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SUCCESS STORY

Scaling Biofortified Zinc Wheat through Policy Reform and Partnerships in Punjab, Pakistan

Innovation Name

Zinc Wheat

Location (Country/Region)

Pakistan



Lead centres

International Food Policy Research Institute

Innovation Type

Product

Current Innovation Readiness Level



Proven Innovation

Current Innovation Use Level



End-Users/Beneficiaries (II)

Scaling Dimensions Achieved

Scaling Up + Scaling Out

Challenge Addressed

- Policy & Regulatory Framework
- Institutional Capacity
- Access to Finance & Markets
- *Market imperfections or failures*
- Infrastructure & Services
- *Insufficient advisory or extension services*

SDG Targets



CGIAR Impact Areas



Between 2019 and 2023, Pakistan’s Zinc Wheat (ZnW) initiative achieved rapid scaling from pilot to national level through coordinated policy reform, institutional investment, and private-sector engagement. Initially constrained by weak seed systems, limited farmer awareness, and fragmented policy implementation, the enabling environment for zinc wheat transformed through reforms in seed certification, public investment in early generation seed (EGS), and targeted digital advisories for farmers. Punjab province, accounting for most of Pakistan’s wheat area, became the central hub for scaling. This was facilitated through the joint efforts of the Punjab Agriculture Department, Ayub Agriculture Research Institute, HarvestPlus, International Maize and Wheat Improvement Center (CIMMYT), and private seed companies, which resulted in the area planted with zinc wheat expanding from 64,000 to over 3.1 million hectares, reaching 3.3 million farming households and more than 20 million consumers. This case illustrates how coordinated institutional, policy, and market interventions can translate research innovation into widespread impact, improving both agricultural productivity and population nutrition.

Context and Ambition

Micronutrient deficiencies are widespread in Pakistan. According to the National Nutrition Survey 2018, 42.6% of women of reproductive age were anaemic, while 46.9% of pregnant women suffered from iron deficiency. Zinc (Zn) deficiency is highly prevalent in the Pakistani population (22.1%), particularly in women (~40%) and children (under 5 years) due to low dietary Zn intake. The survey found significant related adverse health effects that among children under five, 40.2% were stunted, 17.7% were wasted, and 9.5% were overweight.

In Pakistan, wheat is the primary affordable staple food and is typically a poor source of Zinc. More than 75% of the population cannot afford a minimally adequate diversified diet (FAO, 2021). The Ministry of Agriculture and CGIAR partners - HarvestPlus-IPFRI and CIMMYT -worked on developing three varieties of biofortified wheat with elevated levels of zinc, of which the most recent release -Biofortified zinc wheat - is proven to have significant impacts on morbidity (Sazawal et.al, 2018). Akbar 19- received unprecedented acceptance and adoption among consumers and farmers. In initial stages however the lack of EGS availability, seed access and low awareness impeded uptake. This case outlines the key enabling

environment and ecosystem shifts that triggered significant changes in zinc wheat seed production and adoption in the largest state of the crop's production in Pakistan – the province of Punjab.

Creating the Enabling Environment for Scale

Identifying and Addressing Bottlenecks

Punjab encompasses 73 percent of the national cropped area and produces significant shares of the country's primary crops: maize (78 percent), wheat (77 percent), rice (52 percent). The Zincol-16 and Akbar-19 biofortified wheat varieties developed by HarvestPlus, CIMMYT in collaboration with the Ayub Agriculture Research Institute. These were developed for the Pakistan market respectively contain up to 30 and 26 percent ([CAST, 2020](#)) more zinc than traditional wheat varieties. Impacting wheat production and its nutritional quality has potential for nation-wide impacts on zinc intake and health. However, the variety was facing significant hurdles to scale and the preceding zinc wheat variety had failed to commercialize and scale.

Policy and public investment: Agriculture policy in Pakistan was broadly supportive of nutrition sensitive agriculture. However low investments at the Research and Development level and for EGS impeded commercialization of nutritious varieties such as zinc wheat. The biofortified variety Zincol 2016 saw relatively low market penetration between 2016 and 2019 due to a mix of supply and demand side constraints. Since then there has been progress in the regulatory framework governing the seed industry, including certification of seeds, licensing, variety release procedures, and quality control allowing a growing role for private enterprises. The Plant Breeders' Rights Act also represents a crucial step in this direction, establishing a framework that protects innovation while preserving farmers' traditional rights to save and exchange seeds.

