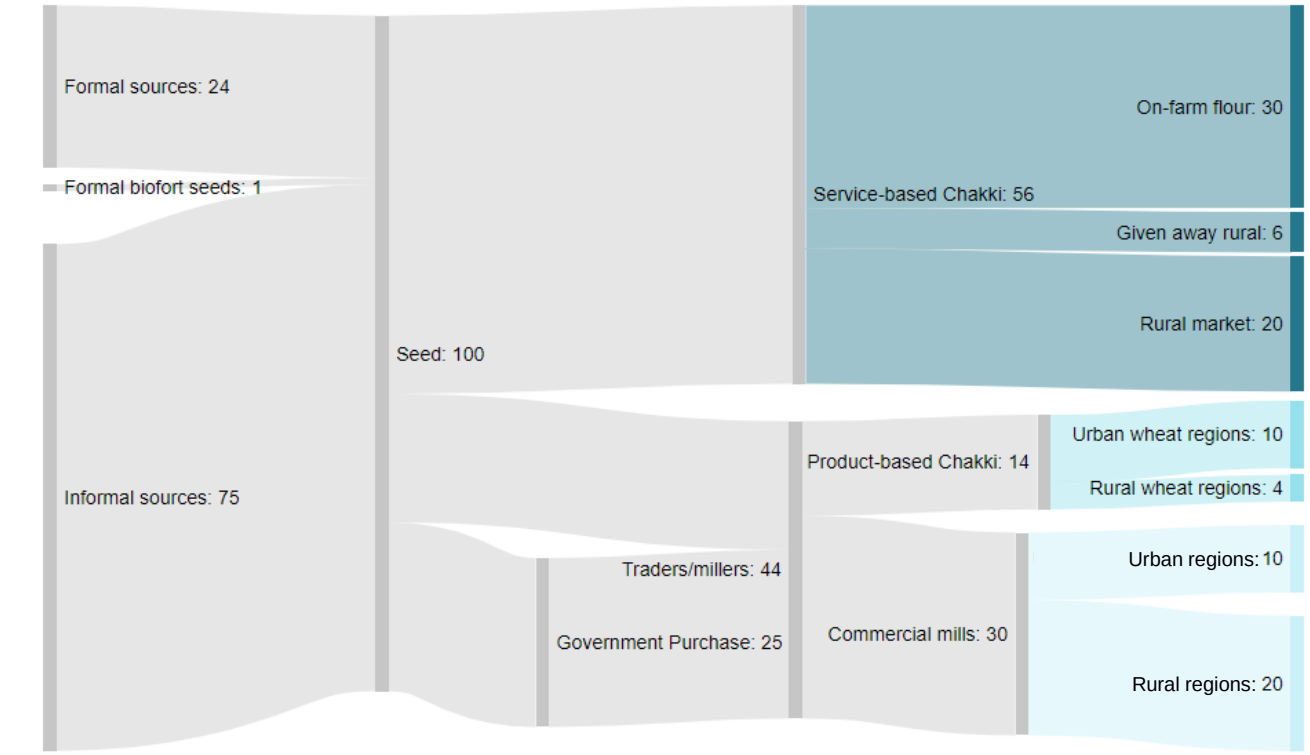
Executive Summary

Current state of the wheat value chain in Pakistan

- The majority of wheat produced in Pakistan (55%) is processed through service-based chakkis
- A significant minority of production (30%) is consumed on-farm
- Government procurement is a substantial component of the wheat market (25%)

Gifting channels are not traced

Flow mapping of wheat value chain in Pakistan[1]
In % of overall volume



Key consumption pathway in Pakistan[4]

1. Service-based chakkis
2. Product-based chakkis
3. Commercial mills

Source: (1) Ansari, et al. "A value-chain perspective on wheat flour fortification in Pakistan," *LANSA*, 2018.

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Executive summary | Overview

- **Zinc deficiency is associated with diminished immune function, stunting, diarrheal disease, and a host of other health challenges.** Over 60 million people in Pakistan have inadequate daily zinc intake with high proportions in deficiency for at-risk populations, like children (21%). In Pakistan, zinc deficiency is the cause of stunting in 40% of the pre-school population.[1]

- **Wheat is the main staple crop in Pakistan, therefore biofortification of wheat with zinc is a possible pathway to reduce zinc deficiency in the national population.** The average annual intake of wheat in Pakistan is one of the highest in the world at 124kg per year, with higher intakes among rural communities. Wheat flour currently makes up 72% of the daily calorific intake of Pakistanis.[2]

- **HarvestPlus has developed a biofortified variety of wheat, Zincol-2016, that contains on average 37 mg of zinc per kg of wheat.** This is about 30% more than most varieties of wheat grown in Pakistan[3]. Since introduction it has reached fewer than 200,000 households through on-farm consumption and makes up less than 0.1% of total wheat production in Pakistan.

- **We have divided the market into four pathways in which we assessed the potential for commercialization:** (i) on-farm consumption, which is 30% of the wheat market, (ii) service-based chakki consumption in rural and urban areas, which is 26% of the wheat market, (iii) product-based chakki consumption in rural and urban areas, which is 14% of the wheat market*, and (iv) commercially milled flour consumption in urban and rural areas, which is 30% of the market.

Note: (*) Individual chakkis provide both service- and product-based production, but it is useful to analyze each mode of production separately
Source: (1) Khalid, N. et al., “A question mark on zinc deficiency in 185 million people in Pakistan--possible way out,” 2014. (2) USDA Foreign Agricultural Service, “Pakistan: Grain and Feed Annual,” 2017.
(3) Hussain, S. et al., "Bioavailable Zinc in Grains of Bread Wheat Varieties of Pakistan," 2012.

Executive summary | Key barriers

There are currently three main barriers across the supply chain to scale Zincol-2016 in Pakistan.

- **Prices in the wheat market are highly controlled by the government. These prices (for seeds, grain and flour) do not take into account nutritional content, and prices are flat for wheat that is 'good enough'.** Both the federal and provincial governments play a strong role in setting prices for wheat at the seed, grain, and flour stages. The government sets and pays flat prices by weight for any wheat that is 'good enough' (based on criteria such as moisture content). Nutritional content is not one of the factors government assesses prioritizes. As such, farmers selling to government (25% of the market) are incentivized to grow as much wheat as possible that meets the minimum government standard, rather than optimize for other measure of quality, such as nutrition.

- **Beyond the government, there is little to no willingness to pay for nutritious forms of wheat.** The struggles with current commercial fortification efforts (representing 30% of the overall market) have revealed little to no additional consumer willingness to pay for nutritious wheat products; there is very little branding or segregation in the wheat value chain to enable premium products for retail consumption (which represents 40% of the market). The one commercial producer of Zincol-2016 states that "There are a few who buy because of the zinc, but many who buy because of the quality of the chapatti".*

- **The lack of consumer preference for a nutritious product means the route to commercialization must be through consumer indifference and farmer preference. However, Zincol-2016 does not clearly outcompete existing varieties of wheat on the trait that matters most to farmers: yield.** For most farmers, the expected yield of Zincol-2016 is slightly less than the other improved varieties in the market (e.g., Faisalabad-208 and Galaxy-13). While Zincol-2016 does have a slight comparative advantage in other important attributes, like disease resistance, this is not considered enough of an advantage to drive farmers (across any segment) to completely switch to Zincol-2016.

Note: (*) This company is targeting high income, urban consumers; despite their higher incomes, they also show limited willingness to pay for more nutritious wheat

Executive summary | Potential opportunities

Recognizing these barriers, we propose two recommendations (in order of importance) to drive uptake at scale of Zincol-2016:

- **Explore financial incentives which can overcome the switching costs and encourage farmers to try growing Zincol-2016.** Instruments such as cash/airtime vouchers, insurance schemes, and mobile money transfers can reduce the risks and costs inherent in switching to a new seed variety. GAIN and HarvestPlus should scope potential options that are effective, efficient (i.e., lowest cost per hectare switched), and acceptable to farmers (e.g. that meet cultural needs and preferences).

- **Develop a capacity-building program for seed multipliers and traders to improve the availability of Zincol-2016, coupled with expanded awareness programs for farmers and rural communities to learn more about the existence and benefits of Zincol-2016.** In Pakistan, seed diffusion starts with "progressive" farmers, who are less risk-averse and trial and showcase new seed varieties that then spillover to smaller farmers nearby. Demonstration days, educational trainings, media campaigns, and rural support programs can be targeted at these progressive farmers to take advantage of these diffusion effects and maximize the overall uptake of Zincol-2016 seeds. These programmes should primarily emphasize the agronomic benefits of Zincol-2016: it is not clear that the added nutrition benefits are as compelling a reason for farmers to switch*.

Note: (*) There may be potential issues around nutrition-based messaging, e.g., confusion with the requirement for zinc as an input, or with GMO varieties, or skepticism about a non-indigenous wheat variety

Pre-farm and on-farm

Two key barriers to scaling uptake of zinc wheat seed exist in Pakistan; intervention design is complicated by market informality

Key barrier	Description	Relative priority*
Government procurement standards	**Farmers have no financial incentive to grow more nutritious wheat** because government does not pay a premium for nutrition in the procurement process (which is the single largest outlet for marketed wheat)	**Medium**
Lack of agronomic differentiation	**Zincol-2016 is not meaningfully differentiated from market-leading varieties of wheat**, providing little agronomic incentive for farmers to switch	**High**

While not a barrier to scale *per se*, **intervention design is complicated by the very high degree of informality in the seed market, especially among small and tenant farmers** (who would be priority targets for a nutrition intervention)

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

In Pakistan, farmer seed preferences are driven by expected yield, chapatti taste, and grain size

Farmer seed preferences remain similar across each main outlet for production[1]

Wheat production for own consumption

Production characteristics

- Farmers reserve about 30% of their wheat harvest on average for household consumption, feed, seed, and other uses.
- Marginal farmers* tend to keep a larger share of their cultivated wheat (~40%) for household consumption.

