BIOFORTIFICATION

A food-systems approach to ensuring healthy diets globally

A technical brief from HarvestPlus and the World Food Programme

WFP World Food Programme

HarvestPlus Better Crops • Better Nutrition

February 2022

FOREWORD

Biofortification is proven to be an efficacious, cost-effective and scalable approach to improving the quality of diets worldwide. It increases the micronutrient content of commonly consumed staple crops, which comprise the backbone of all food systems, and it provides an important safety net for vulnerable populations in low- and middle-income countries whose sustenance relies on these relatively inexpensive staples for much of their diet.

HarvestPlus is a global leader in biofortification technology, policy, and delivery. The vision of HarvestPlus is to transform food systems to deliver sustainable, healthy diets to all people, and it does so by catalyzing the development, promotion, and scaling up of biofortified crops that are rich in vitamin A, iron, or zinc—three essential micronutrients. An estimated two billion people suffer from micronutrient deficiency, or "hidden hunger," which seriously impacts their health, growth, and productivity.

The HarvestPlus program focuses on biofortification of major staples (rice, wheat, maize, beans, cassava, sweet potato, and pearl millet) through conventional plant breeding methods, while ensuring that nutritionally enriched varieties of these staples are as high-yielding and climate-smart as they are nutritious.

The World Food Programme (WFP)'s support to more than 80 countries spans a broad range of activities to save and change lives, with the ultimate goal of a world with zero hunger. Its long experience in humanitarian and development contexts has positioned the organization well to support resilience building in order to improve food security and nutrition. WFP helps the most vulnerable people strengthen their capacities to absorb, adapt, and transform in the face of shocks and long-term stressors.

By working together, WFP and HarvestPlus can leverage one another's expertise, experience, and reach to improve nutrition and food security and help improve the lives of the world's most vulnerable people through inclusion of biofortification in WFP's portfolio.

The purpose of this brief is to help leverage the strengths of both organizations to increase the uptake of biofortified crops and foods and encourage new country initiatives that can be supported by WFP and HarvestPlus, by providing examples of successful country and regional collaborations across the globe.

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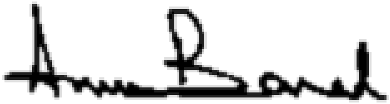


Arun Baral
Chief Executive Officer, HarvestPlus

About the World Food Programme

The World Food Programme (WFP) is the leading humanitarian organization fighting hunger worldwide, delivering food assistance in emergencies and working with communities to improve nutrition and build resilience. Across different contexts —from immediate humanitarian support to longer-term development programming —WFP works with governments and partners to improve nutrition of the most vulnerable populations. The World Food Programme's support to 115 million people in 84 countries spans a broad range of activities to save and change lives, with the ultimate goal of a world with zero hunger.

Nutritious food is required to achieve Zero Hunger. In order to change lives and break the cycle of poverty, ensuring that those in need receive the right food at the right time is crucial. WFP prioritizes nutrition as a core element of its work; it focuses on all forms of malnutrition including vitamin and mineral deficiencies—also known as 'hidden hunger'—and overweight and obesity, alongside undernutrition. These problems stem from the same root causes: poverty, inequality and poor diets.

WFP works to ensure that people, especially those most at risk of malnutrition, meet their nutritional needs, remain free from malnutrition and are able to lead healthy, productive lives. WFP is committed to ensuring the availability, access, demand and consumption of healthy diets alongside efforts to prevent and treat malnutrition. To fulfil this goal, WFP integrates nutrition in its programmes to support improved access to healthy diets and to address both the immediate causes of malnutrition, as well as the underlying determinants. WFP programmes span social protection, agriculture, health, and food systems, recognizing that no single sector or system alone can address malnutrition and all the barriers to healthy diets.

Powered by the passion, dedication and professionalism of 20,000 staff worldwide, WFP works to bring life-saving food to people and help individuals and communities find life-changing solutions to the multiple challenges they face in building better futures.

About HarvestPlus

HarvestPlus leads the development and global scale up of biofortified crops and foods to improve food systems to sustainably deliver healthy diets. HarvestPlus and its partners focus on using conventional plant breeding techniques to increase the micronutrient content of staple food crops with three essential micronutrients that are frequently lacking in the diets of smallholder farmers and other low-resource populations: vitamin A, iron, and zinc.

Regular consumption of biofortified crops has been scientifically proven to improve micronutrient status and several health outcomes, such as cognitive and physical performance, and reduced illnesses. Crops promoted by HarvestPlus include vitamin A maize, sweet potato, and cassava; iron bean and pearl millet; and zinc wheat, rice, and maize. As a result of HarvestPlus' leadership, biofortified varieties are available for planting in 30 countries and are benefiting 9.7 million smallholder farming households who are growing and consuming these crops.

HarvestPlus is based at the International Food Policy Research Institute (IFPRI), one of the CGIAR research centers. HarvestPlus collaborates with several CGIAR research centers on the development of biofortified crops through conventional breeding techniques.

