Breaking Ground
HarvestPlus 2011 Annual Report
Imagine... new varieties of nourishing crops rich in essential nutrients that can be grown and eaten by farming communities in the developing world to improve both their nutrition and their health.
2011 was our year for breaking ground.

Early in the year, we broke ground by reorganizing our teams and beginning the transition from the discovery and development phase for nutrient-rich crops to their delivery. We strengthened our country offices, many established at CGIAR centers, in our eight target countries. Our country managers assumed more responsibility for coordinating efforts with a wide range of stakeholders to promote biofortified crops to both farmers and consumers.

2011 saw the release of our second nutrient-rich crop—vitamin A cassava in Nigeria. The government released three varieties and has put its full support behind their dissemination. We expect a bright future for cassava in this populous nation.

I met with our partners in India and attended both the Brazil Biofortification Conference and the HarvestPlus China biennial meeting—these are three countries with significant scientific expertise that can play a strong role in leading biofortification. I am pleased to report that continued progress is being made in building their capacity to develop nutrient-rich crops.

Within research, policymaking, and donor circles, new ground was also broken. IFPRI led the way in early 2011 with its 2020 Conference in New Delhi, India on leveraging agriculture to improve nutrition and health. We took this message one step further to European stakeholders in Brussels last June, giving them a chance to engage with HarvestPlus on how we could work better together to reduce hidden hunger.

The UN also broke new ground with its High-Level Meeting on Nutrition in September. At this event, UK Secretary of State for International Development Andrew Mitchell promised increased funding to support nutrient-rich crop delivery in Asia and Africa. This decision was informed in part by the positive evidence from our project that disseminated orange sweet potato (OSP) to households in Uganda and Mozambique. We also received a USAID grant to scale-up OSP and expect to reach 200,000 more households in Uganda within a few years.

We’ve captured only our 2011 highlights in this report and intentionally kept them brief so you can grasp the full scope of our work. Please visit our website and subscribe to our newsletter, or follow us on Facebook and Twitter, to stay current. We have an exciting year ahead of us.

Sincerely,

Howarth Bouis
HarvestPlus Director
Micronutrients are vitamins and minerals that are essential for children to grow, learn, and build healthy immune systems. One in three people in the world suffer from a hidden hunger caused by a lack of micronutrients (such as vitamin A, zinc, and iron) in their diets. Hidden hunger also affects adults and can lead to repeated bouts of illness and weakened ability to work, as well as increase the risk of women dying during childbirth.

A diverse diet that includes a variety of fruits, vegetables, or animal products usually provides enough micronutrients. However, millions of people, mostly in poorer countries, rely upon staple foods such as rice or maize that fill up their stomachs but do not have sufficient micronutrients. Foods that are more nutritious are often too expensive or simply unavailable.

Now, through a strategy called biofortification, HarvestPlus and its partners are breeding and disseminating nutrient-rich varieties of the staple food crops that poor people eat every day. Ensuring that these crops reach rural areas and improve nutrition requires a clear roadmap and a multidisciplinary approach. Our strategy for reaching this goal has three components—discovery, development, and delivery.
How We Work

Phase 1: Discovery  
(2003–2008)
We identified populations most at risk of hidden hunger, as well as the staple crops that they consume in large quantities. Scientists searched seed banks to identify nutrient-rich seed lines to use in breeding. Researchers assessed retention and bioavailability of nutrients in foods to set breeding targets. Faster and cheaper methods to measure micronutrient levels in crops were also developed. Economists studied whether consumers would accept new biofortified foods and implemented a pilot program to deliver vitamin A-rich orange sweet potato in Africa. We also helped establish biofortification programs in Brazil, China, and India.

Phase 2: Development  
(2009–2013)
We are working with partners around the world to develop crops with higher amounts of vitamin A, iron, and zinc. These crops are being tested in target regions with farmer participation to ensure they perform well under different growing conditions. Researchers analyze these crops to ensure that they improve nutrition when prepared and eaten in traditional ways and study whether farmers and consumers will accept them. We established country teams and are building our networks to pilot delivery of biofortified crops in target countries.

