HarvestPlus
Better Crops • Better Nutrition

Crop Biofortification: The Pathway to Scaling Up

- Working with 600+ partners globally since 2003 has enabled HarvestPlus to facilitate the release of more than 260 biofortified varieties of 11 staple crops in 30 countries, and delivery of biofortified planting material to 40+ million people.
- Proving the efficacy and effectiveness of biofortified crops in improving micronutrient status and health outcomes, establishing cost-effectiveness and return on investment of biofortification investments, and documentng lessons from delivery models implemented were critical to prepare biofortification for scaling up.
- To catalyze the scaling up of biofortification, HarvestPlus will (a) advise and monitor mainstreaming in CGIAR breeding programs, (b) enable production of biofortified foods along the value chains, (c) assist in embedding biofortification in national, regional, and multilateral policies and programs, and public and private investments, and (d) share its tools and learnings with value chain actors and interested stakeholders.

Globally, an estimated two billion people suffer from micronutrient deficiencies that contribute to weakened immune systems, disease, disability, and even death.[1] One of the main causes of micronutrient deficiencies—also known as hidden hunger—is low-quality diets that rely on calorie-rich but micronutrient-poor staple crops, and include very few animal-sourced foods, fresh fruits, and vegetables that are more nutrient-dense.

Nutritionally enriching staple crops through biofortification is proven to be an efficacious, acceptable, cost-effective, and scalable solution for improving micronutrient intake, micronutrient deficiency status, and other health outcomes. Staple crops are the backbone of any food system; often one of the few crops grown by smallholder farmers, they are consumed, and are projected to be consumed, by all, regardless of demographics and socioeconomic status.[2] Staples are also an equitable vehicle for improving the micronutrient intakes of women, adolescent girls, and children, who are most at risk of deficiencies due to their higher biological needs for key micronutrients, such as iron, zinc, and vitamin A, coupled with their limited access to micronutrient-rich foods, such as animal-sourced foods, which are often preferentially allocated to men or adolescent boys in the household.[3,4,5,6,7]

HarvestPlus, in close collaboration with crop breeding programs of CGIAR Centers and National Agricultural Research Systems (NARS), has facilitated the release of more than 240 conventionally-bred, high-yielding, climate-smart, and micronutrient-enriched varieties of 11 staple food crops in 30 countries, with hundreds of varietal lines being tested in these and in 20 more countries. Through HarvestPlus and its more than 600 partners' delivery efforts, an estimated 9.7 million farming households (translating to about 48.5 million household members) were benefiting from biofortified crops by the end of 2020.

HarvestPlus aims to contribute to transforming food systems to deliver healthy foods for all by catalyzing the development and scaling up of micronutrient-rich staple crops to benefit 1 billion people by 2030. In consultation with key partners, donors, and stakeholders, HarvestPlus developed a four-pronged strategy for catalyzing the rapid scale-up of biofortification:

1. Mainstreaming biofortification (i.e., breeding for micronutrient targets) in global (CGIAR) and national (NARS) breeding programs.
2. Catalyzing and enabling partnerships along the staple seed and crop value chains to replace non-biofortified seeds, grains, ingredients, and foods with their biofortified counterparts.

3. Advocating to integrate biofortification in national, regional, and global policies, programs, and regulations to increase adoption and consumption of biofortified crops and foods, and to incentivize investments in biofortification by governments, private sector, civil society, and international finance institutions (IFIs).
4. Coordinating a knowledge and technical assistance hub on biofortification interventions, and facilitating knowledge and best practices exchange among stakeholders and value chain actors for sustainable and cost-effective scale-up.