Seed supply constraints: Despite policy progress, seed production in the formal public and private sector was

approximately 50% of total demand for wheat seed in Pakistan ([Spielman, 2015](#); [Rana, 2014](#)). Over time there had been little to no improvement in this with the State Bank of Pakistan estimating that as of 2020, only ~48% of wheat seed was certified and sourced from formal channels (public and private) while the rest is informal (farmer saved, uncertified "brown bag seed", farmer to farmer sales etc). Shifts in the expected roles of central and provincial governments in ensuring seed supply adversely affected varietal release and certification (18th Amendment (2010)). Secondly EGS remained a bottleneck. EGS requires upfront investment with delayed or uncertain payoffs, especially when the formal seed market is yet to reach its potential. Any new variety or class of varieties would essentially be seeking to substitute other options in a relatively small and highly competitive formal seed market.

Demand side issues - Adoption: There are two levels of demand side issues confronting seed markets in Pakistan.

One is whether improved seeds are adopted at all. There is low awareness and trust in certified seed, especially for self-pollinated crops (like wheat), and perceived benefits over saved seed are marginal. **Second** is whether nutritious varieties meet preferences of farmers. Farmers are exposed to multiple competitive varieties and nutritional traits do not necessarily drive adoption. Yield is key for shaping farmers preferences. An internal market assessment conducted by HarvestPlus in 2019 revealed that farmers prefer seed varieties based on grain yield and grain size. Farmers keep between 30-40% of the seed production for home consumption but a significant level of product is sold and varietal preferences generally aim to maximize the revenue earned from wheat sale into the open market (~75% of total sales) or to the government (~25% of total sales).

Policy framing: There was no clear mechanism for market and policy signals (like procurement, pricing, or digital information) that



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could shape technology adoption (specific varietal adoption) at the farm level. Neither government grain procurement, nor its extension system, nor any recent digital advisory efforts (farmer registration, precision agriculture) had explicitly tested varietal adoption.

Upstream Marketing: Value addition and commercialization are constrained. There is limited use of farmer aggregation models, poorly functioning wholesale produce markets, high transaction costs, inefficient post-harvest practices, and poor infrastructure supporting storage and transport. ([International Finance Corporation, 2021](#))

Identifying and Addressing Bottlenecks

A series of coordinated policy reforms, institutional actions, and innovative partnerships between 2018 and 2024 created the enabling environment for scaling biofortified wheat seed systems in Punjab and nationally. These measures directly addressed long-standing bottlenecks in varietal release, seed availability, and farmer awareness, and together formed the foundation for the inclusion and rapid uptake of zinc biofortified varieties such as Akbar-19 and Zincol-16.

Policy Momentum and Key Enablers (2018–2024)

Between 2018 and 2024, multiple government-led initiatives progressively strengthened the seed system and created entry points for biofortified crops.

From Policy to Practice: Enabling Innovations and Implementation Mechanisms

A key distinction of these initiatives was that, unlike broader agricultural reforms such as grain procurement or price stabilization, the measures between 2021 and 2024 were variety-specific and implementation-oriented. They explicitly linked input subsidies, certification, and digital outreach to high-performing biofortified and other varieties with both nutrition and yield advantages.

This alignment between policy intent and delivery mechanisms marked a turning point. The 2022–2023 provincial subsidy reforms, for example, tied financial support directly to approved zinc-rich varieties, incentivizing farmers to adopt them and giving the seed sector a clear signal to increase supply. The government’s commitment to fast-tracked varietal release and certification reduced bureaucratic bottlenecks, while seed multiplication programs and the Kissan Package improved the physical availability of certified seed.