With operations in 15 countries across Asia, Africa, and Latin America and the Caribbean, HarvestPlus leverages 18 years of operations in crop development, nutrition, and socio-economic research on biofortification, as well as over a decade of experience and learnings on the delivery of biofortified crops along seed to food value chains. HarvestPlus works with hundreds of partners worldwide—from the research, public, private, and civil society sectors—through various catalytic mechanisms (policies, programs, and financing) to make biofortification an integral part of sustainable food systems for healthy diets.

Introduction

Global food systems have succeeded in providing a wide variety of foods for billions of people, yet malnutrition numbers are still high. While there have been significant advancements in increasing the supply of food, these food systems have failed to provide adequate nutritious, healthy, safe, affordable, and sustainable diets to all.

The 2021 UN State of Food Security and Nutrition in the World (SOFI 2021) report showed that, even before the onset of the COVID-19 pandemic, the global burden of hunger was growing, and the pandemic will likely exacerbate it. The impact of the pandemic is projected to add up to 161 million more people to the ranks of the undernourished.

Key findings of the 2021 UN SOFI Report

- Current estimates are that between **720 and 811 million people went hungry in 2020**, or roughly 10 percent of the world population—as many as 161 million more than in 2019.
- Globally, the burden of malnutrition in all its forms remains a challenge. According to current estimates, in 2020, **22 percent (149.2 million) of children under 5 years of age were stunted, 6.7 percent (45.4 million) were wasted, and 5.7 percent (38.9 million) were overweight.**
- **Low-income countries** rely more on staple foods and less on fruits, vegetables and animal source foods than high-income countries.
- The most conservative estimate shows **healthy diets are unaffordable for more than 3 billion people** in the world. Healthy diets are estimated to be, on average, five times more expensive than diets that meet only dietary energy needs through a starchy staple.

The triple burden of malnutrition, where undernutrition, overweight, and micronutrient deficiencies coexist, is an escalating problem that is associated with the largest number of deaths globally. In addition, climate change is having devastating and far-reaching effects on agricultural production, global food supply, and nutritional quality of food, thereby directly impacting the health and well-being of the most vulnerable populations, particularly women and children in smallholder farming households. Floods and droughts destroy land, heighten food shortages, increase economic instability, and exacerbate food and nutrition insecurity. Climate change will not only change the nutrient content of crops, but will also impact the distribution of pests and disease, compounding the negative impact on nutrition through, for example, increasing the occurrence of harmful aflatoxins in crops in many countries. When shocks hit livelihoods and incomes, those affected reduce their food expenditures, switching to cheaper staple foods and sacrificing consumption of higher-nutrient-quality foods.

There is an urgent need to transform food systems to sustainably deliver better-quality diets for improved nutrition and health outcomes. This means adopting a whole-of-diet approach, including a focus on improving the nutrient quality of staple crops. Nutritionally enriching staple crops through biofortification has a significant role to play in this global food systems transformation. It is an efficacious, cost-effective, sustainable, and scalable approach. According to cost-benefit estimates by leading economists from the Copenhagen Consensus, as much as USD 17 of benefits in health improvements can be gained with every USD 1 investment in biofortification[3].

Biofortification is a food-systems approach to improving nutrition. Its entry point is the seed or planting material grown by smallholder farming households. It targets populations at high risk for nutritional deficiencies who typically do not have access to year-round diverse diets, supplements, or fortified foods mainly sold in urban markets. The premise of biofortification is to increase the quality (not the quantity) of diets by replacing some or all of the high-energy, nutrient-poor staple crop varieties in the diet with nutrient-rich versions of the same crop.

This brief summarizes the latest evidence on how biofortification can help sustainably transform food systems to deliver healthier diets. It provides examples of WFP-HarvestPlus collaborations in supporting country-level initiatives to scale up biofortified seeds, crops, and foods, and it highlights opportunities to implement WFP's recent procurement policies and integrate biofortification in other relevant WFP programs.

The climate threat to food security

In 2019, a severe drought in the Central American dry corridor, especially in Guatemala, El Salvador, Honduras, and Nicaragua, destroyed over half of all maize and bean crops and left over 1.4 million people in need of emergency humanitarian assistance[1]. In Lesotho, droughts during the 2018/2019 planting seasons reduced national cereal production by over 60 percent and left over one quarter of the population on the brink of famine[2]. The WFP estimates that with a 2 °C increase in global temperatures, over 180 million people worldwide will be affected by hunger and malnutrition.