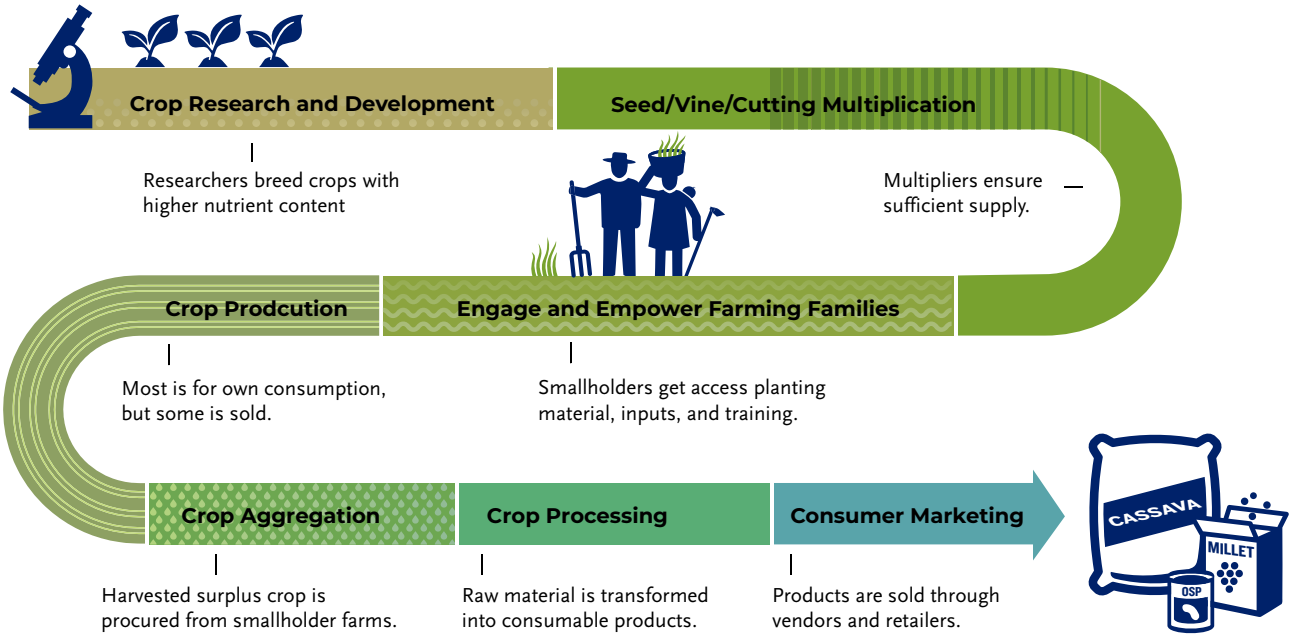
Mainstreaming Biofortification

A central tenet of a successful, long-term biofortification strategy is that all future varieties developed by CGIAR Centers, NARS and private seed companies be biofortified. By adding micronutrient density to best performing varieties coming out of public and private breeding programs, currently grown varieties would eventually be replaced by higher-yielding biofortified varieties — thus "mainstreaming" these characteristics into all varieties.

Mainstreaming, from a consumer acceptance perspective, is easiest to accomplish for iron- and zinc-biofortified crops, as increased micronutrient levels in the crops are invisible and tasteless to consumers in seeds and grains. Although mainstreaming will take time as all major breeding lines will have to be biofortified, this strategy is highly cost-effective. Uptake does not depend on changing consumer behavior, and is often automatic and inevitable, relying on the profit incentive of farmers. Success has been seen in production and consumption of zinc-biofortified rice and wheat, and iron-biofortified pearl millet in South Asia and iron-biofortified beans in East Africa. This strategy does not work as easily for vitamin A-biofortified crops in countries where white color cassava or maize dominate, as increasing the density of vitamin A changes the color of these crops to yellow or orange and can affect taste as well (albeit positively as evident from the literature). Demand must be generated for these varieties by raising consumer awareness on nutritional and agronomic benefits of biofortified varieties. While widespread demand for these varieties is yet to be catalyzed, color and taste are not barriers to consumer demand once household members taste the vitamin A varieties and understand the reason for the color change—and that improving vitamin A intake with the new variety does not increase the cost.
Investing in "targeted" breeding programs at CGIAR Centers and NARS was key to developing competitive biofortified varieties and to proving the concept of biofortification. Doing so not only proved high yields could be combined with mineral and vitamin density, but it also built crop development pipelines.
Facilitating the release and delivering the seeds of biofortified varieties in several countries across Africa, Asia, and Latin America over the past 15 years provided experience and learnings in different delivery models along the value chain. With this crop development and delivery success, the generation of positive nutrition and impact evidence, and a successful global advocacy campaign in place, biofortification is now broadly accepted in the international development and nutrition communities as an efficacious and cost-effective intervention for addressing micronutrient deficiencies and improving diet quality.