However, the success of these reforms also depended on the presence of strong, coordinated partnerships that could translate policy decisions into on-the-ground change. Here, several practical and enabling solutions emerged:

- 1. Public-Private Partnerships for Seed System Strengthening:** HarvestPlus’ long-term collaboration with the Ayub Agriculture Research Institute (AARI) was instrumental in moving zinc-

Policy Support for Wheat Seed System

Year/Period	Key Reform or Initiative
2018–19	Release and farmer distribution of high-yield, disease-resistant wheat varieties with HarvestPlus and CIMMYT support.
2020	Punjab Agriculture Department expanded IFAD*-supported programs with Precision Agriculture for Development (PXD), providing digital advisories to approximately 886,000 wheat and 490,000 cotton farmers.
2021–2022	Fast-track seed multiplication program; amendments linking certification and breeder rights to accelerate varietal release.
January 2022	Government mandate for fast-tracked release and adoption of ≥30% drought- and disease-tolerant seed varieties.
August 2022	Major certified seed distribution (1.2 million bags) under the Kissan Package.
September 2023	Punjab doubled subsidized seed provision and launched incentive campaigns to promote high-yield varieties.
January to December 2024	Final drafting and federal approval of a National Seed Policy; restructuring of the Seed Authority and deregulation of low-quality firms.

*International Fund for Agriculture Development.

biofortified varieties from research to release. AARI’s engagement with the Punjab Ministry of Agriculture helped institutionalize support for biofortified seeds, while HarvestPlus provided technical and financial facilitation for EGS especially breeder seed production.

2. **Digital Advisory Systems and Market Information Models:** The partnership between HarvestPlus and PxD introduced a digital advisory model that directly reached farmers with tailored information on the health and yield benefits of biofortified wheat. This innovation bridged a critical information gap in an environment where farmer awareness of certified seed is often low.
3. **Coordinated Supply Chain Planning:** HarvestPlus played a catalytic role in linking seed companies, public institutions, and government programs. Timely demand projections and communication with seed producers enabled synchronization between production, distribution, and subsidy allocation — a key factor in ensuring farmers could access approved varieties during the sowing season.
4. **Integrated Farmer Support and Incentive Mechanisms:** Government distribution programs, digital outreach, and local dealer networks worked in tandem to provide farmers with the three essential conditions for adoption:
 - Availability of named nutritious varieties through adequate EGS and certified seed production;
 - Access via timely distribution and affordable pricing; and
 - Trust in performance through information campaigns emphasizing yield stability, pest resistance, and nutritional benefits.

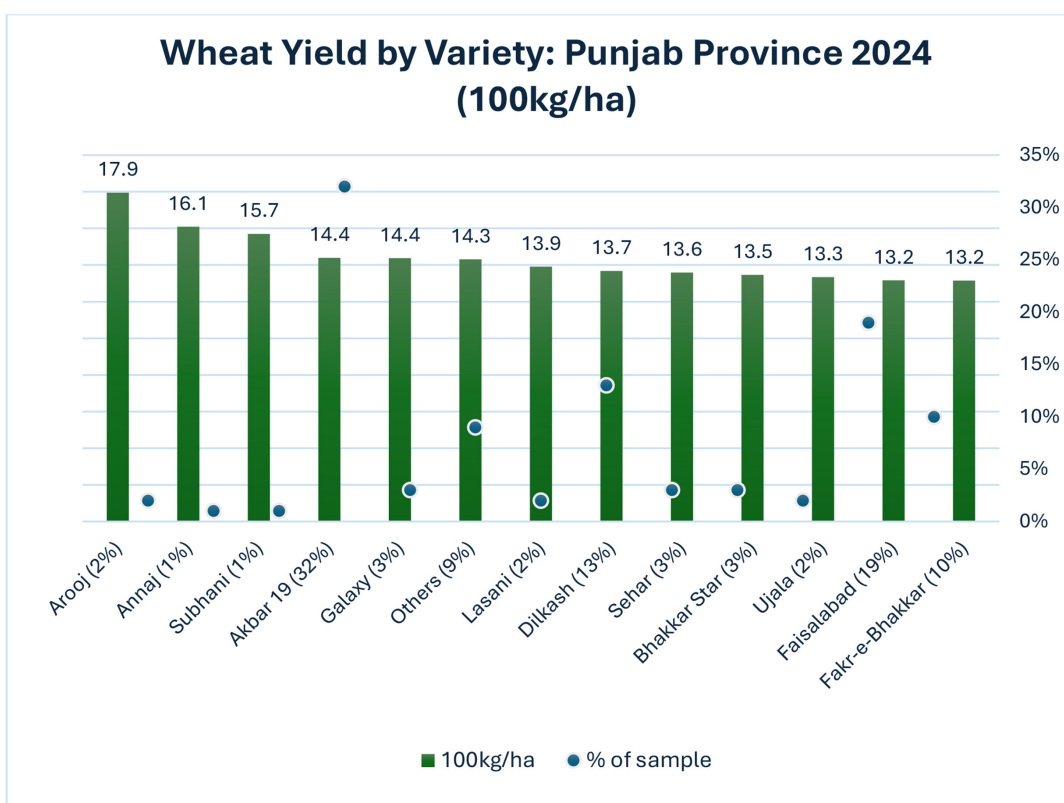
These experiences demonstrate that coupling policy reforms with enabling mechanisms — coordinated partnerships, digital communication platforms, and well-funded distribution systems — helps translate high-level mandates into widespread adoption of nutritious varieties. The integration of biofortified varieties into subsidy and certification frameworks, combined with effective communication and delivery models, provides a replicable blueprint for scaling other nutrition-sensitive seed technologies in South Asia.