Biofortified crops have been included in many of WFP's influential Fill the Nutrient Gap analyses. One analysis revealed that if households in Punjab province, Pakistan, were provided access to zinc wheat, the cost of a nutritious diet for an adolescent girl would be reduced by 25 percent. Another analysis in Guatemala showed that providing access to iron biofortified beans would reduce the cost of a nutritious diet for adolescent girls by 10 percent (WFP 2020)

What is biofortification: Nutrient-enriched crops

Biofortification is the process of increasing the density of nutrients in food crops during plant growth. This can be achieved through three different approaches[4]:

- Conventional plant breeding: Increasing the nutrient content of plants within the natural genetic boundaries of a species by selecting for varieties that are naturally high in targeted micronutrients and crossbreeding them with locally available varieties. These varieties are not GMOs.
- Agronomic biofortification: Increasing the mineral content in the edible portion of plants through leaves or soil mineral fertilizer application and/or through adding minerals to irrigation water.
- Genetic modification: Altering the DNA structure of plants to increase the micronutrient content above what occurs naturally in a species. These varieties are GMOs.

The HarvestPlus biofortification program within the CGIAR

HarvestPlus has a catalytic and coordinating role in a global effort by the CGIAR to improve the nutrition and health of vulnerable populations through its crop portfolio. The cornerstone of this effort is scaled-up delivery of staple crops that have been conventionally bred to contain higher amounts of vitamin A, iron, or zinc—three nutrients that together are associated with the largest global nutritional disease burden. To date, all biofortified crops released through the efforts of HarvestPlus and its partners have been developed through conventional plant breeding methods, and thus they are not GMOs.

HarvestPlus works with several CGIAR research centers* and national agricultural research systems (NARS) to develop and release biofortified crops. Between 2004 and 2020, HarvestPlus and its partners have supported the release of 262 varieties of 12 biofortified crops in 30 countries (see Appendix 1). Thousands of additional varietal lines are currently in testing in these and other countries.

Agricultural benefits and acceptability of biofortified crops

In addition to their higher micronutrient content, many biofortified crops have other beneficial traits that are valued by farmers and consumers. Biofortified varieties are bred to yield at least as much as the highest-yielding variety of that crop in a given country. Evidence from the field suggests significant yield increases for adopters of biofortified varieties, compared to non-adopters[5-6]. For example, in Rwanda, iron bean growers had 16-23 percent higher yields than growers of the non-biofortified bean variety it replaced[7], translating to an estimated 14 percent increase in the value of beans produced and almost 4 percent increase in overall income[8].

Biofortified varieties of several crops are also bred to be climate smart (e.g., heat and drought tolerant and require lower levels of inputs such as water); biofortification can help counteract the negative effects of climate change on the nutritional quality of food crops[9]. An estimated 3-17 percent decrease in iron, zinc, and protein content of food crops as a result of projected carbon dioxide emissions would put hundreds of millions more people at risk of stunting, anemia, and other diseases. Vitamin A maize is also less susceptible to aflatoxin contamination, compared to non-biofortified maize, resulting in both higher vitamin A intake and reduced nutritional damage from aflatoxin consumption[11].

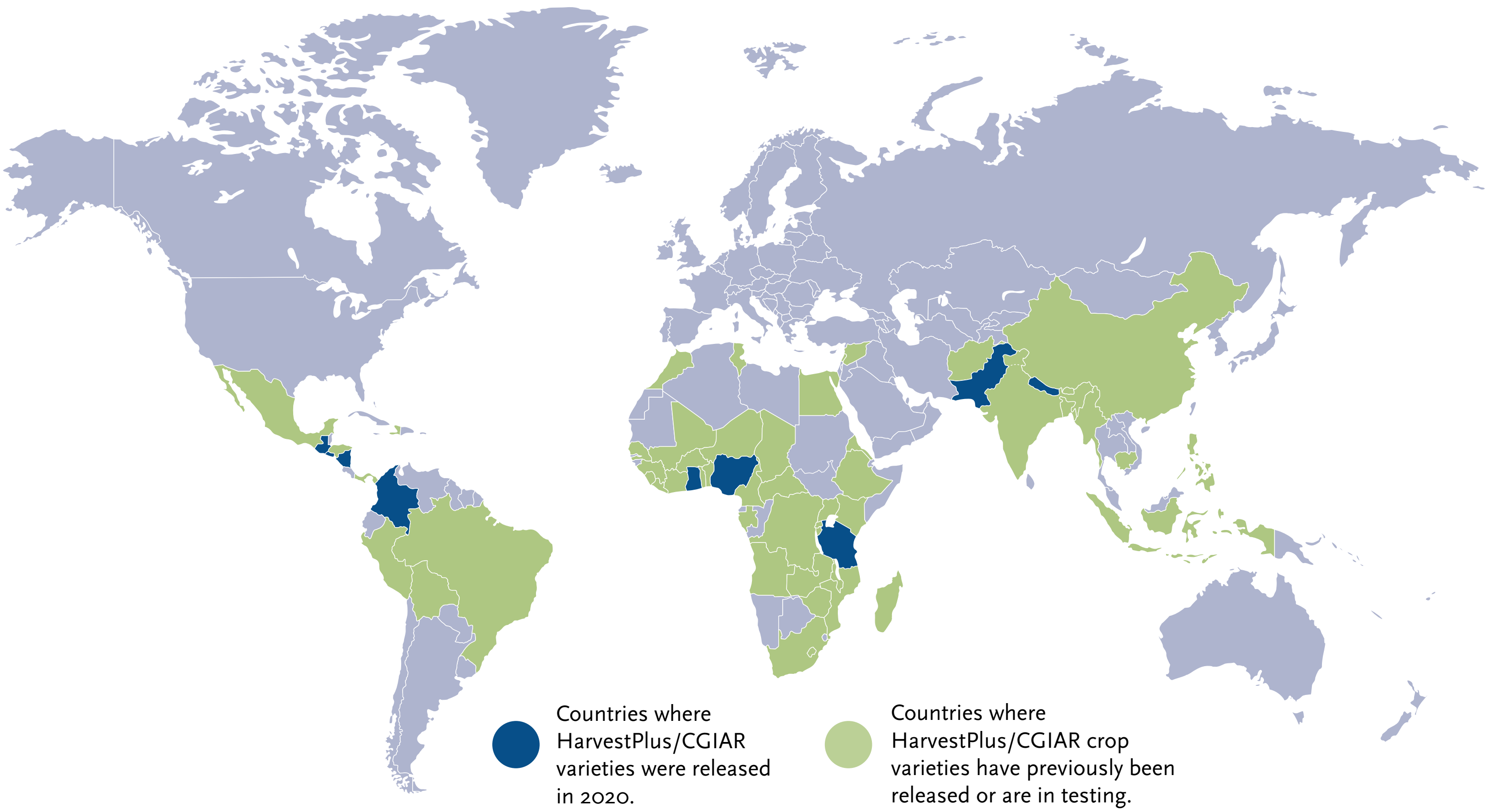
Biofortification can also be used to improve the macronutrient quality of grains. The grain of quality protein maize (QPM) varieties contains nearly twice as much lysine and tryptophan, amino acids that are essential for humans and monogastric animals. QPM is a product of conventional plant breeding.[†]