Primary traits looked for in wheat seed

- Farmers prefer seed varieties based on grain yield, chapatti taste, and grain size.
- There are strong consumer preferences for chapati/roti taste and color as they are the staple foods made from wheat flour (74-99% of farmers see the traits as important in their choice of wheat variety).

Wheat production for sale in market and to government

Production characteristics

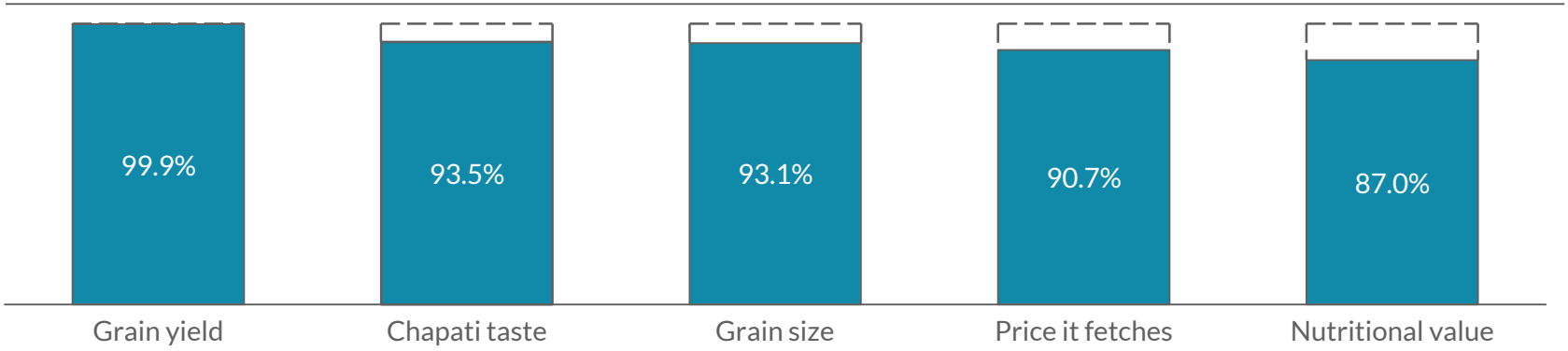
- A majority of wheat harvest (~70%) is marketed among several channels depending on the type of farm. One channel is government procurement (25% of harvest)
- A majority of a farmer's total income (~70%) comes from on-farm activities, like marketing cultivated wheat.
- Larger farmers* have a larger share of on-farm income in their total income (~80%).

Primary traits looked for in wheat seed

- Farmers prefer seed varieties based on grain yield and grain size (to meet minimum quality standards)
- These preferences generally aim to maximize the revenue earned from wheat sale into the market or to government.

Among these key characteristics, farmers see grain yield as the most important factor in choosing a wheat variety[2]

% of farmers rating† each trait as "important" in their choice of wheat variety



(*) marginal farmers are defined as operating less than 5 acres, larger farmers cultivate more than 25 acres
(†) based on a Likert scale score of 1-5 (unimportant- very important). Scores 4 and 5 were counted here
Source: (1) Ansari, N. et al., "A Value-Chain Perspective on Wheat Flour Fortification in Pakistan," 2018.; (2) Nazli and HarvestPlus, "Farmer's Choice of Wheat Varieties in Punjab, Pakistan," *HarvestPlus*, 2012.

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Key barrier | Farmers selling to government are incentivized to maximize output rather than quality, reducing the value-add of biofortification

Government agencies bear the costs for food security by stabilizing the price of wheat[1]…

Pledged procurement
The goal of provincial food departments (mainly Punjab and Sindh) and Pakistan Agricultural Storage & Services Corporation (PASSCO) **buy around 25% of the total wheat crop from each harvest.**

Cost of support prices
In order to keep prices affordable, government agencies accumulate large debt burdens by **buying their pledged amount at a higher fixed price** and then redistribute it back on the market for processing **at a subsidized rate.**

…leading to a standardized procurement system that does not provide a premium for more nutritious wheat[2]

Indifferent wheat procurement
The Food Department does not preferentially procure certain wheat varieties and therefore **does not pay farmers more for more nutritious wheat.** As long as wheat is clean, healthy, and free of excess moisture, it is acceptable to government procurement agents.

A guaranteed buyer
Government agencies provide a fixed sales price for wheat farmers, who prefer a reliable market outlet for their product. **This creates a significant barrier to uptake for Zincol-2016** for farmers who sell to the government, as there is no downstream market incentive for them to switch varieties.

- **Government price fixing complicates efforts to promote Zincol-2016 among farmers.** The government is a significant buyer of wheat that is unlikely to pay a premium for nutrition in the future given the complex political economy surrounding the wheat procurement and subsidy system
- **Farmers selling to the government have no incentive to produce Zincol-2016 over a variety with higher yield** given that government procurement standards are not based on the nutritional content of wheat

Source: (1) Interview with Punjab Food Department; (2) Interview with commercial land-owning farmer.

Zincol-2016, a biofortified variety, has similar agronomic characteristics to leading wheat varieties

Zincol-2016's yield, which is the most important trait for wheat farmers choosing a new variety of wheat, slightly underperforms the two market-leading varieties[1,2]

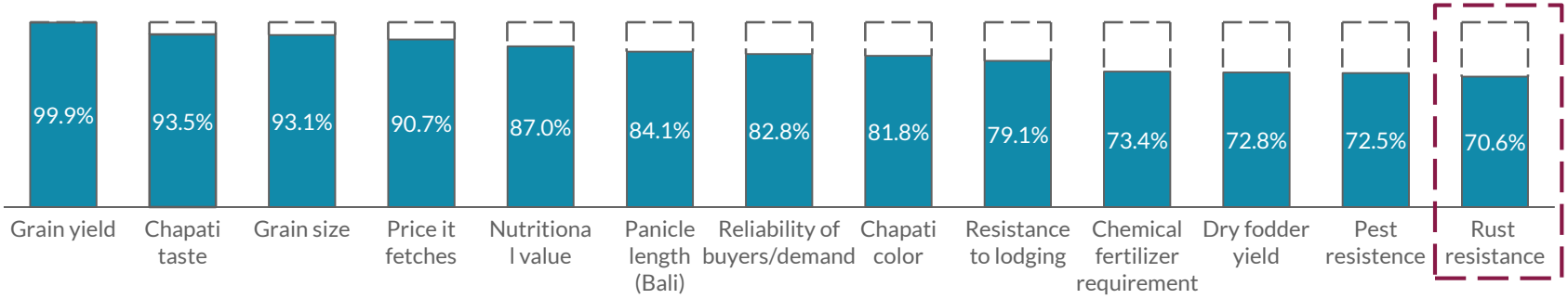
Faisalabad-208 and Galaxy-13 are currently the two market-leading varieties, or "mega-varieties", of wheat

Seed variety	Yield (maunds*/acre)	Taste (chapati and roti)	Disease resistance (for rust)
Zincol-2016	45	Satisfactory	Above Average
Faisalabad-208	48	Satisfactory	Average
Galaxy-13	48	Satisfactory	Below Average[3]

While Zincol-2016 does have a slight comparative advantage in other important attributes, like disease resistance, these traits are not primary drivers of farmer seed choice. For example, farmers relayed that seed selection based on disease resistance is occurs most frequently immediately after a rust epidemic (e.g., after the 2018/19 growing season, in which farmers faced significant incidence of rust)

Improved disease resistance is not a leading trait that determines farmer choice of wheat variety[4]

% average of farmers scoring† the importance of varietal traits in their choice of wheat variety, 2012



(*) A maund is a agronomic metric used in South Asia that roughly equates to 37.2 kg

(†) Based on a Likert scale score of 1-5 (unimportant- very important). Scores 4 and 5 were counted here

Source: (1) Interview with Chairman of wheat R&D board in Faisalabad; (2) interview with select Zincol-2016 farmers sourced by HarvestPlus; (3) Interview with the chairman of the wheat R&D board in Faisalabad. Galaxy-13 performed well until there was a rust epidemic last harvest (4) Nazli and HarvestPlus, "Farmer's Choice of Wheat Varieties in Punjab, Pakistan," 2012.

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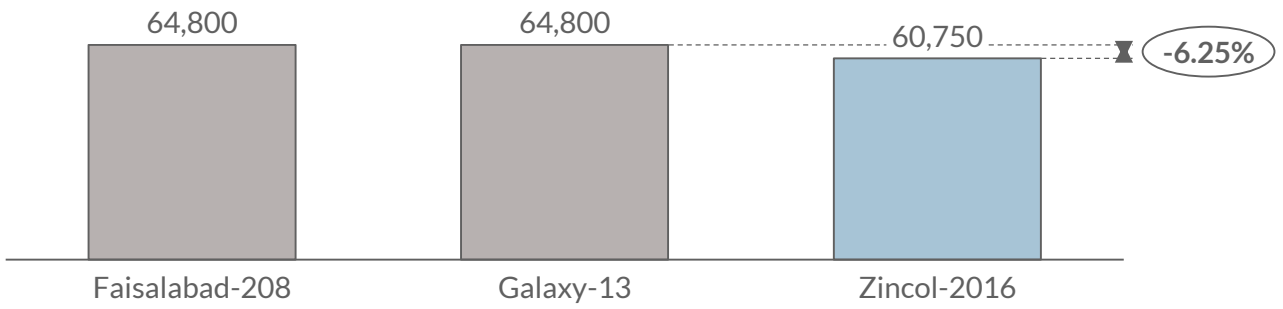
Key barrier | The lack of a differentiated agronomic value proposition for Zincol-2016 is a barrier to uptake by farmers

The decrease in expected revenue given the slightly lower yield of Zincol-2016 is a slight agronomic disincentive for farmers to choose the variety over Faisalabad-208 and Galaxy-13*[1]
Expected revenue per acre of harvested wheat (PKR/acre)



Farmer risk aversion – particularly for small farmers – compounds this agronomic disincentive. Farmers are hesitant to switch to a variety that is not demonstratively better than what they currently grow.