Phase 3: Delivery  
(2014–2018)
We will evaluate pilot delivery strategies from Phase 2 to guide scaling-up of delivery of crops with our full target levels in collaboration with public- and private-sector partners. Our teams will implement strategies to create consumer demand for micronutrient-rich crops and food. Researchers will also measure the extent to which micronutrient-rich crops are adopted and improve the nutrition of target populations. This is critical to mainstreaming biofortification and ensuring its long-term sustainability.

The HarvestPlus Strategy

Discovery
- Identify Target Populations & Set Nutrient Targets
- Validate Nutrient Targets
- Discover & Screen Crop Genes

Development
- Improve & Evaluate Crops
- Test Nutritional Efficacy of Crops
- Study Farmer Adoption & Consumer Acceptance

Delivery
- Release & Disseminate Crops in Target Countries
- Promote Consumption of Crops
- Measure Crop Adoption & Improvements in Nutritional Status
Goal: Provide 50% of daily vitamin A needs for women and young children. In 2011 varieties that could provide 25% of daily needs were released.

Target Countries: Nigeria, Democratic Republic of Congo (DRC)

Deficiency Rates: 30% of children under 5 in Nigeria and 61% of children under 5 in DRC are estimated to be vitamin A deficient.

Agronomic Traits: High yielding, virus resistant

High amounts of vitamin A in cassava turn the flesh of this root crop from white to a deep yellow. It does not require much labor, which has also contributed to its popularity, particularly among subsistence farmers in much of Africa, including the Democratic Republic of Congo and Nigeria.

The Government of Nigeria released three varieties of vitamin A-rich cassava in late 2011. These were developed in collaboration with the International Institute of Tropical Agriculture (IITA) and the National Root Crops Research Institute (NRCRI). These varieties can contribute up to 25% of a woman’s daily vitamin A needs. There has been much demand for these new varieties throughout Nigeria. Working with partners in the private, public, and NGO sectors, we are producing stem cuttings and plan to multiply these over the next few growing seasons to distribute to farmers.

High amounts of vitamin A in cassava turn the flesh of this root crop from white to a deep yellow. Many often question whether consumers will find this acceptable. A study in Nigeria showed that when consumers are presented with nutrition information on the benefits of “yellow” cassava, they prefer these varieties to the local white ones. Rural farmers also said they prefer receiving stem cuttings from extension agents and other government agencies, rather than international organizations, since federal authorities are more widely trusted for their agricultural expertise. With this in mind, HarvestPlus is partnering with local government authorities to distribute vitamin A cassava to farmers.

In DRC, laboratory space at our local partner Institut National pour l’Etude et la Recherche Agronomiques (INERA) was renovated for installation of a spectrophotometer in 2012. This installation is intended to build INERA’s capacity to carry out vitamin A analysis of cassava samples directly in country (previously, samples have been sent to Nigeria for analysis at IITA).
Plans for 2012

- Conduct a study to measure vitamin A losses when cassava is processed and stored using typical rural household methods.
- Conduct varietal adoption surveys in Nigeria.
- Strengthen our partnerships with the Government of Nigeria in order to increase the availability of stems for dissemination to vulnerable households.

Research Highlights

- Nutritionists concluded that although the retention of vitamin A in gari (the most common method of cassava consumption in Nigeria) is low, the high bioavailability and intake findings for cassava more than offset the retention results, suggesting that preliminary breeding targets were on the high side.
- Near-infrared spectroscopy (NIRS) equipment was installed at IITA with technical assistance from the International Potato Center (CIP) to estimate vitamin A levels in cassava.
- Five varieties with more than 100% of the target level of vitamin A were in trials.

You say provitamin, I say vitamin

Vitamin A is essential to good health. It is available in the diet, either as preformed vitamin A (from animal-sourced foods) or from a group of pigments found in plants called provitamin A carotenoids. Foods rich in provitamin A such as carrots, mangoes, or orange sweet potato are typically dark yellow, orange, or red in color. When eaten, the provitamin A is converted into vitamin A by the body. Beta-carotene is the best known and most desirable carotenoid since it provides more vitamin A than other provitamins when converted.