There is significant evidence that both rural and urban consumers enjoy dishes made with biofortified varieties at least as much as—and sometimes more than—those prepared with non-biofortified varieties, and in some cases even in the absence of information about their nutritional benefits[12-19]. Schoolchildren often prefer vitamin A biofortified crops, such as maize, sweet potatoes and cassava, in school feeding programmes as these tend to have a slightly sweeter taste. In addition, biofortified bean crops often have far shorter cooking times than their non-biofortified counterparts, potentially reducing the amount of time that women and girls spend gathering wood for fuel and cooking, allowing mothers to spend more time with their children, and reducing the impact on the environment through the decreased use of wood and fuel with the shorter cooking time.[19]

** HarvestPlus collaborates with the following CGIAR centers on the development of biofortified crops: Alliance of Bioversity International and CIAT; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); International Institute of Tropical Agriculture (IITA); International Maize and Wheat Improvement Center (CIMMYT); International Potato Center (CIP); and International Rice Research Institute (IRRI).*

† QPM was developed by Surinder Vasal and Evangelina Villegas at CIMMYT in the late 1990s. For their achievement, they won the 2000 World Food Prize.

Biofortified crops around the world



Nutrition and health benefits of biofortified crops

The micronutrient target content for vitamin A, zinc and/or iron biofortified crops are set to meet the dietary needs of non-pregnant, non-lactating women of reproductive age (WRA) (aged 15–49 years) and young children (aged 1–6 years), based on their usual eating patterns and common food processing practices. However, these crops are also a source of essential micronutrients for other population groups, including pregnant and lactating women, and adolescent boys and girls. Improving young women's and girl's nutritional status is a critical step in breaking the intergenerational cycle of poor nutrition and poverty; improved nutrition prior to pregnancy not only helps improve the health of the mother; it also improves the health of the baby, both before and after birth. Biofortified staple crops can be more accessible to women and girls because in some cultures women and girls eat last and least, with less access to "preferred foods" such as animal source foods and a diet more dominated by staple foods.

When consumed daily by non-pregnant, non-lactating WRA and children (1–6 years), vitamin A maize, sweet potato, and cassava can provide between 50–100 percent of average daily vitamin A needs; iron beans and pearl millet can provide 80 percent of average daily iron needs; and zinc wheat, rice and maize can provide between 50–90 percent of average daily zinc needs. Scientific research and published evidence show that when consumed regularly, biofortified crops significantly reduce micronutrient deficiencies and improve health, including through improved physical and cognitive performance and reduced illness (see Appendix 2). For example, a randomized controlled trial with approximately 240 marginally iron-deficient female Rwandan university students (18-27 years) showed significant increases in measures of iron status after the women consumed iron biofortified beans daily for 4.5 months[10].

BIOFORTIFICATION
IN NUMBERS

262 varieties

of 12 HarvestPlus-facilitated biofortified crops released in 30 countries

9.7 million

smallholder farming households growing HarvestPlus-facilitated biofortified crops, benefitting 48.5 million household members. (as of end-2020)

290,000

people (58 percent women) trained in 2020 alone on biofortification best practices by HarvestPlus and its partners.