"For them [small tenant farmers], seeing is believing"

*- General Secretary of a social organization for peasant cooperatives commenting on small farmer **reluctance to adopting new seed varieties due to uncertainty**[2]*

"It all depends on the promotion… **only a competitive [variety] in production** capabilities can get growers"

- Official from the Ministry of Food Security responding to the few consumer pull factors to switch seed varieties[3]

- **Most farmers are risk averse** and therefore less likely to try a new variety if it is not clearly better
- The imbalance in revenue and potential costs associated with risk leads actors to face a **potential decrease in profitability if they switch to Zincol-2016 products.**

Note: (*) Calculated using expected yield of each variety. The actual yield for a given farmer will differ based on local environmental and farm management factors
Source: (1) Interview with Zincol-2016 farmers sourced by HarvestPlus; (2) Interview with General Secretary of a social organization for peasant cooperatives; (3) Interview with Ministry of Food Security

In Pakistan, wheat varieties primarily diffuse through informal channels

Informal Seed Distribution[1]

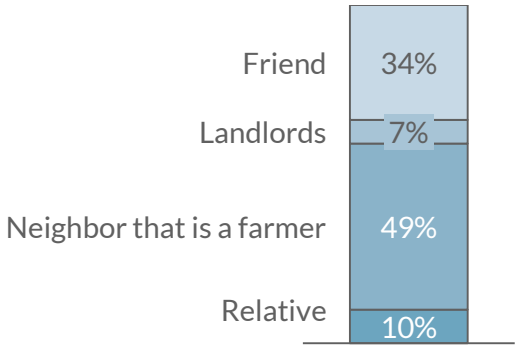
Description	Farmer knowledge of agronomic techniques (e.g., seed choice, farming practices) primarily comes from their surrounding communities, and can take the form of free advice or samples. Famers often get seed informally through bartering with other farmers or landlords
Share of seed supply	~75%
Public actors	N/A
Private actors	Farmers, commission agents, neighbors, landlords, friends

Formal Seed Distribution

Description	Typically, the supplier or farmer travels for formal seed sale. Transactions include payment or formal agreement
Share of seed supply	~25% (80% private and 20% public)
Public actors	Government agencies, public input dealers, and extension workers mainly distribute seed via seed depots and seed dealers of seed corporations
Private actors	Seed companies (national/multinational), private input dealers, and local village shopkeepers mainly sell seeds via sale points and agro-chemical shops

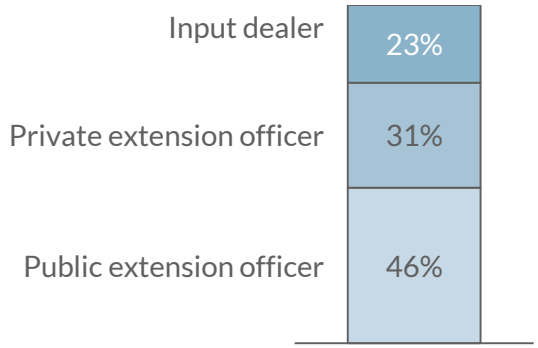
Proximity influences farmer decisions about seed[2]

% share of farmers' sources of wheat seed information, informal



Awareness among formal actors is largely built with mobile agents

% share of farmers' sources of wheat seed information, formal



Source: (1) Ansari, N. et al., "A Value-Chain Perspective on Wheat Flour Fortification in Pakistan," 2018; (2) Nazli, "Farmer's Choice of Wheat Varieties in Punjab, Pakistan," 2012.

Informal seed channels begin with large, "progressive" farmers who have greater access to formal seed markets

Diffusion of new varieties

Input providers

(Formal seed market)

Seed companies, government agencies, village shopkeepers, etc. that have mobile agents or physical locations for distribution

Progressive farmers[1]

(Formal seed market)

A "Progressive" farmer is a conceptual term used to describe larger holding farmers that have the ability and willingness to take on riskier initiatives, like testing a new seed variety, on their plots of land. They have this willingness because of available land and financial security that permits them to test the uncertainty of new products. Progressive farmers are seen as influential leaders to nearby farmers that adopt the new practices that performed well. They interact with formal input providers for new varieties.

More traditional farmers[2]

(Informal seed market)

More traditional land-owning farmers share similar characteristics to progressive farmers in their farm types, but differ in practices related to testing new products throughout their operations. These farmers are more willing to try a new wheat seed variety after they have seen it perform well and usually look to progressive farmer peers to validate the new variety.

Tenant farmers[3]

(Informal seed market)

Smaller, tenant farmers do not actually own the land they farm; they operate on the larger farms of both progressive and more traditional farmers. Many of these farmers work on small plots for subsistence purposes, making them risk averse due to their vulnerability to poverty. Therefore, tenant farmers often do not adopt new practices until they see one that consistently demonstrates increased agronomic value.

- **Progressive farmers are a strategic market entry point** because they act at the intersection of formal and informal markets.
- **Progressive farmers should be the initial target** for awareness building in order to penetrate this informal market.
- **Zincol-2016 can naturally diffuse** once progressive farmers prove its value proposition through a good harvest.

Source: (1) Interview with Engro Foods; (2) interview with Zincol-2016 farmers sourced by HarvestPlus; (3) Interview with a commercial land-owning farmer

For current stakeholders, zinc wheat seed distribution has primarily been informal

Formal Seed Channel

Stakeholder*	Interaction with distribution channel
Tara Group[1]	Currently holds over 600 franchises across Pakistan to sell seed and other necessary inputs as a "one-stop solution" for all farming needs. In the 2019/2020 growing season, the company plans to begin selling Zincol-2016 through informal channels (~5000 kg).
CKD Seeds[2]	Pakistan's oldest seed company that provides seed for different crops. While the company produces zinc wheat seeds, only a small part of this production is marketed through formal channels
Family's Farm Foods[3]	Primarily purchases zinc wheat seeds through formal distribution channels
Select Zincol-2016 farmers[4]	Over a dozen farmers were introduced to Zincol-2016 through outreach activities (e.g., free seeds provided by the R&D Board in Faisalabad)

Informal Seed Channel

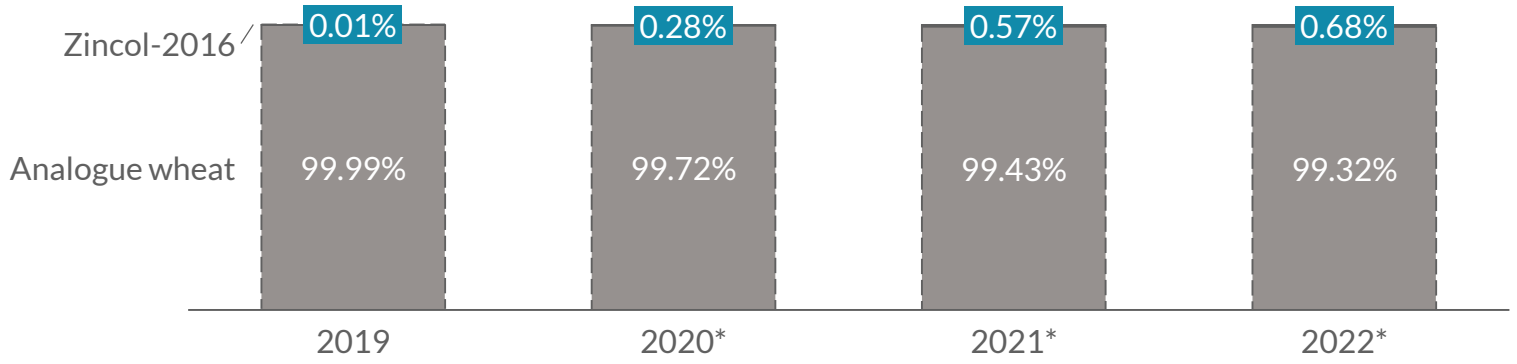
Stakeholder*	Interaction with distribution channel
Tara Group	Prior to the 2019/20 growing season, despite being a commercial seed distributor, Tara Group had primarily informally distributed Zincol-2016 seed to its employees rather than sell it through formal distribution channels
CKD Seeds	The majority of zinc wheat seed production is informally given to employees rather than sold on the market
Family's Farm Foods	The CEO initially heard of Zincol-2016 through his network four years ago. He currently uses a Whatsapp group to discuss new seed developments
Select Zincol-2016 farmers	These farmers discuss Zincol-2016 with current and potential growers via a Whatsapp group.