The Intervention and Actions

A number of coordinated actions by the Punjab Agriculture Ministry, Ayub Agriculture Research Institute, HarvestPlus and its CGIAR partners aimed to address precisely these pain points and offer an important blueprint for scale. Three critical efforts were:

Specific investment in EGS was approved by the Provincial Agriculture Department of Punjab for three years (2021-2023). Of the total investment from the department of around 350,000 US\$ roughly half, that is 175k was committed to Akbar-19 on recommendation of the Ayub Agriculture Research Institute - generating approximately 200,000 Kg of EGS for this variety.

PXD’s well documented work on weather advisories was rolled out under a collaborative project with the Punjab Agriculture Department and the International Fund for Agricultural Development in 2018. Leveraging this initiative, HarvestPlus worked with PXD on a zinc-biofortified wheat pilot in five districts. Advisory



(Source: Author’s own analysis based on data from the Punjab Crop Report (Provincial Agriculture Department, 2024).

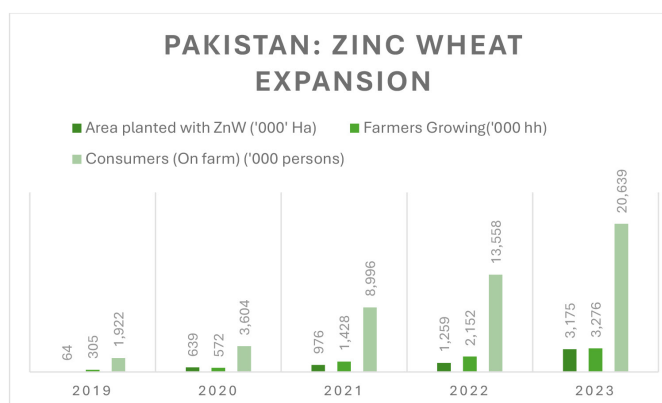
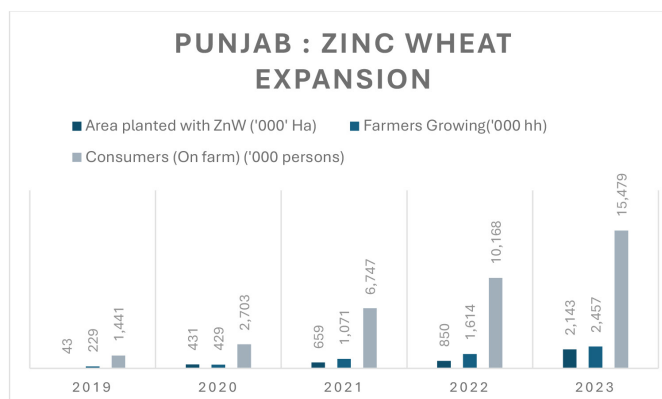
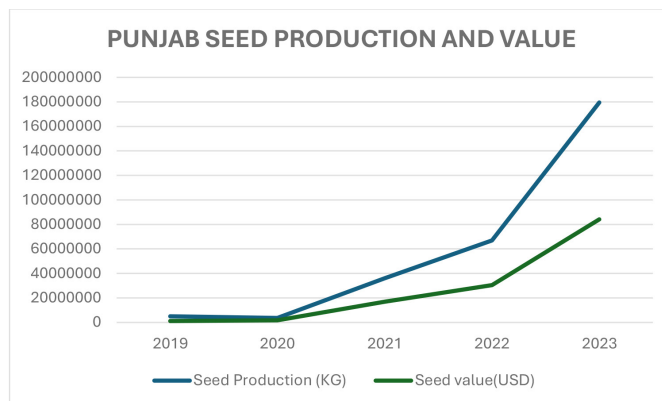
messages in Urdu and Saraiki promoted Akbar 19 and Zincol 16, to 100,000 farmers, highlighting their nutritional and agronomic advantages. Digital campaigns (SMS and robocalls) achieved high engagement: 1.3 million SMS, ~967,000 calls, pickup rates of ~53%, and listening rates of ~76%. Adoption of zinc wheat seed reportedly surged by 566% among users, though formal evaluations were not used to ascertain this effect.