105

strategies and policies covering biofortification in place at the global, regional and multilateral levels; at the national level, policies and/or regulations in place in 24 countries.

20 percent

of all beans grown in Rwanda were iron-biofortified beans by the end of 2018—an example of critical mass rapidly achieved in a biofortified food system.

Frequently asked questions about biofortification

Is biofortification equivalent to genetic modification (GM)?

No. There are three approaches to biofortification: conventional crop breeding, agronomic practices, or genetic modification. HarvestPlus promotes conventionally bred biofortified crops given the technology is acceptable, in a regulatory sense, in all countries. Genetic modification can offer benefits by adding a micronutrient not found naturally in the crop, or multiple micronutrients, but crops resulting from this technology, as GMOs, are subject in some countries and regions to greater regulatory control and negative perceptions, and are not permitted in many countries. HarvestPlus respects the right of all countries to determine their preferred breeding approach to advancing biofortification to improve the nutrition and health of their citizens.

Does biofortification undermine biodiversity?

No. Biofortified crops developed through conventional plant breeding are the result of genetic diversity conserved in seed banks around the world. The process leverages the natural variation in micronutrient content across the spectrum of varieties of a crop, often utilizing varieties that are no longer grown in conjunction with varieties that are well-adapted for a given location. In addition, for a given biofortified crop that is bred for a given location, multiple varieties are released over time, recognizing that different farmers have different preferences. Biofortified crop varieties have improved nutritional content and are well adapted to changing environments and market demands.

Can biofortified seeds be reused?

Yes. Most food crops in low- and-middle income countries are not hybrids (i.e., they do not need to be purchased annually). Biofortified crops that are non-hybrids include zinc wheat, rice, and open pollinated maize; iron pearl millet and iron beans; and vitamin A maize, orange sweet potato, and cassava. These biofortified crops can be saved, shared, and replanted, although periodic replacement with new seed or roots is encouraged to sustain higher yield advantage and avoid propagation of seed-borne diseases.

Existing collaborations between HarvestPlus and the World Food Programme

Latin America and the Caribbean (LAC)

HarvestPlus currently works with WFP's regional bureau for LAC and with WFP's country programs in Colombia, Guatemala, Honduras, and Nicaragua. Collaborations between HarvestPlus and WFP in LAC date back to 2016 and are expanding throughout the region. Most of the work focuses on jointly implementing School Feeding Programs (SFP) and/or Purchase for Progress (P4P), now known as Smallholder Agriculture Market Support (SAMS) programs.

Central America: Starting in 2020, with funding provided by the Korea International Cooperation Agency (KOICA), WFP's regional bureau for LAC, HarvestPlus and CIP are going to be working together to promote biofortification in national policies and among farmers and vulnerable populations by strengthening the capacities of the NARS in Guatemala, El Salvador, and Nicaragua. Over a three-year period, a total of 60 researchers, scientists, and technical staff working for NARS will be trained on: breeding for improved vitamin and mineral content; multiplication of vitamin A cassava cuts and sweet potato stems; mineral and carotenoids analysis; nutrition labelling; post-harvest preparation (e.g., food product development and food safety); good agricultural practices; communication (i.e., why biofortification matters); and monitoring and impact evaluation. This program will help enhance the knowledge of NARS in LAC to promote biofortification by creating a regional network of scientists, researchers and experts in biofortification.

Guatemala: In 2018, WFP purchased iron beans (commercial grains) and zinc maize grain from the seed producer associations APAS and ATESCATEL. These associations used HarvestPlus' seed to produce biofortified grain. The biofortified crops were then distributed by WFP, under their P4P program, to smallholder farmers and consumers in different communities in Guatemala's dry corridor, which were severely affected by the drought in 2017–2018. These crops provided an important source of food and nutrition for farmers and communities in need of humanitarian assistance because of the drought.

Colombia: HarvestPlus and the WFP have been working together to ensure a sustainable and inclusive market for biofortified crops in Colombia since 2017. HarvestPlus provides seeds and technical support and training to farmers and low-resource populations across rural Colombia. Farmers and communities use the seed to produce biofortified grain and sell it to WFP under their P4P program. In addition, in 2020 HarvestPlus will sign an agreement with WFP to participate in a project funded by KOICA, which will help support women farmers and their families in areas affected by conflict.

Honduras: WFP and HarvestPlus work together to empower farmers to grow biofortified crops. For this pilot project, HarvestPlus will provide iron bean seeds to WFP for distribution to lead farmers in several regions of Honduras. WFP will work with these lead farmers to set up demonstration plots following the farmer field school (FFS) methodology and farmers will participate in trainings in these locations. In addition to providing seeds, HarvestPlus will provide agronomic and nutrition training to WFP technicians and some lead producers, who in turn will train groups of farmers in the FFS. HarvestPlus will also provide informational material to be used by WFP and farmers during training sessions. WFP staff will also receive hands-on training through a field study mission at the CIAT campus in Cali and other off-site areas in Colombia. Depending on the results of the pilot project, there may be a possibility to scale up these activities to reach more farmers.