- Many actors are introduced to zinc wheat by either **receiving its seed for free or hearing about it through friends.**
- After three years of engagement, seed developers **are just starting to sell Zincol-2016 through formal commercial channels** after primarily using the seed for in-kind payments to employees. **This may point to a lack of perceived demand by seed producers for Zincol-2016 seed in formal market channels.**

Note: (*) Please see annex for a description of these stakeholders and their role in the value chain
Source: (1) Interview with Tara Group, (2) interview with CKD Seeds, (3) Interview with Family's Farm Foods (4) Interview with Zincol-2016 farmers

Zincol-2016 has a marginal share of the market and faces supply challenges in the future

Even if Zincol-2016 meets its growth targets for output, it will still only make up less than 1% of total output[1,2]
*% of Zincol-2016 as a share of total wheat output in Pakistan, 2019-2022, assuming full uptake of seed supply**



Given the dynamics of informal seed diffusion in Pakistan, the rate of informal uptake of Zincol-2016 is likely to be slow[3]

Wheat seed varieties perform differently based on local environmental characteristics and farm management practices. Since neither of these two characteristics change for farmers in the short run, **only about 23% of wheat farmers purchase new seed varieties** in a survey season. Farmers tend to only purchase/replace a new seed variety in two situations:

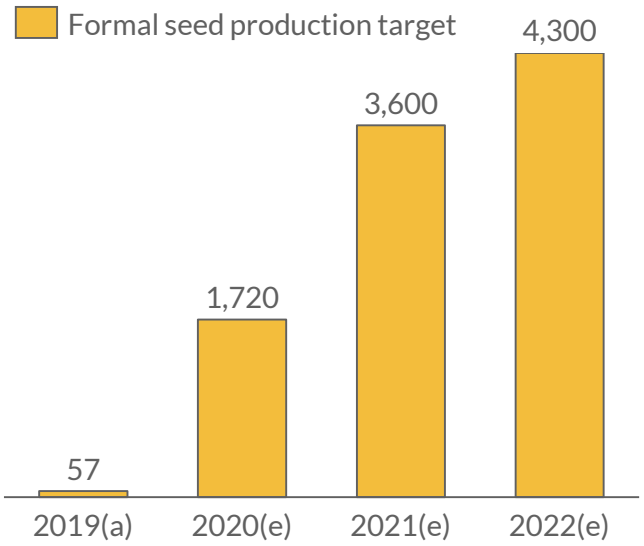
1. If they want to improve their harvest output because **"last year's crop was not good"**
2. If involuntary **mixing of crops with other varieties** dampens the agronomic performance of saved seed

- **In the near term, Zincol-2016 will likely not reach a market share that is comparable to the mega-varieties** currently available in the market, like Faisalabad-208 and Galaxy-13, given the estimated supply of Zincol-2016 seed available on the market through the lifetime of the program
- **The supply of Zincol-2016 may constrain aggressive programs to promote seed uptake**, particularly those aiming to capture a significant share of the market over the lifetime of the program

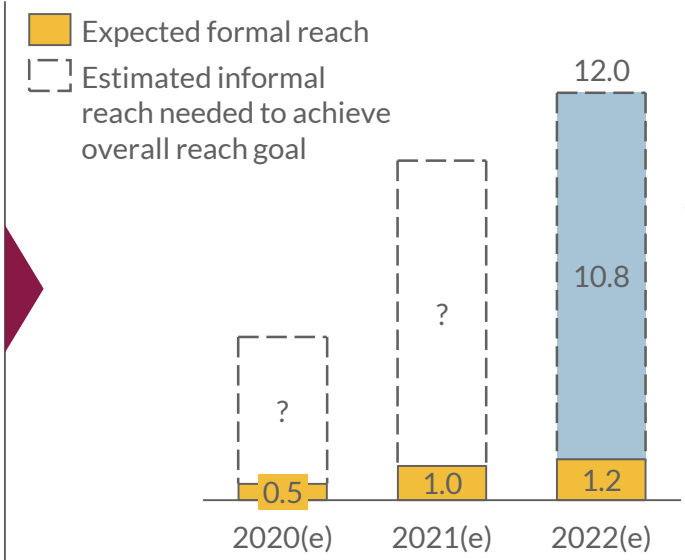
(*) note these are projected wheat outputs based on a constant growth of wheat production from a 2.1% forecast for increased wheat output in 2020. Targets are set by GAIN/HarvestPlus for Zincol-2016 output.
Source: (1) GAIN and HarvestPlus, "Commercialization of biofortified crops country/Crop strategy," 2019 (2) GAIN, "Pakistan Grain and Feed Annual Report," 2019 (3) Nazli and HarvestPlus, "Farmer's Choice of Wheat Varieties in Punjab, Pakistan," 2012.

To achieve our reach target of 12M people, nearly all production will need to come from informally-acquired seeds

The draft country strategy for Pakistan sets formal seed production targets for zinc wheat…
Formal seed production targets, 2019-2022, in MT[1,]*



… but the expected production from these targets are likely to only reach ~1M people. To achieve the reach target, the remainder will have to be reached through zinc wheat produced from informally-acquired seeds
Estimated reach form zinc wheat produced from formal seed markets and implied informal reach needed to achieve reach targets, in millions of people[2,†]



To achieve our goal of reaching 12M people by 2022, 90% of zinc wheat production will have to come from seeds sourced informally

<u>For discussion</u>

Do we think 12M is still a reasonable target for reach?
Can we expect ~90% of zinc wheat production to occur from seeds sourced informally by 2022?
Can informal seed production happen fast enough to achieve the reach target?
Assuming 90% of reach comes from informal seed transfer, is this an appropriately "commercial" end state?

Given that the supply of formal zinc wheat seeds is fixed throughout the lifetime of the program, the remainder of our reach goal will need to be achieved through informal zinc wheat production and distribution

Note: (*) projected seed production was estimated on a standard of 40 kg wheat seed/acre and the projected zinc wheat harvest by GAIN and HarvestPlus (†) See annex for the full methodology for this calculation.
Source: (1) GAIN and HarvestPlus, "Commercialization of biofortified crops country/Crop strategy," 2019.; (2) Ansari et al., "A Value-Chain Perspective on Wheat Flour Fortification in Pakistan," 2018.;

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Interventions | Given these dynamics, there are two potential models to drive the uptake of zinc wheat seeds

Program archetype	Description
Incentives to induce farmers to switch to Zincol-2016	**Explore financial incentives which can overcome the switching costs and encourage farmers to try growing Zincol-2016.** Instruments such as cash/airtime vouchers, insurance schemes, and mobile money transfers can reduce the risks and costs inherent in switching to a new seed variety. GAIN and HarvestPlus should scope potential options that are effective, efficient (i.e., lowest cost per hectare switched), and acceptable to farmers (e.g. that meet cultural needs and preferences).
Expand programs to build awareness among consumers and the availability of seed among private traders	**Develop a capacity-building program for seed multipliers and traders to improve the availability of Zincol-2016, coupled with expanded awareness programs for farmers and rural communities to learn more about the existence and benefits of Zincol-2016.** In Pakistan, seed diffusion starts with "progressive" farmers, who are less risk-averse and trial and showcase new seed varieties that then spillover to smaller farmers nearby. Demonstration days, educational trainings, media campaigns, and rural support programs can be targeted at these progressive farmers to take advantage of these diffusion effects and maximize the overall uptake of Zincol-2016 seeds. These programmes should primarily emphasize the agronomic benefits of Zincol-2016: it is not clear that the added nutrition benefits are as compelling a reason for farmers to switch.

Interventions | The informality of wheat seed uptake complicates interventions to increase adoption

Potential intervention	Given the informality of the seed market, it will be difficult to determine…
Incentives to induce farmers to switch to Zincol-2016	**What incentives need to be offered:** • It is not yet clear which financial incentives (e.g., should it drive the most farmer uptake of Zincol-2016 or should it be the most feasible to offer to small or tenant farmers in Pakistan) **How to verify that farmers are actually using Zincol-2016:** • Given that no existing incentive programs exist to promote uptake of wheat varieties, designing a system to verify farmer uptake of Zincol-2016 – and socialize it with farmers – will be a significant program design challenge, especially since farmers primarily receive zinc wheat seed from other farmers, rather than formal market actors
Expand programs to build awareness among consumers and the availability of seed among private traders	**What aspects of Zincol-2016 to promote** • The nutritional benefit is likely to be primarily valued by higher-income farmers[1] • Zincol-2016's improved rust resistance is a trait that is seen as most desirable by farmers immediately after rust epidemics[2] **How best to reach farmers in informal markets** • More qualitative work needs to be done to understand the dynamics of informal seed diffusion between progressive farmers and smaller farmers • The messaging of the targeted campaign should work to build demand among these smaller farmers so that they seek out Zincol-2016 seed from larger farmers • At the same time, it will be important to target progressive farmers with resonant messaging to ensure smaller farmers have Zincol-2016 seed available in their communities **What organizations are responsible for promoting Zincol-2016:** • Public-sector actors have multiple potential points of contact with farmers who use informal channels for seed uptake at different levels of government (R&D centers, food departments, and local union councils)[3] • Private actors, mainly seed companies, have a strong presence in formal market channels (e.g., input dealers, agents, and seed stores) but will likely need to be engaged through a formal partnership to support awareness-building efforts

Source: (1) Interview with Family's Farm Foods; (2) Interview with Agricultural Research extension Punjab; (3) Interview with PARC

