HarvestPlus
Better Crops • Better Nutrition

Biofortification and Climate Change

Climate Change Threatens Nutrition

A warming global climate is impacting agricultural production systems, limiting the ability to feed a growing population and provide adequate nutrients. Some of the effects of climate change, including floods, droughts, rising average temperatures, and greater exposure to crop diseases and pests, are affecting crop yields and impacting plant—and thereby human—nutrition.

A warming climate thus poses a direct nutritional threat to the billions of smallholder farmers who rely on staple food crops for much of their diet and are responsible for one third of the global food supply.

Research has shown that higher concentrations of carbon dioxide (CO_2) in the atmosphere and higher temperatures may bring greater threats from insects and microbiological diseases and will deplete the protein and nutrient content (especially iron and zinc) by 3-17 percent in most plants.

There are already an estimated 1.5 billion people who are zinc deficient and 662 million who are protein deficient. As CO_2 levels rise, climate-induced impacts are expected to push an additional 175 million people into zinc deficiency and an additional 122 million into protein deficiency. What's more, over a billion women and young children could lose at least 4 percent of their dietary iron intake.

People living in South Asia, Southeast Asia, Africa, and the Middle East are at highest risk of climate-induced impacts on health. They are extremely vulnerable because they are limited in their ability to invest in adaptive and innovative technologies.

Malnutrition is the result of the actions or inactions of global food systems; emergency food and nutrition systems in regions affected by climate emergencies are in urgent need of strengthening.

Biofortified Crops Strengthen Food Systems and Mitigate Climate Change Losses

By harnessing the natural and significant genetic variation in plants and using innovative selective breeding and agricultural techniques, it is possible to enrich staple food crops with added nutrients and breed for climate-smart traits. HarvestPlus is the global leader in this process, known as biofortification. **Biofortification makes food crop varieties more nutritious and more stable under a variety of challenging environmental conditions.**

With partners, HarvestPlus develops staple food crops higher in iron, zinc, and vitamin A that are tailored to and stress-tested for specific country conditions. Breeding against pests, diseases, drought, heat, and other abiotic factors, is an integral part of the development process for all biofortified crops. **Improvements in crop micronutrient density and resilience via biofortification offers a solution to help offset climate-induced declines in agricultural productivity and nutrition.**

Biofortified Millets, Maize, and Beans: Resilient and Nutritious

Millets grow well in dry soil and have been a staple food crop for low-income families in dry areas of Africa and Asia for thousands of years. They are also one of the very few food crops (known as C4 crops) for which elevated CO2 does not affect their protein and micronutrient levels. Pearl millet has a high temperature tolerance (up to 420C) and low water requirement (<400 mm annual rainfall). This raises pearl millet's potential as a very important crop for addressing hidden hunger in the face of climate change.

Moreover, pearl millet is a low-resource-intensive crop and—when biofortified—can provide up to 80 percent of average daily iron needs and adequate amino acids. Its impact on physical and cognitive health is proven. Biofortified varieties are being grown in India and Niger. Another millet, finger millet, is also highly nutritious; it has the highest calcium content among cereals, with the potential to be bred to become a progressively even higher source of calcium and health-promoting phytochemicals.

Maize, like millet, is also a climate-smart crop. Provitamin-A biofortified maize hybrids have been released that are resilient to drought stress and have high tolerance for heat (up to 45°C). More than 60 of these provitamin-A rich varieties have been developed and released by HarvestPlus, with CGIAR breeding partners, in 11 countries, with proven improvement to health. Another set of 11 biofortified maize varieties high in zinc were developed based on "quality protein maize" germplasm (QPM). They contain higher levels of protein (amino acids) and have been released in Latin America and the Caribbean; they are proven to be resilient to tropical conditions, showing high tolerance for heat (up to 45°C) and for high moisture. Currently, these varieties are grown in Honduras, Guatemala, Colombia, El Salvador, and Nicaragua.

Iron-biofortified beans developed from crosses with Mesoamerican beans, a species originating in the arid southwestern United States and northwestern Mexico, show strong tolerance to temperatures up to 4°C higher than the range normally tolerated by bean varieties. Thirteen varieties have been released in Latin America and the Caribbean with this profile, and they are currently grown in Guatemala, El Salvador, Nicaragua, Honduras, and Colombia.

Biofortified Crops: Climate-smart Traits and Productivity Advantages

Biofortified crop	Nutrition trait	Climate-smart traits	Sample varieties	Yield, tons per hectare (maturity time)
Rice	High zinc	Extra early maturity	BRRI Dhan 62	4 t/ha (Extra early: 100 days)
Wheat	High zinc	Stem rust resistance Drought tolerance	Akhbar-2019	4.47 t/ha (Intermediate: 140 – 145 days)
Maize	High vitamin A	Drought tolerance Early maturity	SAMMAZ 60	5 t/ha (Early to medium: 110 – 120 days)
Pearl Millet	High iron	Downy mildew resistance High temperature and drought tolerance Extra early maturity	Dhanshakti	2.5 t/ha (Extra early: 70 – 75 days)
			HHB299	3.3 t/ha (Intermediate: 80 – 85 days)
Beans	High iron	High temperature tolerance (up to 4°C higher than the range normally tolerated by bean varieties grown in drought conditions in Latin America and the Caribbean)	ICTA Peten ACM	4.2 t/ha
			CENTA Ferromas	2.3 t/ha
			ICTA Superchiva	4.2 t/ha
			Corpoica Rojo 43	1.2 t/ha

Contact HarvestPlus for more information: harvestplus@cgiar.org

HarvestPlus improves nutrition and public health by developing and promoting biofortified food crops that are rich in vitamins and minerals, and providing global leadership on biofortification evidence and technology. HarvestPlus is part of the CGIAR and is based at the International Food Policy Research Institute (IFPRI).

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