Nicaragua: HarvestPlus and WFP are working together to strengthen farmer cooperatives and incorporate iron beans into WFP's SFP. Currently, HarvestPlus provides iron bean seeds to WFP, which then distributes them for testing by smallholder farmers in different regions in Nicaragua. The main objective of these activities is to increase demand for biofortified seed by farmers, who would then produce large volumes of biofortified grain for sale (through a competitive process) back to WFP. Although this activity is in its pilot stage, it has the potential for large-scale impact, since WFP feeds approximately 165,000 school children every year and would be able to use the biofortified grains in the school program. WFP and HarvestPlus are also working together to develop a cost-effective traceability protocol for iron bean grain to allow WFP to differentiate biofortified grain from other locally available bean grain.

Africa

HarvestPlus works or has worked with WFP in several countries. Collaboration will continue in these countries, and the partners aim to expand to other countries in Africa.

Zambia: In 2019, HarvestPlus and the WFP signed a four-year agreement to increase the production and consumption of biofortified crops in Zambia. One of the main goals is to increase the quantity of biofortified crops available for the home-grown school meals program (HGSM), including vitamin A maize and orange sweet potato, and iron beans. HarvestPlus will provide training to farmers and WFP staff on production, post-harvest handling, and marketing of biofortified crops; link famers and processors with the WFP-supported aggregator system to ensure quality and traceability of biofortified crops; and together with WFP, provide technical advice and support to relevant government ministries on biofortification and the development of HGSM guidelines. Ultimately, HarvestPlus and WFP wish to establish a long-term relationship in Zambia that supports institutional and capacity development to help further each organizations mission.

Zimbabwe: HarvestPlus and WFP are discussing a program of activities similar to that in Zambia.

Rwanda: In 2013, WFP and HarvestPlus initiated a pilot project in Rwanda with three objectives: (1) create a sustainable market for farmers' surplus of high-iron beans, (2) provide WFP beneficiaries with both food and nutrition security, and (3) reduce the country program's reliance on imported beans.

Smallholder farmers were grouped in cooperatives, which were registered by WFP Rwanda based on strict eligibility criteria. HarvestPlus provided extension services, facilitated storage, ensured the high-iron beans were of good quality, and helped farmers negotiate competitive prices. WFP in turn procured iron beans for their P4P program. This partnership has evolved over the years and is now under the WFP's project on post-harvest handling (PHL), and P4P cooperatives are now working with Farm to Market Alliance (FtMA), another platform within WFP that links farmers to markets beyond WFP.

Malawi: Initial demonstration work is happening in one district in Malawi. Biofortified maize seeds will be planted into demonstration areas of up to 20 schools with a view to incorporating the production into home grown school feeding in those schools.

Leveraging WFP procurement policies

Over the years, WFP has steadily increased its share of local sourcing in its food procurement, with more than half of WFP food commodities being purchased locally in recent years. Local and regional food procurement can have a significant impact on the livelihoods of smallholder farmers. A large institutional buyer like WFP has leverage to improve the overall food system, particularly when its procurement activities also support value chain actors such as farmers, farmer organizations, processor groups, aggregators and traders.

In November 2019, WFP updated its local and regional food procurement policy and referenced biofortified crops. This should now enable procurement policy compliant purchase, program integration with nutrition and promotion of partnership activities with other UN efforts. A partnership between HarvestPlus and WFP can facilitate WFP to act on this policy.

The Way Forward

WFP has committed to prioritizing availability of and access to nutritious food in in its work to achieve zero hunger. HarvestPlus, along with its CGIAR and other partners, is working to scale up the production and consumption of nutritious biofortified crops and foods by including biofortification into national, regional, and global food systems, as well as in food support programs, as appropriate.

HarvestPlus-facilitated biofortified crops have already been included in several WFP activities, and an effective working relationship has been developed between the two partners. They also agree that there is scope for significant expansion in their collaborations.

Among WFP's potential role in scaling up the use of biofortified crops, WFP can advocate for the use of biofortified crops in delivery platforms such as home-grown school meals programmes and resilience programmes, such as Food For Assets (FFA) capacity strengthening activities.

WFP is able to incentivize farmers to grow biofortified seed through advocacy, capacity strengthening, and working with farmers to decrease supply chain inefficiencies, as well as increase demand through SBCC and awareness activities related to increasing consumption of healthy diets.

For its part, HarvestPlus will bring to bear its experience and expertise in scaling up the delivery of biofortified seed, crops, and foods to ensure that farmers are sufficiently supplied, supported, and connected to food value chains, and that WFP is able to authenticate sources of biofortified crops. HarvestPlus plans to work with the food industry to secure access to the food market for smallholder farmers, providing them further incentive to grow biofortified crops, which could then be used in humanitarian purchases.