Plant breeders are trying to increase the levels of provitamin A in cassava, maize, and sweet potato. Scientists often have to work with multiple carotenoids to increase the overall amount of provitamin A in these crops. When communicating to non-scientists, we refer to these crops as being rich in vitamin A instead of the more accurate, but less well-understood, technical terms such as provitamin A or beta-carotene. Since the purpose of these crops is to provide more vitamin A, this shorthand more clearly communicates our purpose in developing these crops—to provide more vitamin A in the diet to improve health.
Benard is just your average rural farmer in Zambia. But in 2011 he decided to start growing “orange” maize that is rich in vitamin A. Benard was one of a handful of farmers in three Zambian provinces who were selected to test these new maize varieties. Extensionists trained the farmers on the agronomic traits and nutritional benefits of the new variety.

In 2011 five varieties of hybrid vitamin A maize were tested in the second year of national performance trials. The best performing ones will move up the ladder and be considered for official release by the government in 2012.

Vitamin A maize was also promoted through radio programs that aired to about 1 million listeners in rural Zambia. (see Agfax story on page 18). Radio is the most important and frequently used source of information about new varieties for rural farmers given the vast size of Zambia.

Surveys provided further insights into habits of maize growers in Zambia. Most farmers grow enough maize to eat at home and have enough to last all year. Almost two-thirds of farmers received subsidized maize seed and fertilizer from extension services, which are the most trusted sources of information for new agricultural technologies. Therefore, HarvestPlus has partnered with extension services to disseminate orange maize throughout three provinces.
The world of plant sex: hybrids and open-pollinated varieties

In nature, plants rely on wind, birds, and insects to “openly” pollinate flowers and produce seed. This random process is, of course, impossible to control. This is where hybrids come into the picture. To produce hybrids, plant breeders first select parents for the qualities they want and then pollinate the seed by hand. Among these hybrid qualities are overall vigor, higher yield, and other traits such as disease resistance or drought tolerance. The only drawback to hybrids is that farmers have to buy and plant hybrid seed afresh every year to get the same results. Despite this additional cost, more than 8 in 10 Zambian farmers, for example, use hybrid maize seed.

Seed from open-pollinated varieties (OPVs), on the other hand, can simply be collected by farmers at harvest and replanted the next season with similar results each time. Farmers can grow hybrids, OPVs, or a combination of both depending on their growing conditions, incomes, and production targets, as well as what seed and other inputs, like fertilizer, are available to them.

Plans for 2012

- Conduct three nutrition feeding trials to test the efficacy of orange maize on public health.
- Submit best performing varieties of hybrid vitamin A maize for official release.
- Collect information from farmers who tested orange maize or attended farmer field days to understand their evaluation of orange maize varieties vis-à-vis white ones.

Research Highlights

- An independent study on bioconversion values found that the beta-carotene (see sidebar on page 5) in orange maize is converted to vitamin A in the body at a much higher rate than in other vitamin A food sources. In orange maize, it takes 5 molecules of beta-carotene to produce 1 molecule of retinol (the form of vitamin A used by the body) versus 12 molecules of beta-carotene in vitamin A-rich sweet potato, for example. This validates the more efficient conversion rates found in an earlier study.

- Using a technique called marker assisted selection (MAS), scientists identified the favorable combinations of genes needed to boost the amounts of selected carotenoids in maize that are then converted to vitamin A by the human body. This allowed us to greatly accelerate our breeding program.

HarvestPlus
From 2007–2009, HarvestPlus and its partners painted parts of Uganda and Mozambique orange with vitamin A-rich, “orange” sweet potato (OSP). When households switched from their white varieties to the orange ones, vitamin A intakes among women and children dramatically increased. More vitamin A in the diet can translate into improved vitamin A status.

Following the success of this pilot project that reached 24,000 households, HarvestPlus increased the distribution of OSP to more districts in Uganda in 2011. Beans with high iron were also brought into the mix, since most Ugandans eat beans with sweet potato.

