iron Bean

Millions of Africans suffer from iron deficiency and iron deficiency anemia. During infancy, childhood, and adolescence, this deficiency impairs physical growth and endurance, mental development, and learning capacity. For more than 300 million people, beans are an important part of the diet, especially in regions of Africa and Meso- and South America. The common bean is, in fact, the world's most important food legume, and widely eaten in Africa where it can be a highly productive crop. Beans that are bred to be high in iron can contribute to a reduction in iron deficiency in regions of Africa where daily bean consumption is high.

At a Glance

Nutrient Target
Iron content (µg/g)
Average Nutrient Content: 50
HarvestPlus Target: 94

Agronomic Traits
Virus resistance
Heat and drought tolerance

Strategy: Conventional breeding

Release Year: 2010

Photo: CIAT

Target Countries:
D.R. Congo, Rwanda

Spillover Countries in Africa:
Burundi, Kenya, Tanzania, Uganda, Mozambique, Malawi, Zambia, Zimbabwe, Ethiopia

Target Countries: Democratic Republic of Congo and Rwanda

Beans are consumed mainly in the eastern provinces of North and South Kivu in the Democratic Republic of Congo (D.R. Congo), at an estimated 300 grams per capita per day. Prevalence of anemia among preschool children is 36% in North Kivu and 47% in South Kivu. Daily consumption of beans in Rwanda, across the border, is lower at 200 grams per capita, and the prevalence of anemia among preschool children is nearly as high at 33%, 50% of which is due to iron deficiency in the diet.

The breeding strategy combines high iron with other desirable agronomic traits. Breeding for high iron has built upon early investments made during proof of concept studies. Consequently, beans are projected to be the second biofortified crop to be officially released by the program pending the results of nutritional efficacy trials.

HarvestPlus estimates, under an optimistic scenario, that 10 years after release, two million people in D.R. Congo and three million Rwandans would consume high iron beans each year. It is anticipated that biofortified beans could also be adapted to growing environments in Burundi, Kenya, Tanzania, Uganda, Mozambique, Malawi, Zambia, Zimbabwe, and Ethiopia.

Target Country Partners

CGIAR

Colombia:
- International Center for Tropical Agriculture (CIAT)

National

D.R. Congo:
- Ministry of Health
- National Institute for the Environment and Agricultural Research (INERA)
- PRONANUT (National Nutrition Program)
- University of Goma
- University of Bukavu

Rwanda:
- Ministry of Health
- National Institute for Agricultural Science (ISAR)
- National University of Rwanda- Faculty of Medicine, School of Public Health
- National Laboratory

Other

Australia:
- Flinders University
- Waite Analytical Services

Switzerland:
- Swiss Federal Institute of Technology (ETH-Zurich)

Tanzania:
- East and Central African Bean Research Network

Uganda:
- Pan-Africa Bean Research Alliance

USA:
- Helen Keller International
- Project Healthy Children

HarvestPlus

Breeding Crops for Better Nutrition

For each crop under development, HarvestPlus and its partners work along an impact pathway. Accomplishments, as well as ongoing and planned activities, are described sequentially under each step of the pathway.

Achievements

Step 1: Identify target populations who can benefit from biofortification

- Collected data on bean production and consumption patterns from nearly 500 households in two provinces in D.R. Congo.

Step 2: Set appropriate nutrient target levels for selected populations

- Set initial breeding target at 94 micrograms iron/gram of bean in order to provide 30% of the mean daily iron requirement through normal consumption habits.*

**Adult women used as reference. Assumptions: 200g bean intake/day, 90% retention of iron after cooking beans, and 5% bioavailability.*

Step 3: Screen crop varieties and germplasm for use in breeding

- Screened germplasm from wide representation of bush and climbing beans from Africa and Latin America. Found to have a high variation for iron.
- Partially sequenced iron reductase and transporter genes responsible for iron transport in bean.
- Investigated anti-nutrient properties related to iron bioavailability.

Step 4: Breed new biofortified varieties of staple food crops with higher micronutrient levels

- Developed prototype candidate varieties with up to 50% of the iron breeding target in final product development.
- Multiplied and distributed lines found to already contain high levels of iron to African farmers after testing.

Ongoing and Planned Research

Step 5: Test performance of new crop varieties in the field

- Farmers selecting breeding lines during field performance evaluation in D.R. Congo and Rwanda, and in Burundi, Kenya, Malawi, Madagascar, Uganda, and Tanzania in complementary projects.
- Scientists testing selected bush lines for mineral stability in different agroecological environments (GXE) and identifying factors favoring expression of high mineral trait and parental source.
- Effects of NPK fertilizer, soil type, organic amendments, and moisture stress on agronomic and minerals performance being investigated in multi-location experiments.

Step 6: Measure nutrient retention in crops and foods

- Nutritionists will quantify iron content of all major sources of dietary iron and bean cooking methods in rural settings.
- Will evaluate iron content of local bean varieties and iron biofortified beans produced in Rwanda in raw and processed forms.
- Will undertake controlled studies of retention of iron, phytate, and polyphenols for iron beans being evaluated for release in Rwanda.

Step 7: Evaluate body's capacity to absorb and use micronutrients from biofortified crops

- Nutrition studies underway on iron absorption from beans to determine relative effects of phytate and polyphenols and dose response effect of bean polyphenols on iron bioavailability.
- Will conduct efficacy trials on women in Rwanda and school children in Mexico to improve indicators of iron deficiency and iron deficiency anemia.

Step 8: Officially release biofortified varieties

- Will support national partners in Rwanda and D.R. Congo in generating agronomic and nutritional data required by national varietal release committees for formal release of biofortified varieties.

Step 9: Promote marketing and consumption of biofortified crops and foods

- Will support production of nucleus seed for large-scale multiplication in Rwanda and D.R. Congo via formal and informal seed multiplication systems. Will support the development of a viable seed production industry.
- Will support national partners to coordinate in-country product development and delivery. This will include schemes to add value to biofortified beans by adapted marketing.
- Will develop advocacy strategy with national partners for the dissemination of biofortified beans.
- Will create a market for biofortified crops by communicating the special nutritional value of these crops.

Step 10: Measure improvement in nutritional status of target populations

- Will conduct effectiveness study in Rwanda. Inferences regarding impact of iron beans in Eastern D.R. Congo will be made, given similarities in two regions.

HarvestPlus is a global alliance of research institutions and implementing agencies that are working together to breed and disseminate crops for better nutrition. It is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). HarvestPlus is an initiative of the Consultative Group on International Agricultural Research (CGIAR).

Donors

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