WFP and HarvestPlus: A guide for working together

Biofortified varieties of crops are released and available in over 40 countries, including all countries where WFP is currently operating. Below are some recommended steps for developing a collaboration with HarvestPlus to integrate biofortified crops in programmes for WFP beneficiaries:

1. Engage with HarvestPlus during Stakeholder Mapping for a Fill the Nutrient Gap Analysis and identify any relevant products that could be modelled in terms of their potential to improve the cost and affordability of nutritious diets in local areas, for different target groups.

2. A partnership can be initiated by either HarvestPlus or WFP. The key contacts listed below can link you with a nearby expert among HarvestPlus staff located across Africa, Asia, and the Americas.

3. Arrange a meeting to discuss both parties' relevant business priorities and the local context; identify existing programmes and share learnings from past experiences.

4. If helpful, HarvestPlus can help organize learning workshops to better familiarize WFP teams with the basics of biofortification and its potential for programmes.

5. Identify programmes that could increase nutritional impacts by introducing biofortified crop production, such as home-grown school feeding, smallholder agriculture programmes, and resilience-building programmes.

6. Estimate quantities of foods required; HarvestPlus teams can then establish accurate requirements so that seed quantities needed for production can be calculated.

7. HarvestPlus will then identify current seed availability of biofortified varieties and the potential of crop production (supply).

8. Co-convene supply chain actors and establish what is required at each step of the value chain, from seed production to food consumption.

9. Conduct a gap analysis and identify resource requirements. Seek help from WFP and HarvestPlus regional or global offices for additional support and resources.

10. Document and communicate an action plan. This needn't be a complex or legal document, as long as it makes clear to both parties the respective accountabilities, outcomes, and costs of activities. Templates and past examples are available upon request from the key contacts below.

Contact Information

HarvestPlus: Jenny Walton: j.walton@cgiar.org or Lynn Brown: l.brown@cgiar.org

WFP: Frances Knight: frances.knight@wfp.org or Corrine Ringholz: corinne.ringholz@wfp.org

Appendix 1: Availability of Biofortified Crop Varieties, by Country* Released (R) or in Testing (T)

Africa	HIB	IPM	ZIM	ZIR	ZIW	ABP	VAC	VAM	OSP	IZC	IZP	IZL	ZIS
Angola								T	R				
Benin Rep		T					T	T					
Burkina Faso		T						T	R				
Burundi	R					R			R				
Cameroon						T	R	R					
Central African Rep							T						
Chad							T						
Côte d'Ivoire						T	T		R				
DR Congo	R					R	R	R					
Egypt					T			T					
Eritrea		T							T				
Ethiopia	T				T		T	T	R		T	T	
Gabon							T						
Gambia		T					T						
Ghana		T					R	R	R				
Guinea						T	T						
Kenya	T	T					T	T	R		T		
Liberia							T	T					
Madagascar		T		T					R				
Malawi	T	T					T	R	R		T		
Mali		T						R	T				T
Morocco									T			T	
Mozambique							T	T	R				
Niger		R					T	T	T				
Nigeria		T	T			T	R	R	R	T			T
Rwanda	R					T		R	R		T		
Senegal		T					T	T	T				
Sierra Leone							R	T					
South Africa					T			T	R				
South Sudan	T	T						T	T				T
Swaziland							T						
Tanzania	R	T				T	T	R	R				
Togo		T						T					
Tunisia		T											
Uganda	R	T				T	T	T	R		T		T
Zambia		T			T		T	R	R				
Zimbabwe	R	T			T			R	T				

HIB = Iron Bean
IPM = Iron Pearl Millet

ZIM = Zinc Maize
ZIR = Zinc Rice
ZIW = Zinc Wheat

ABP = Vit. A Banana/Plantain
VAC = Vit. A Cassava
VAM = Vit. A Maize
OSP = Vit. A Orange Sweet Potato

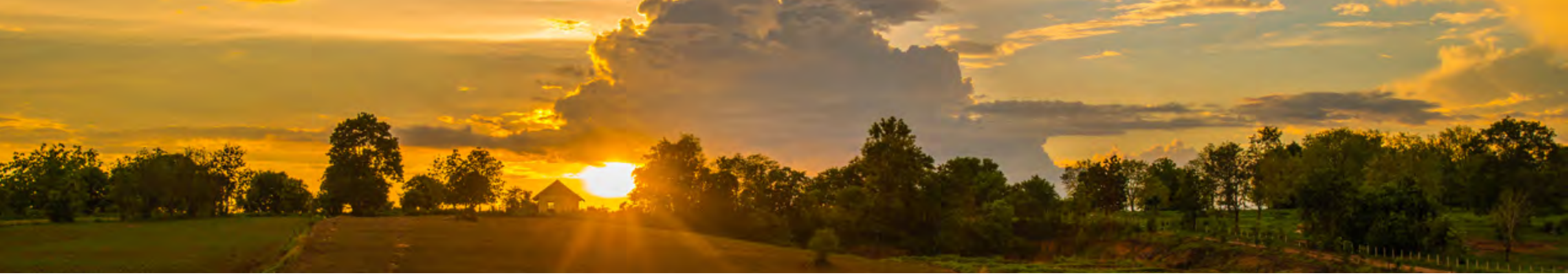
IZC = Iron/Zinc Cowpea
IZP = Iron/Zinc Irish Potato
IZL = Iron/Zinc Lentil
ZIS = Zinc/Iron Sorghum