In collaboration with the World Food Programme, farming households in Isingiro and Bundibugyo districts received OSP and iron bean planting materials, as well as basic training in OSP farming practices, nutrition, and marketing. With our partners, we also identified commercial farmers who could grow OSP in order to reach urban markets, such as the capital Kampala.

Most of the work focused on promotion and marketing activities at different points in the value chain. At the household level, mothers learned how to integrate OSP into local dishes for their children through cooking demonstrations. Radio programs highlighted the nutritional benefits of OSP as well as addressed issues important to farmers such as post-harvest handling and marketing. Field days allowed farmers a hands-on look at the orange crop. At the market level, retailers who sold OSP received marketing boards, aprons, t-shirts, and baseball caps to promote the orange varieties. We also sought out small- and medium-sized bakeries interested in incorporating OSP into their products, such as cakes, donuts, bread, and chapatti.
**Plans for 2012**

- Continue working with the National Agricultural Research Organization to develop even better varieties of OSP and iron bean that meet people’s preferences and are adapted to local climates.
- Expand our program to more than 10,000 farmers in 13 new districts; work with local farmers to multiply OSP vines and iron bean seed, provide agronomic information and nutrition education on the benefits of OSP and iron bean, and promote access to these nutrient-rich crops by linking farmers, traders, and retailers at markets.
- Conduct a study on the adoption and nutrition impact of the large-scale distribution of OSP, with a specific focus on understanding the best ways to encourage farmer-to-farmer diffusion.
- Conduct a varietal adoption study for both beans and OSP to provide relevant data to inform the ongoing delivery efforts.

**Research Highlights**

- Findings from the OSP project in Mozambique published in the *British Journal of Nutrition* showed that 65% of households in Mozambique adopted OSP. While many farmers substituted OSP for yellow or white ones on their plots, a good number were “new” sweet potato farmers. As more OSP was grown, households were eating more of it, which in turn doubled vitamin A intakes for women and children. By project end, OSP provided more than 70% of all dietary vitamin A and was the third most important food in the diet (after maize and rice) for young children in Mozambique.
- More than 6,000 farmers in Isingiro and 1,500 farmers in Bundibugyo in Uganda received bags of OSP vines and seeds for planting iron beans.
- We received additional funding from the United States Agency for International Development’s Feed the Future initiative to distribute OSP and iron bean. This funding will go to delivering OSP to at least 225,000 households over the next 5 years and will allow us to reach districts in other parts of the country.

**Elsewhere in Africa...**

The International Potato Center (CIP) is expanding cultivation of OSP to improve nutrition and lives in Mozambique, where OSP is being delivered to an additional 120,000 households. CIP and its partners have also started Sweetpotato Action for Security and Health in Africa (SASHA), a five-year initiative to directly improve the food security and livelihoods of at least 150,000 families in Sub-Saharan Africa and to develop effective delivery systems to reach many more. Given the widespread, informal farmer-to-farmer sharing of OSP vines for planting that was observed by the HarvestPlus OSP project, the number of total beneficiaries is likely to exceed 1 million families. It is expected that SASHA will lay the groundwork for improving the lives of 10 million Sub-Saharan households across 17 countries within a decade.
In many parts of east and central Africa, common beans are an essential part of life. Most Rwandan women and children eat beans every day, which contribute about a quarter of their daily energy intake. And almost all Rwandan farmers grow beans at some point during the year. HarvestPlus and its partners are increasing the iron content of bean in Rwanda and the Democratic Republic of Congo (DRC).

In 2011 four climber and bush bean varieties with higher iron were sold at subsidized prices to more than 15,000 farmers. It is expected that 90,000 household members will benefit from consuming these beans following harvest. In addition, five climber iron bean varieties—with even higher amounts of iron—were readied for official release in 2012.

Bean delivery in DRC follows a similar path as Rwanda, but there is no official release system. In 2011 we worked with the Institut National pour l’Etude et la Recherche Agronomique (INERA) and other local partners to distribute over 15,000 seeds packs of four iron-rich varieties. A second wave of iron bean with even higher levels of iron will be distributed in 2012.