Post-farm and consumption

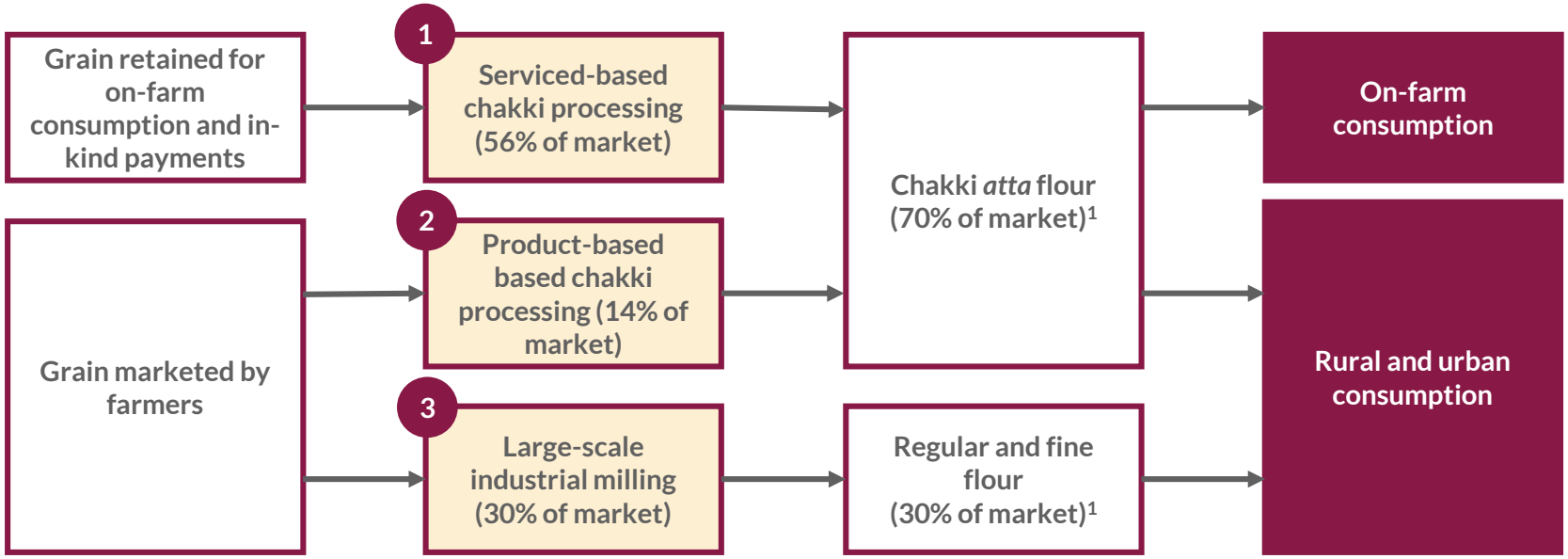
There are two key barriers to the introduction of a biofortified wheat flour product in the Pakistani market

Key barrier	Description	Relative priority*
Lack of consumer willingness to pay for nutrition	**Consumers are unlikely to be willing to pay a premium for nutritious wheat products** (based on prior market experience with fortified wheat flour); as a result, millers are unlikely to be able to profitably introduce a new biofortified wheat flour product	**High**
Price floors and ceilings for industrial mills	**Commercial millers are unable to receive any additional revenue from biofortified products** given the rigid system of government price-setting in the flour market so they will not be able to recover the added costs associated with the production and marketing of a biofortified wheat flour product	**High**

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

Wheat is milled into flour through small mills (chakkis) and large industrial mills; consumers tend to prefer chakki flour

Wheat is processed for consumption through three primary channels: (1) service-based chakki processing, (2) product-based chakki processing, and (3) large-scale industrial milling[1]



Despite retailing at a generally higher price than flour produced by large-scale mills, *atta* flour produced by chakkis is generally preferred by consumers for its texture, taste and perception of "goodness"[1]

Illustrative spot prices for flour in major urban areas in the Punjab (2016/17)[1]

Price (PKR/kg)	*Lahore*	*Multan*
Regular	38.7	37.1
Chakki *atta**	42.6	40.8
Fine	50.0	39.5

- Despite retailing at a higher price than regular industrial flour, **chakki *atta* remains competitive due to strong consumer preferences for the product**, particularly in rural areas[1]
- **Fine flour, or *maida*, is more popular in urban areas and among higher-income consumers**, as it is associated with upward mobility[1]

Note: (*) Estimated; chakki atta typically retails at 110% of the price of regular-grade flour
Source: (1) Ansari, et al. "A value-chain perspective on wheat flour fortification in Pakistan," *LANSA*, 2018 (2) Ghauri, "Assessment of premix distribution options in Pakistan: option analysis," *GAIN*, 2017

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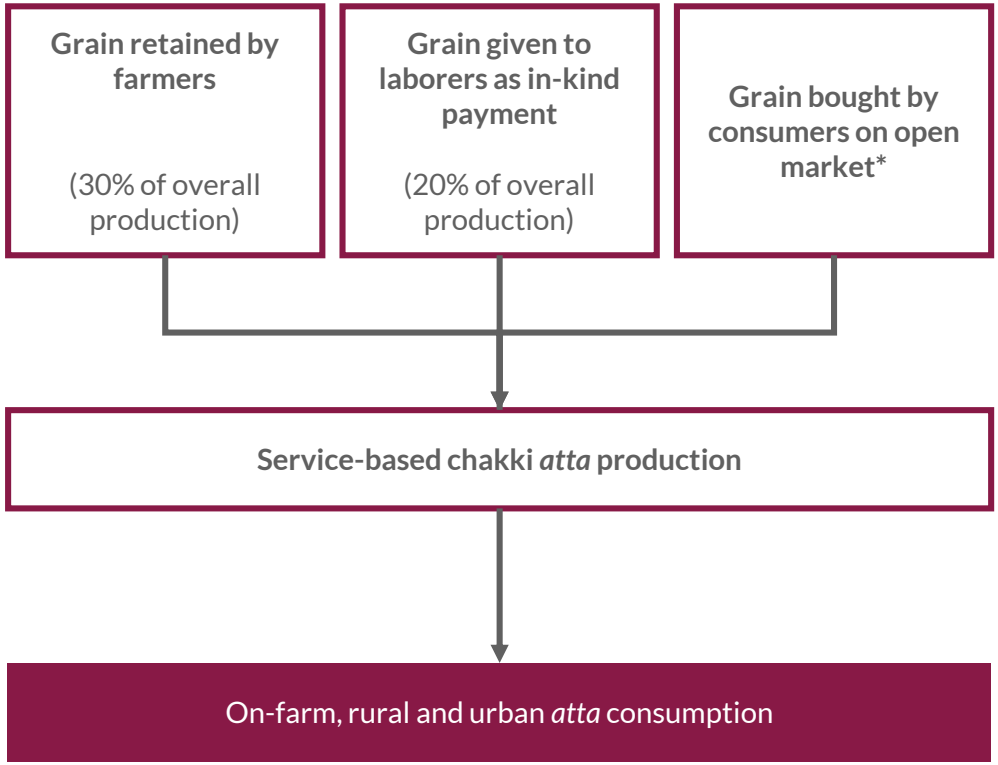
Chakkis engaged in service-based processing provide flour for both on-farm consumption and rural/urban markets

1 Channel

Service-based chakki processing creates flour from grain already owned by end consumers for a small fee[1]



- **All grain which does not enter the formal market – about 50% of total production – is ground into flour through service-based chakki processing.** This method of processing is the primary means through which wheat used for on-farm consumption and in-kind payments is processed for consumption
- **This pathway is the primary mode of consumption for rural households** until their stores of wheat run out (typically in January, several months before the new harvest)
- Chakkis generally charge a small fee to their customers – roughly 2-4 PRK/kg – to process wheat into whole-wheat *atta* flour[1]

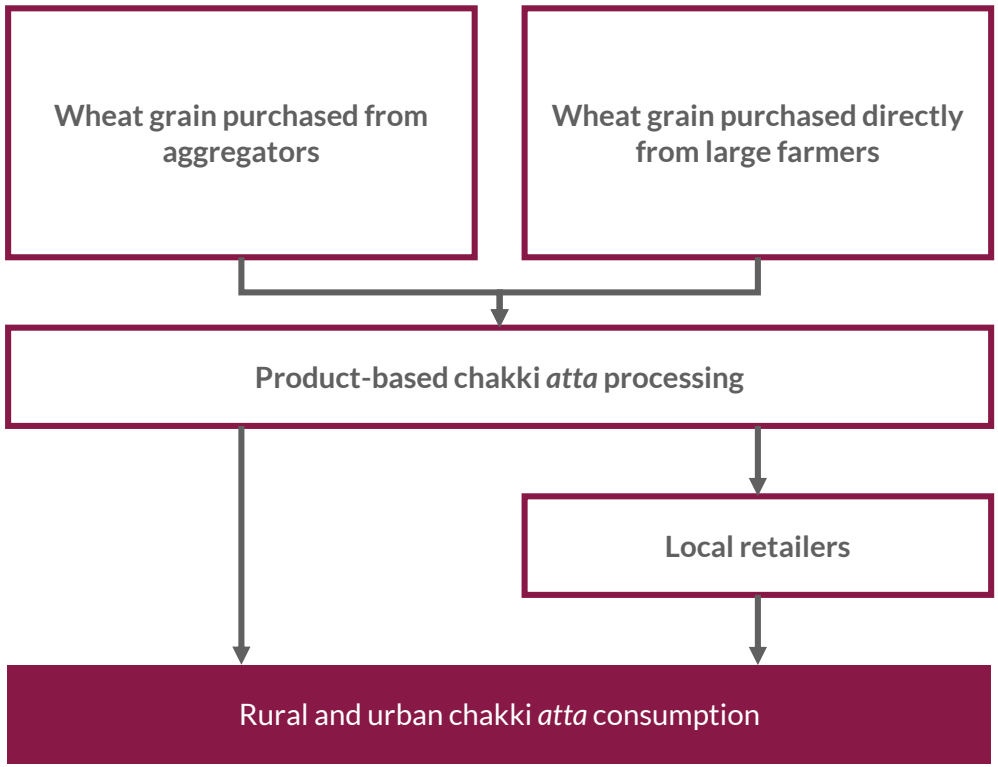
Because the mills engaged in service-based chakki processing do not directly procure flour from farmers or the market, **the only way to penetrate this consumption pathway is to build the market share of zinc wheat produced on-farm** (which can then be used for in-kind payments, which are then processed by service-based chakkis into *atta* used by consumers)