The time has come to start transitioning out of targeted breeding for biofortification, and to move to mainstreaming of nutritional traits in broader germplasm of major staple crops. Biofortification mainstreaming would help address micronutrient needs of billions of people whose diets are based on these staples, both sustainably and cost-effectively.
In addition, direct funding to CGIAR Centers to mainstream breeding for bioavailable iron and zinc traits will be an integral part the CGIAR's Excellence in Breeding (EiB) Platform, and initial efforts will be expanded to public and private NARS breeding programs. Further success will ensue with varieties that provide increasing levels of bioavailability of minerals. HarvestPlus will continue to provide advice and guidance in development of the mainstreaming workplans; monitoring of agronomic, nutritional and socioeconomic outputs and outcomes, and in the use of evidence-basedadvocacy to resource mainstreaming efforts. Achieving and coordinating mainstreaming goals across crops and food systems requires a holistic approach, especially in the areas of resource mobilization, micronutrient target setting and testing, quality control, monitoring, standards, advocacy, and public support.

Sustainable Value Chains for Biofortification



Catalyzing and Enabling Partnerships

The challenge and opportunity of scaling requires catalyzing and enabling partnerships along the biofortification value chain to increase the production and consumption of biofortified foods. Effective partnerships with public, private, and civic, nonprofit and humanitarian entities, of all sizes and scales, will strengthen partners' capacities to cost-effectively or profitably and sustainably integrate biofortification in their operations, programs, and investments.

Crop research and development: In addition to CGIAR Centers' mainstreaming biofortification in breeding programs, selected NARS will need continued support to strengthen capacity and improve skills and knowledge to carry out biofortified breeding. Capacity development at crop trait research and crop development stages will include training public sector breeders (NARS) and the private sector, mostly small- and medium-sized seed companies. Trainings will include: improved methods in biofortification breeding; using diagnostic tools; identifying best germplasm; selecting the best breeding environments; and micronutrient bioavailability and retention. HarvestPlus has fostered the development of independently funded biofortification programs with large research portfolios in Brazil, China, and India, and will continue its current collaborations with these three programs, which are then expected to influence the development of biofortified crops in additional countries.

Seed multiplication: Partnerships with private seed companies are particularly important for hybrid crops such as maize in Africa (e.g., SeedCo) and pearl millet in India (e.g., Nirmal Seeds). HarvestPlus has also worked with private wheat and rice seed companies in India and Bangladesh, respectively. Experience has shown smaller companies are more readily inclined to become involved with biofortified crops as a result of their reliance on public sector R&D, while larger companies enter when demand is already established. HarvestPlus will continue to engage with private seed companies by providing them with information/training on the benefits of biofortification and quality control, and access to biofortified lines where needed for integration of biofortified lines in their product portfolios. For crops or seed systems that don't lend themselves to investments by the private sector, public sector multipliers, NGOs, women's groups, and farmer organizations will continue to be targeted for trainings on producing high-quality seeds to grow biofortified crops.

Distribution to and demand creation for farmers: Farmers are critical to successfully developing and adopting biofortified varieties. Their engagement must continue, not only in co-development and testing of new varieties, but also to develop their capacity in nutrition habits, improved agronomy practices, crop rotation, pest management, and using digital technologies to access markets and improve profitability. HarvestPlus will continue to collaborate with public, private, and civil society/NGO sectors to build their capacity in implementing these activities.

Food processing and value addition: Partnerships with small and medium-sized food processing and food manufacturing companies, including InnerBeing in India, GraceCo in Nigeria, PRAN foods in Bangladesh, and Sky Brands in Zimbabwe, have generated learning and experience. Future activities for catalysing food companies will cover support in developing healthy foods using biofortified ingredients; retaining micronutrients during processing, packaging, transportation, and storage; maintaining traceability (i.e., supply chain integrity); and food safety, as well as capacity development in marketing, contract development, nutrition labelling, and accessing finance.

Retailers and consumers: According to acceptance studies conducted among rural and urban consumers, traditional foods made with biofortified crops are liked as much as – if not more than – the same foods made with non-biofortified crops, sometimes even in the absence of nutritional benefit information. Awareness-raising and demand-creation campaigns targeting a wide range of consumers and local small- and medium-sized food enterprises, as well as a partnership with the Global Alliance for Improved Nutrition (GAIN) on commercialization are helping to build a knowledge base on efficacious, cost-effective, scalable, and sustainable media and messaging to engender consumer demand for biofortified foods. Engagement with leading global food manufacturers and retailers creates global awareness and demand for "naturally nutritious" biofortified products, as demand "pull" mechanisms.