Source: HarvestPlus, International Potato Center (2020)

Asia	HIB	IPM	ZIM	ZIR	ZIW	ABP	VAC	VAM	OSP	IZC	IZP	IZL	ZIS
Afghanistan					T								
Bangladesh				R	R				R			R	
Bhutan					T						T		
Cambodia				T									
China				T	T			T	R		T		
East Timor									R				
India		R		R	R			T	R	R	T	R	R
Indonesia				R					R				
Lebanon												T	
Myanmar				T									
Nepal					R			T			T	R	
Pakistan					R			T				T	
Philippines					T								
South Korea									R				
Syria												R	

LatAm/Caribbean	HIB	IPM	ZIM	ZIR	ZIW	ABP	VAC	VAM	OSP	IZC	IZP	IZL	ZIS
Bolivia	R		R		R						T		
Brazil	R			T	R		R	R	R	R			
Colombia	R		R	R			T	T	R				
El Salvador	R		R	R									
Guatemala	R		R	T			T		R				
Haiti	T		T	T			T	T	T				
Honduras	R		R						T				
Mexico			T		R		T	T					
Nicaragua	R		R	R					R				
Panama	R		T				T	T	R				
Peru									R		T		

Biofortified crops are bred for other traits demanded by farmers such as high yield, resistance to disease, drought tolerance, and heat tolerance. Consult HarvestPlus staff for a detailed profile of any variety included in the table above. Note that biofortified varieties of vitamin A banana/plantain, iron cowpea, iron lentil, and zinc sorghum are also available in some countries, though these are not currently focus crops for HarvestPlus.



Appendix 2: Nutrition and health benefits of biofortified crops

Biofortified crops are bred to meet the dietary needs of non-pregnant, non-lactating women of reproductive age (15-49 y) and children (1-6 years) based on their usual eating patterns. When consumed regularly, there is strong evidence that biofortified crops significantly reduce micronutrient deficiencies and improve health.

	Crop*	CGIAR Crop Research Partner(s)	Target nutrient level* (ppm)	Nutrition** and health benefits
IRON	**Beans**	**Bioversity/CIAT**	**94**	• Provides up to 80% of average daily iron needs • Prevents and reverses iron deficiency in young women [30] • Improves young women's cognitive performance and physical work capacity [25–28]
	Pearl millet	**ICRISAT**	**77**	• Provides up to 80% of average daily iron needs • Reverses iron deficiency in adolescent children [34] • Improves adolescent children's cognitive performance and physical activity [29,30]
VITAMIN A	**Orange sweet potato**	**CIP**	**32**	• Provides up to 100% of average daily vitamin A needs • Improves women and children's dietary vitamin A intakes [22–24] • Reduces child morbidity: children under 5 years had diarrhea less often and for shorter duration [20, 21]
	Maize	**CIMMYT; IITA**	**15**	• Provides up to 50% of average daily vitamin A needs • Improves vitamin A reserves in children after 3 months [26,27] • Improves visual adaptation to darkness in children with previous marginal vitamin A status [22, 23]
	Cassava	**IITA; Bioversity/CIAT**	**15**	• Provides up to 100% of average daily vitamin A needs • Improves vitamin A status in preschool and school-aged children [24]
ZINC	**Wheat**	**CIMMYT**	**37**	• Provides up to 50% of average daily zinc needs† • Reduces morbidity in women and children: women spent fewer days ill with fever, and children spent fewer days ill with pneumonia and vomiting [31]
	Rice	**IRRI; BRRI**	**28**	• Provides up to 90% of average daily zinc needs‡
	Maize	**CIMMYT; IITA**	**37**	• Provides up to 70% of average daily zinc needs for children under 5 years

** Total target micronutrient concentration is calculated as baseline micronutrient content + increase from biofortification, expressed as parts per million (ppm); target micronutrient level is the max level achieved in released varieties or tested material.*

*** The percent average daily needs met reflects the total amount of micronutrient provided that meets the physiological requirements for young children (1-6 years) and non-pregnant, non-lactating women of reproductive age (15-49 years), expressed as a percent of estimated average requirement (EAR) met. The EAR is the nutrient intake value that is estimated to meet the requirement of half of the healthy individuals in a specific group.*

† The total zinc contribution of fully biofortified whole wheat flour

‡ Based on total zinc from white rice (440 g x 90% retention x 25% absorption and 2.96 mg physiological requirement)

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