Note: (*) Separate data is not available on the size of this flow to service-based chakki processing
Source: (1) Ansari, et al. "A value-chain perspective on wheat flour fortification in Pakistan," *LANSA*, 2018

Chakkis engaged in product-based processing provide bulk flour for urban and rural markets

2 Channel

Product-based chakki flour processing produces *atta* flour from wheat grain purchased directly from aggregators and farmers



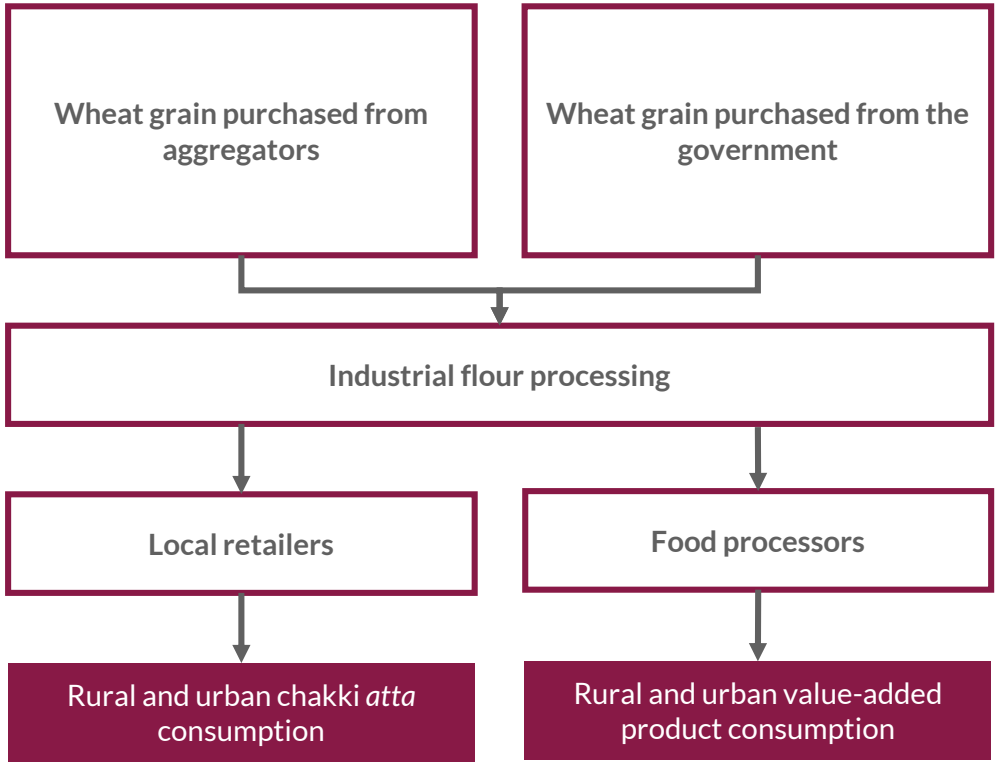
- **Chakkis also directly procure ~15% of wheat production from the open market and process it into bulk *atta* flour** for rural and urban consumption
- Consumers purchase flour directly from chakkis or through local retailers, who purchase the flour in bulk
- The price of chakki *atta* is typically 10-12% greater than regular, industrially-milled flour. **However, strong and entrenched consumer preferences, particularly in rural areas, contribute to the significant market share of chakkis in flour consumption** (estimated to be between 50-70% across both service and product-based chakkis)[2]

Chakkis procure smaller amounts of wheat from farmers and middlemen in local areas for sale in the community. However, given the significant fragmentation and informality in the market (there are between 8,000-30,000 chakkis in Pakistan with no formal registry or industry association)[1,2], **it will be difficult to build relationships with enough chakkis to bring a zinc wheat product into the market at any kind of scale.**

Source: (1) MQSUN, "Pakistan food fortification scoping study," 2014 (2) Ansari, et al. "A value-chain perspective on wheat flour fortification in Pakistan," *LANSA*, 2018

Commercial mills provide a fine, white flour that is seen as less desirable by rural consumers

Industrial flour processing produces regular and fine-grade flour from wheat grain purchased directly from the market and from government storehouses



- **Industrial milled flour is consumed by 60-70% of the population in urban areas and 25-30% of the population in rural areas.** This percentage is expected to increase over time as part of a secular shift towards the consumption of cheaper, industrially-milled flour[1]
- **However, rural consumers – and urban consumers with strong ties to rural areas – tend to strongly prefer chakki atta** and will preferentially purchase it as their incomes allow because of perceptions about industrial flour's lack of freshness, potential for adulteration, and lack of nutritional value[2]

Commercial mills are seen as the most "formal" channel and are subject to strict government price controls for their inputs (a significant portion of which comes from government wheat procurement) **and outputs** (government sets the target price for *atta* flour in coordination with the PFMA, the industry association). **These strict price controls present a significant impediment for commercialization efforts.**

Source: (1) MQSUN, "Pakistan food fortification scoping study," 2014 (2) Ansari, et al. "A value-chain perspective on wheat flour fortification in Pakistan," *LANSA*, 2018

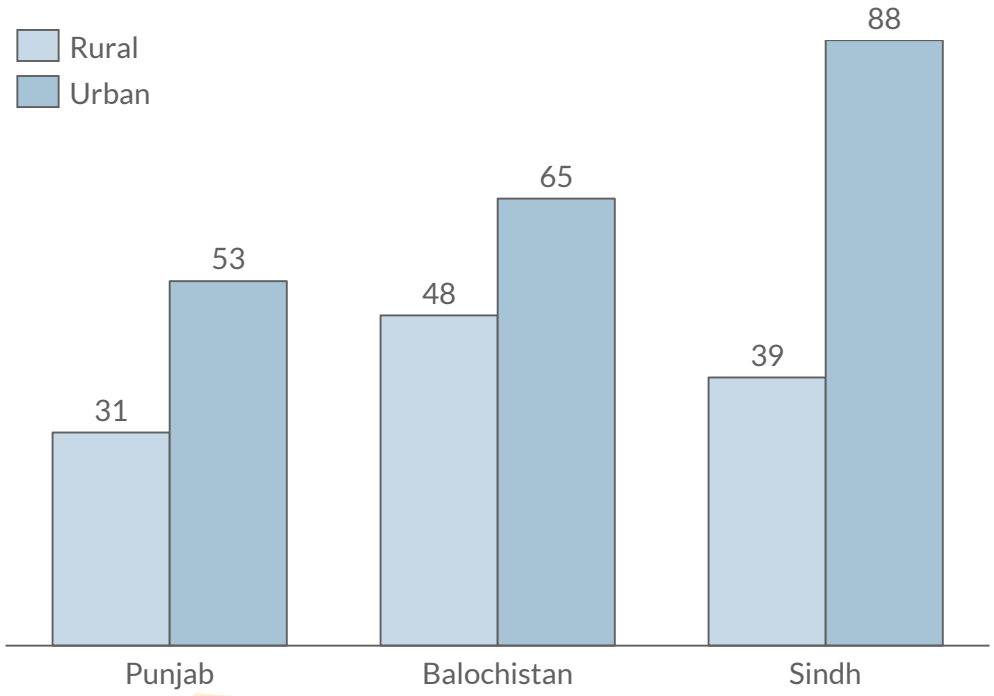
Large-scale mills are already encouraged to fortify flour with four micronutrients, although there are gaps in program coverage

3 Channel

- **In 2014, the province of Punjab enacted mandatory fortification of industrially-produced flour with zinc, iron, folic acid, and vitamin B-12.** Industrial flour mills had been encouraged to voluntarily fortify their products since 2007.
- **This fortification program is managed in partnership by public sector actors** (e.g., the Food Fortification Program, the Punjabi Food Board) **and private-sector actors** (e.g., the Pakistan Flour Mills Association).[1]
- **Millers received the necessary equipment to fortify their products and a partial subsidy for the cost of the premix** needed to fortify their production
- **Because the price of wheat flour is fixed, millers must absorb some of the additional costs of production.** The PFMA estimates that this marginal cost borne by millers is about 0.5% of the final sale price of flour[2]

Because a significant number of rural consumers consume chakki flour, rather than flour from large-scale mills, gaps in potential nutrition coverage remain

% of consumers consuming a fortifiable form of wheat flour by province, 2017[1,]*

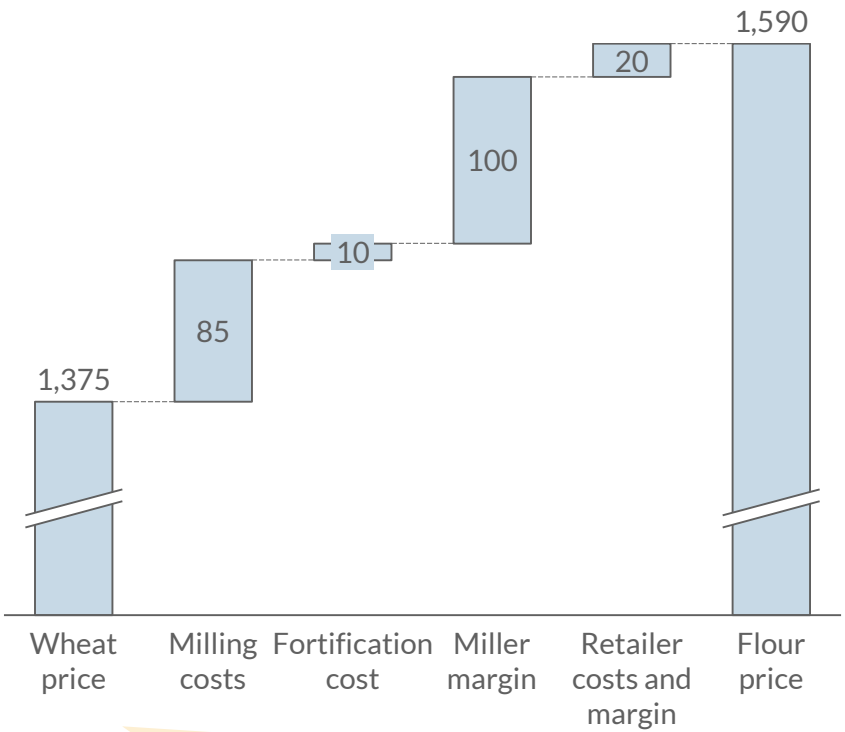


Rural households in Punjab – which predominantly farm wheat -- are largely excluded from formal fortification programs due to their consumption preferences. **These households could be easily reached through biofortification, as they are largely on-farm consumers of wheat**