Finally, HP’s engagement with the provincial government and seed companies culminated in the integration of biofortified zinc-enriched wheat varieties into Punjab’s annual wheat production plan. HarvestPlus projected the volumes of EGS and seed multiplication and this was integrated in the state government’s production plan. The Punjab government simultaneously included Akbar 19 in the WPEI seed subsidy program. This exemplifies the tangible impact of coordinated policy actions in solving different issues in the seed value chain and supporting the adoption of nutrient-rich wheat varieties.

As we can see below there are a few varieties which are yield competitive with Akbar 19 – performing as well or better and also having attributes such as drought tolerance and pest resistance. However, Akbar-19 emerged as a mega variety, demonstrating an outsized effect on adoption (see next section). Variety (or class of varieties) specific policy supports, well sequenced public investment and relatively cost-effective market messaging which provided a critical mass of varietal adoption - have been key to setting the stage for the impressive scale of biofortified varieties in Punjab. Other factors have also contributed (for example farm demos and lead farmer engagement).

Results and Impact

Between 2019 and 2023, Pakistan’s ZnW initiative demonstrated remarkable growth in seed production, market value, and farmer adoption, reflecting its rapid transition from pilot to national scale. Seed production rose from just over 5 million kg in 2019 to nearly 179 million kg in 2023, while the seed value increased more than seventyfold, from USD 1.2 million to USD 84 million, indicating strong commercial expansion. Correspondingly, the area planted with Zn wheat expanded from 64,000 hectares to over 3.1 million hectares, and the number of farmers cultivating Zn wheat grew from 305,000 to 3.3 million households, reaching more than 20 million on-farm consumers (farming families who consume what they grow) nationwide. Punjab province led much of this progress, accounting for about two-thirds of the total area in 2023 and showing parallel gains in farmer participation and consumer reach. Overall, these results highlight Pakistan’s substantial advancement in scaling biofortified zinc wheat, with significant impacts on both agricultural productivity and nutritional health. Zinc wheat and regular wheat grain and flour are highly substitutable, and any surplus zinc wheat is marketed through regular channels such as flour



Source (Tableau): Landholding size (Pakistan Agriculture Census, 2024); Seed production (HarvestPlus monitoring data- Nutri-Agri Futures).

mills and bakeries. This has allowed broad distribution of zinc wheat at competitive prices to both rural and urban consumers.

Reflection and Learning

Scaling nutrition-smart crops requires coordinated and variety specific regulatory, financial, and institutional interventions. Critical policy interventions paved the way for strong supply of zinc wheat seed. Fast-tracking varietal release, linking subsidies to biofortified varieties, and fostering public-private partnerships to strengthen EGS and certified seed production enabled significant production of certified seed. Coordinated and variety specific public investments in both EGS and seed multiplication were critical for crowding in seed companies.