Advocating for Policy and Program Integration

To ensure sustainability of biofortification interventions implemented to date, it is crucial to ensure biofortification is included in the policies, strategies, and investment plans of national governments, international financial institutions (IFIs), and UN agencies; resources are then allocated to implement these policies, strategies, and investment plans.

To date, 24 countries have included biofortification in their national agricultural and/or nutrition agendas, policies, plans and programs: Bangladesh, Burkina Faso, Burundi, Colombia, Democratic Republic of Congo, El Salvador, Ethiopia, Ghana, Guatemala, Honduras, India, Kenya, Malawi, Mozambique, Nicaragua, Nigeria, Pakistan, Panama, Rwanda, Senegal, Tanzania, Uganda, Zambia, and Zimbabwe. In November 2019, agriculture ministers of the African Union (AU) recommended to their heads of state to officially endorse biofortification. At the international level, UN and Rome-based agencies have integrated biofortification in programs and recommendations, including UNICEF's State of the World's Children 2019 Report, World Food Programme's local and regional food procurement policy, and IFAD's Nutrition Sensitive Value Chains guidelines. Several IFIs, including the World Bank, African Development Bank, and Inter-American Development Bank, have included biofortification in health and nutrition-sensitive agricultural investment plans and strategies, and the World Bank has issued grants and loans that include biofortification. Work will continue with these and others, including the Asian Development Bank and the Islamic Development Bank, to integrate biofortification in their loan portfolios and investment plans, strategies, and grants; and to evaluate the impact, and conduct cost-benefit analyses of investments.

Future policy and advocacy efforts will include developing evidence on nutritional efficacy and cost-benefit/cost-effectiveness analysis and return on investment of including biofortification in specific policy and regulatory changes and public programs, such as subsidy or safety net programs. Such information is expected to catalyze national governments and the private sector to invest more of their own resources to incorporate biofortified seeds and foods into their programs, reducing the need for international aid for food and nutrition security.

To strengthen the global enabling environment for integration of biofortification in food systems as a means for improving food and nutrition security, HarvestPlus will continue to engage with and provide evidence to the World Health Organization (WHO) Guidelines Review Committee to facilitate their issuance of evidence-based guidance to UN member states' health and agriculture ministries and provide input to the UN Committee on World Food Security (CFS) Voluntary Guidelines on Food Systems and Nutrition. Considerable progress toward a global definition for biofortification was achieved through the FAO/WHO *Codex Alimentarius* process, and efforts are underway to develop publicly available standards for biofortified products.

Biofortification Knowledge & Technical Assitance Hub

One main pillar of catalyzing scale-up of biofortification is to produce and share all evidence, learnings, and tools with other value chain actors and public, private and NGO stakeholders, empowering them to scale up biofortification interventions on their own. To achieve this, HarvestPlus is developing a Knowledge and Technical Assistance Hub, where we will be able to add interactive tools, such as ones to help estimate effective breeding targets for each crop-micronutrient-country combination; cost-effectiveness and cost-benefit analyses of planned, ongoing, and completed biofortification interventions, and to better target interventions across and within countries.

This hub will also provide user-friendly access to the evidence generated to date, briefs and presentations summarizing the evidence; an electronic, searchable library of biofortification products; guidelines on how to introduce, scale up, and anchor sustainable and cost-effective biofortification interventions; and monitoring, evaluation, learning, and impact assessment guidance. The Hub will facilitate knowledge exchange and learning among stakeholders on biofortification scale-up.

Continuing Work to Feed Into Catalytic Efforts

In parallel to its catalytic efforts to scale up biofortification, HarvestPlus will continue to invest in (a) targeted breeding to ensure a healthy pipeline of biofortified varieties are available until mainstreaming takes effect; (b) crop development research to assess the feasibility of develop new biofortified crops; (c) nutrition research on novel topics such as biofortification and noncommunicable diseases prevention and gut microbiomes; biomarkers of micronutrient status, and synergies between biofortified byproducts/feed and livestock health/productivity; and (d) development, implementation, and evaluation of delivery models (especially in new geographies such as the Sahel or with new populations such as refugees) and documentation of lessons learned. This ongoing work will feed into the abovementioned four-pronged strategy for catalysing the scale-up of biofortification.

ENDNOTES

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