Note: (*) The cited study notes that there may be significant underreporting of coverage; actual coverage gaps may be smaller than those presented here, but should be directionally correct
Source: (1) GAIN/USAID, "Fortification Assessment Coverage Toolkit Survey in Pakistan, 2017," 2018 (2) Interview with the PFMA

However, commercial fortification efforts have revealed a lack of consumer WTP for and awareness of nutrition

Millers are unable to pass on the additional costs of fortification since the retail flour price is fixed by the government…
Illustrative flour price decomposition, in PKR / 40kg of flour[1,2]



The government sets both a price floor for wheat and a price ceiling for commercial flour, constraining the ability of millers to set prices to recoup additional costs of production (e.g., fortification or procurement of biofortified wheat)

… so consumer WTP for nutritious flour has not been directly observed from the fortification program. However, miller experiences with marketing fortified flour provides insight into initial consumer attitudes towards a biofortified flour product[2]

Millers see almost no consumer awareness of the existence or benefits of more nutritious flour	PFMA representatives (the industry association for industrial flour producers) noted that very little demand creation work had been done; **neither millers nor the public sector had committed significant resources to marketing and differentiating the fortified product**
Millers do not see any willingness to pay for improved nutrition by consumers of fortified flour	PFMA representatives estimated that **raising the price of fortified flour by 10 PKR/40kg** (or about 0.5%) **would limit its market exclusively to wealthy urban consumers** who have the budget to pay for premium flour
Government price ceilings prevent millers from recouping added costs from more nutritious products	PFMA representatives noted that any added costs associated with the fortification program (e.g., premix, marketing) cannot be passed on to consumers given the current regulatory regime; **these added costs must come out of their margin**

Source: (1) Baig, Zahid, "PFD to release wheat to flour mills tomorrow," *Pakistan Recorder*, 2019. (2) Interview with the PFMA

Key barrier | This lack of WTP for nutrition is likely present across major consumer segments, particularly those that most need the nutrition intervention

Consumer segment	Rural consumers	Urban low-income consumers	Urban high-income consumers
Description	Rural farm or non-farm consumers who primarily mill wheat that they grow or receive through in-kind payments and may purchase flour later in the season	Price-sensitive urban consumers who may purchase cheap commercial flour or mill wheat brought back from the countryside	High-income urban consumers willing to pay a premium for high-quality, fine flour or more nutritious flour
Main drivers of consumption	Price, *atta* quality (observed preference for chakki *atta* despite 10% greater price)[1]	Price, *atta* quality (some preference for chakki atta in urban consumers with ties to rural areas)[1]	Price, *atta* quality, nutrition[1]
		Primary sources of flour[1,2]	
Service-based chakki production	**1**	**3** *(in wheat-growing areas)*	
Product-based chakki production	**2** *(seasonally)*	**2**	**2**
Commercial flour		**1**	**1**
Potential WTP for nutrition	Low to nonexistent, as many consumers in this segment are very price sensitive and do not have the income to buy enough flour to meet household caloric needs in a given year[1,3]	Low to nonexistent, as many consumers in this segment are very price sensitive and do not have the income to buy enough flour to meet household caloric needs in a given year[1,3]	Potentially present, as consumers are willing to spend more for higher-grade flour (maida) seen as higher-quality

Low consumer WTP for nutrition – especially for those rural and urban low-income consumers outside the coverage of conventional fortification programs – **will create a significant challenge for product-based chakki production by disincentivizing the introduction of a new biofortified product.**

Source: (1) Ansari, et al. "A value-chain perspective on wheat flour fortification in Pakistan," *LANSA*, 2018 (2) GAIN/USAID, "Fortification Assessment Coverage Toolkit Survey in Pakistan, 2017," 2018 (3) Interview with the PFMA

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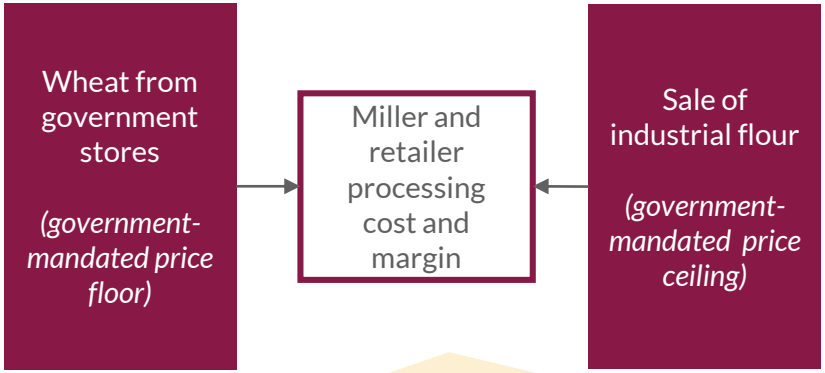
Key barrier | Additionally, commercial millers are unable to pass on added costs to consumers, reducing biofortified products' value proposition

Wheat wholesale prices are subject to a price floor while flour prices are subjected to a price ceiling, making it impossible for millers to pass on any additional costs incurred in the production of a wheat flour product to consumers[1,2]



- Commercial millers purchase a significant portion of their wheat from the government, **who sets a price floor in the market through regional food boards**
- As part of this arrangement, **the government sets a maximum retail price for atta flour** (pegged to the market price for flour)
- **In this way, commercial millers and retailers of commercial flour have fixed margins** that can only be increased by reducing processing cost

- **Millers would incur additional costs in the production of any biofortified flour product** (e.g., the setup and maintenance of a supply chain for biofortified wheat given the undifferentiated wheat market, including the verification and testing of that supply chain; marketing and demand creation expenditures).
- **Milers would be unable to recoup those costs by passing them on to the consumer** because the final price of flour is fixed by the government
- **Therefore, it is unlikely that any mill would invest in creating a biofortified product without a subsidy to ensure that product has the same margin as conventional flour**. This subsidy would have to be ongoing over the life of this program, as it is very unlikely that these added costs would go away as production scales.

Consumers are neither willing nor able to pay for the additional costs incurred in the production and marketing of a packaged biofortified flour product. **Given these significant constraints, it is unlikely that biofortified wheat can effectively scale through the retail consumption pathway.**

Note: (*) Cost of fortification omitted here
Source: (1) Baig, Zahid, "PFD to release wheat to flour mills tomorrow," *Pakistan Recorder*, 2019. (2) Interview with the PFMA

Policy and financing

The government directly supports R&D for biofortified crops, but has not taken a leading role in marketing or demand creation

The Government of Pakistan leads the development of new biofortified varieties of crops

- **Fortification and biofortification are codified priorities** in the National Strategy for Nutrition. At the provincial level, Punjab and Sindh acknowledge nutritional enhancement mechanisms in their PC-1 reports.
- **The government directly supports R&D for new biofortified varieties of wheat** on both the national and provincial levels.
- The Ministry of National Food Security and Research (MNFSR) oversees the R&D efforts of the Pakistan Agricultural Research Council (PARC) and the National Agricultural Research System (NARS), which jointly developed Zincol-2016.
- **Agricultural authorities in Punjab have planned to introduce a PKR 3.5BN initiative to develop biofortified varieties of crops** beyond wheat, including staples such as rice and maize, fruits, and vegetables[1].

However, there has not been demonstrated policy support for marketing and demand creation for nutritious wheat and flour

- Neither private nor public actors in existing fortification programs (e.g., in conjunction with the Punjab Food Department) have devoted resources to branding or awareness creation for fortified products. This has been cited as one factor in the lower-than-expected uptake of these products and compliance with the fortification program[2].
- **Similarly, there has been little public leadership to build awareness about biofortified products**, particularly downstream in the value chain. Additionally, regional actors (e.g., the Punjab Food Department) have not involved themselves in the rollout of biofortified products[2]
- **More could be done to socialize government entities on the value proposition of biofortified products** and their position as a complementary, rather than supplementary, nutrition intervention to commercial fortification.
- **Most direct financing for wheat programs comes from donors** (e.g. DFID pledged 46mn GBP); the Government indirectly finances programs using in-kind mechanisms.
- **Only ~2% of the total seed supply is subsidized** at the provincial level with targets in geographic regions where certified seed is not commonly used.