Policies and subsidies offer an opportunity but more needs to be done to bridge this with adoption. Nearly all seed companies in Punjab distributed zinc wheat seed by the 2022-23 growing season. Seed supply chain coordination and digital advisory platforms aligned production with farmer demand and stimulated adoption in the zinc wheat scaling model. Dedicated resources, accountability, and coordination between government, research institutions, and private partners were critical to translating high-level reforms into tangible adoption and impact at the farmer level.

A key research question is whether farmers exhibit diminishing marginal valuation of yield gains, such that beyond a certain threshold, they are willing to trade off additional yield for other desirable varietal attributes — notably nutritional quality. This pattern would help explain the relatively limited uptake of some high-yielding but nutritionally inferior varieties (e.g., Arooj and Annaj). From an economic standpoint, it is important to assess whether varieties with average yield performance generate comparable or greater social returns when accounting for their nutritional externalities. Such varieties may offer much higher total welfare payoffs (mediated by high uptake) once both productivity and health benefits are internalized, relative to purely yield-maximizing alternatives.

Like any other variety that has demonstrated scale, sustainability is going to mean successful replacement by another variety which includes and even improves on attributes and impacts of the previous. ARRI and HarvestPlus have helped develop a pipeline of new zinc wheat varieties which will face similar scaling challenges that Akbar 19 did. Going forward a key part of sustaining success of zinc wheat more broadly is to be able to carry through the specific policies and investments made in strengthening seed production and distribution. Over time as the production and adoption of certified seeds improves in Pakistan as a whole and as information constraints get resolved –

we can expect a fully self-sustaining market system where farmers can make well studied trade-offs across a range of varieties.

Affordability for Users

Akbar 19 seed is competitively priced ranging from USD 22-26 per 50Kg Bag (depending on the seed company). This is comparable with higher yielding varieties such as Anaj and Arooj (see Figure 1). Varieties such as Faisalabad and Bhakkar Star are priced slightly higher at USD 26.50 to USD 29.

Financial Sustainability

With seed production growing at a CAGR of 78% we fully expect that the marginal cost of seed production improved over time. This is also evidenced by seed sales (adoption) and the fact that nearly every seed company involved in wheat seed supply in Punjab were selling Akbar -19 by the 2022-23 growing season. Akbar 19 in and of itself is sustainable – no further subsidies have been supporting its growth through 2023-24 and it has continued to keep momentum. However, with varietal replacement an innovation “class” (zinc wheat) can become financially sustainable as broader market constraints are resolved. There remains a strong case for continued public private investment in zinc wheat. Given the significant sales and zinc intake benefits we expect a strong net positive economic rate of return to zinc wheat in Pakistan making it an important candidate class of innovation to promote and support in coming years.

Temporal & Environmental Sustainability

The main concern for any wheat variety in Punjab is that as adoption becomes widespread—especially across contiguous farms—the covariate risk of pest or disease outbreaks increases. This makes regular varietal replacement critical as varieties scale.



Partners

- Punjab Agriculture Department
- Ayub Agriculture Research Institute
- HarvestPlus
- CIMMYT



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Inclusivity and Responsible Scaling (GenderUp Framework):

Socio-economic inclusion is a critical pillar of HarvestPlus expansion strategies. Biofortified technologies are critical for equitable intra-household distribution of nutrients because staples are generally consumed by all household members particularly in low-income households. HP's activities go beyond supporting inclusion in consumption to facilitating direct participation of men and women as economic agents. HarvestPlus conducted several capacity building training sessions to empower smallholder women farmers to cultivate biofortified zinc-enriched wheat varieties in Pakistan. The sessions provided essential nutrition education and highlighted the benefits of cultivating biofortified crops to combat malnutrition and improve family health. The hands-on trainings also featured the latest agricultural practices, input use, weed control, postharvest storage techniques, product development, and marketing of nutritious crops. Additionally, HarvestPlus provided a 30 percent subsidy on zinc-enriched seed to vulnerable women farmers, helping to increase their access to zinc-enriched crops varieties. While structural issues around land ownership and market access remain, these kinds of training activities have helped improve technical capacity and nutritional intake for over 2000 female farmers in Punjab.

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