Source: (1) Mahmood, Amjad, "Alleviating hunger through biofortification," *Dawn*, 2018 (2) Interview with the Provincial Fortification Alliance, Punjab Food Department

It is unlikely that provincial governments will preferentially procure zinc wheat in the near term

At the national level, government officials from several agencies expressed difficulty about preferential procurement in a system where multiple levels of government control different parts of the supply chain

"It would be difficult because flour is not in our mandate… wheat is"

- Official from the Ministry of Food Security responding to the question "would the government support a separate price ceiling for biofortified flour?"[1]

"We need to really negotiate regulations… how do we approach the negotiation for provincial governments to pay more"

- Official from the Pakistan Agricultural Research Center (PARC) discussing the difficulty of government created demand for zinc wheat[2]

Punjab's provincial food department mission to empower all farmers, regardless of the seed variety they grow, means they are reluctant to launch a program to preferentially support farmers who grow a biofortified variety[3]

"The goal of the Food Department is to purchase from farmers and sell to flour mills… presently, the Food Department does not discriminate between varieties purchased"

- Translation of an official from the Provincial Fortification Alliance, Food Department, Government of Punjab

"The premix used in fortification already includes zinc, there is a concern by government officials present that there is no real need for biofortification since premix will be added anyways"

- Translation of an official from the Provincial Fortification Alliance, Food Department, Government of Punjab

Source: (1) Interview with Ministry of Food Security official; (2) Interview with PARC (3) Interview with Punjab Provincial Fortification Alliance, Food Department

Financing exists, but financial institutions can lack credibility from the perspective of farmers

Key issues around farmer perceptions of financing	Description	Qualitative evidence
Mistrust of banks or financial institutions	Farmers may have had negative experiences with bank loans or the terms of credit and are adverse to seeking financing	"These institutions [banks] only work for large, feudal lords… none of us trust the [banking] system" *- General Secretary of a peasant farmer cooperative*[1]
Cultural values and norms	Farmer cultural values may preclude the use of credit instruments (e.g., Islamic values against interest). While Islamic financing exists, it is a relatively small segment of the market	"Islamic banking increases the satisfaction level of farmers because they are trying to avoid *Riba* (Interest)" "Meezan Bank is the only Islamic bank to offer Islamic agri-products in Pakistan.[2]
General aversion to debt as a way of doing business	Wealthier farmers may prefer to finance expansion in other ways (e.g., by selling assets) rather than use bank lending services	"I don't like bank loans, they **drain my profitability**" *- CEO of Family's Farm Foods on the availability of commercial loans*[3]

Source: (1) Interview with General Secretary of a social organization for peasant cooperatives (2) Ashraf, "Islamic and Conventional Agri-financing in Pakistan," 2013 (3) Interview with Family's Farm Foods

Smaller farmers typically receive credit through informal channels; larger farmers use formal sources

Informal sources of credit[1,2]

- **The majority of small farmers depend on informal sources of credit** and often lack access to formal credit providers for reasons including a lack of formal credit history, lack of collateral, or a required loan size that is too small for formal providers to profitably provide
- **These informal sources of credit are often community members**, including commission agents, input suppliers, landlords, traders, employers, and friends and family
- **Small farmers often receive lending for both production and household consumption purposes;** loans can be structured for in-kind or cash repayment

Formal sources of credit[1,2]

Government bank *(~20% of formal credit market)*	• ZBTL (formally the Agricultural Development Bank of Pakistan) is the specialized public agrifinance window in Pakistan • ZBTL offers a number of publicly-subsidized loan products, including agricultural production lending and SME lending, in coordination with the State Bank of Pakistan
Commercial banks *(~50% of formal credit market)*	• Five leading commercial banks supply the majority of formal credit, including ABL, HBL, MCB, NBP, and UBL • These institutions primarily lend greater amounts of money to larger entities (e.g., millers, processors, large landholders)
Private banks and MFIs *(~30% of formal credit market)*	• There are 15 registered private banks and seven MFIs active in Pakistan's formal credit system • These institutions tend to lend smaller amounts of money to smaller entities (e.g., medium-sized farmers, SMEs) • However, small farmers and tenant farmers usually access credit through informal channels

Source: Chanido, et al. "Types, sources and importance of agricultural credit in Pakistan," 2017. (2) Chanido and Sahito, "Impact of formal credit on agricultural output: evidence from Pakistan," 2016

A set of financing interventions could be considered to promote zinc wheat in Pakistan

Illustrative financing interventions – *for discussion*			
Instrument	*Target beneficiaries*	*Description*	*Relative feasibility*
Cash incentives / conditional cash transfers	• Farmers • Millers	• Cash incentives or discounts could be provided to farmers to reduce effective cost of zinc wheat seeds, improving their agronomic competitiveness • Conditional cash transfers could be provided to millers or farmers who produce or process verified zinc wheat or *atta* flour	**Medium.** Once an appropriate channel has been identified, organizations could work directly with large seed traders and extension workers to develop an incentive system
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 wheat, potentially in coordination with the State Bank of Pakistan	**Low.** No other lending incentives exist for specific varieties or crops; these interventions would also likely require significant buy-in from a wide range of actors
Direct policy incentives	• Millers	• The Government of Pakistan could provide structural incentives (e.g., tax benefits) to millers who process verified zinc wheat as a certain % of their output to bring	**Low.** No other direct policy incentives exist for specific varieties or crops; verification and buy-in from a range of public stakeholders will be difficult
Programmatic financial support (e.g., 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	**High.** This instrument would only require a deepening partnership between development and public actors

The most effective and efficient instruments will only provide financial incentives for the ramp-up of adoption. Incentives can ramp down once consumer preferences evolve in favor of zinc wheat and a critical mass of dedicated consumers is developed

Annex

Urban retailers across different settings typically do not brand their wheat products

Unbranded wheat products are commonly seen across different cities and consumer markets

Photographs from field research in Islamabad and Lahore, October 2019[1]

A selection of unbranded wheat flour in a middle class grocery store in Islamabad.

Outside of a wheat flour store in Lahore's market, where wheat is packaged and sold in a re-used sugar cane bag, then distributed in clear plastic bags.

Branding for a nutritious wheat product will likely be costly and may not provide additional return to justify the added costs

"Branding works for fertilizers, pesticides, and maybe other inputs, but not for wheat flour…"

- General Secretary of a social organization for peasant cooperatives commenting on the futility of branding wheat products[2]

"With the introduction of a new product and its associated costs such as branding, it would be cheaper to simply provide cheap zinc sachets to address deficiencies"

- Translation of an official from the Provincial Fortification Alliance, Food Department, Government of Punjab[3]

Source: (1) Dalberg analysis; (2) Interview with General Secretary of a social organization for peasant cooperatives; (3) Interview with the Provincial Fortification Alliance, Food Department, Government of Punjab

In-country interviews conducted

Date	City	Stakeholder	Type
14 October 2019	Islamabad	Ministry of National Health	Policy (national)
15 October 2019		Ministry of Food Security	Policy (national)
		Chairman of PARC	R&D (national)
16 October 2019	Lahore	Engro Corporation	Input provider
		MP/Commercial farmer	Farmer
17 October 2019		Tara Group	Seed developer
		Chakki millers	Processor
		Peasant farmer cooperative	Farmer
18 October 2019		Family's Farm Foods	Retailer
		Punjab Food Department	Policy (provincial)
		MP/Commercial farmer	Farmer
21 October 2019	Faisalabad	Pakistan Flour Mills Association	Processor
		Ayub Agricultural Research Center	R&D (provincial)
		Small Chakki miller	Processor
22 October 2019		Chairman Wheat R&D Board	R&D (provincial)
		Select Zincol-2016 farmers	Farmer

A range of important stakeholders in the seed value chain were consulted

Stakeholder	Overview and significance
Tara Group[1]	Started using Zincol-2016 four years ago. Active across the value chain, from research farms growing and studying zinc wheat to consuming zinc wheat roti on-site. Currently holds over 600 seed trader franchises across Pakistan that will start distributing Zincol-2016 seed this year.
CKD Seeds[2]	Pakistan's oldest seed company (operating since 1930) that provides seed for many different crops. An important stakeholder in the early parts of the value chain because it primarily sells to other seed companies, distributing basic and certified seed varieties. It is therefore an influential actor in the diffusion of new seed varieties throughout the wheat market.
Family's Farm Foods[3]	A vertically-integrated stakeholder that has Zincol-2016 for four years and is currently the only business engaged in producing processed/prepared Zincol-2016 foods that are packaged and branded.
Select Zincol-2016 farmers[4]	Over a dozen farmers from across the Punjab region, including progressive and traditional farmers, that grow zinc wheat for subsistence and retail use.

Source: (1) Interview with Tara Group, (2) Interview with CKD Seeds, (3) Interview with FFF, (4) Interview with select Zincol-2016 farmers sourced by HarvestPlus

Methodology for target reach calculation

Indicator	Baseline	2020	2021	2022
Target quantity of food vehicle volume harvested that is biofortified (MT)[1]	2400	72000	150000	180000
Estimated required seed to reach target quantity of biofortified wheat harvest (MT)[2]	57	1720	3600	4300

Procedure to estimate seed requirements:

- Estimate the required seed based on wheat production targets outlined in Pakistan country strategy by dividing targets (above, converted to kg) by expected zinc wheat output (1674 kg/acre) to get the number of acres to be seeded to achieve the target production
- Multiply the number of acres needed to reach target production by the standard requirement of 40 kg of seed per acre to estimate the total amount of seed required for each target year

Procedure to estimate population reach:

- Divided total kg wheat harvested at each target year by the estimated annual wheat consumption of an individual (152 kg)
- Backsolve the remaining production from informal sources of seed needed to reach 12 million people across both formal and informal channels

Key assumptions:

- 40 kg/acre is standard for wheat seed usage in Pakistan[1,2]
- Zincol-2016 has a yield of 45 maunds/acre (1674 kg/acre)[3]
- Average annual consumption of wheat in Pakistan is 152 kg/person based on rural daily consumption at 459.4 g and urban at 249.5 g (weighted average based on rural/urban share of total wheat consumption at 80/20%)[4]
- "Reach" is represented as one person switching the entirety of their consumption to zinc wheat

Source: (1) Draft Pakistan country strategy document (2) Estimated using methodology