A varietal adoption survey in Rwanda confirmed that informal networks, such as neighbors, extended family, and friends, are the most important sources of information about new bean varieties and that women play a significant role in producing beans, from choosing varieties to sowing, harvesting, and cooking. These findings are helping to define our delivery strategies.

Beans were also combined with the scaling-up of orange sweet potato in Uganda. See the sweet potato section on page 8 for more information.
**Plans for 2012**

- Conduct nutrition studies to measure iron retention in beans using traditional cooking methods and screen for iron deficiency among rural tea plantation workers.
- Submit five iron-rich varieties for official release.
- Conduct two studies to evaluate the bean value chain and consumer acceptance of iron bean.
- Conduct a survey among adopters of the higher-iron varieties to solicit their input on the performance and taste of the new varieties.

**Research Highlights**

- A nutrition survey in the Northern and Southern Provinces in Rwanda found that 31% of children under five and 12% of women are anemic. Women in the Southern Province were nearly two times more likely to be anemic compared to those living in the Northern Province. The daily average bean consumption was also assessed at 198 g/day for women and 107 g/day for children.
- An additional survey that screened iron levels among more than 1,000 public boarding school children and 200 university women found iron deficiency to be about 20% in these groups.
- Breeding in Rwanda: RAB evaluated several new climber, bush, and semi-climber lines with 94% of breeding target, which could provide 27% of daily iron needs for women and young children. Varieties with diverse grain colors and sizes that satisfy consumer preferences were identified for future release. X-ray fluorescence (XRF) technology is now being used to determine iron and zinc levels in Rwandan beans, allowing samples to be screened more quickly and cheaply.
- Breeding in DRC: Three INERA technicians were trained on bean sample collection and preparation and screening of iron and zinc content with XRF machines.

What is a varietal adoption study?

Varietal adoption studies collect data on:

- Popular varieties that farmers currently grow
- Farmers’ preferred production and consumption traits when selecting varieties
- Sources of information about new varieties
- Sources of seed (i.e., markets, recycled seed, neighbors, etc.)
- Gender roles in crop production
- Income contribution of crop
- Membership in farmers’ associations
- Frequency of crop consumption and preparation methods

These surveys allow delivery teams to make evidence-based decisions when designing promotion and marketing activities and are conducted in all target countries.
More than 50 million people in India eat pearl millet (bajra) every day. While pearl millet provides dietary iron, more than 50% of women in Maharashtra, where pearl millet is a staple food, still suffer from iron deficiency.

Scientists have bred a higher-iron version of a popular open-pollinated variety (see page 7 for more information on OPVs), ICTP-8203 Fe, that also has 15% higher yield. HarvestPlus’s partners Nirmal Seeds Company Pvt. Ltd. and the International Crops Research Institute for Semi-Arid Tropics tested several versions of the new ICTP-8203 Fe. Feedback from farmers who grew the higher-iron varieties in various locations was instrumental in selecting the best version to commercialize in 2012.

Nirmal has created interest in ICTP-8203 Fe through farmer demonstration days and by sharing information on the benefits of consuming iron pearl millet throughout Maharashtra. More than 3,000 farmers participated in the first mega-farm meeting held in Nandgaon, Maharashtra (see photo on right). HarvestPlus and Nirmal Seeds’ goal is to have at least 150,000 farmers growing ICTP-8203 Fe in 2012.
**Plans for 2012**

- Conduct a bioavailability study among women.
- Distribute results from a feeding trial to test pearl millet’s impact on iron status and physical activity among rural school children in Maharashtra.
- Commercialize iron pearl millet as truthfully labeled seed in the 2012 rainy season with the goal of reaching 150,000 farming households.
- Study how farmers evaluate the new biofortified variety and how nutrition information and branding affect consumer preferences for iron pearl millet.
- Solicit input among adopters of iron pearl millet on the performance and taste of the new variety.
- Develop marketing materials and branding for iron pearl millet seed.

**Research Highlights**

- Nutrition studies in three pearl millet-producing states in India supported previous assumptions that pearl millet is a major energy source for women and children and that both groups suffer from iron deficiency.
- In a bioavailability trial among children age 2–3 years, researchers found a significant difference in total iron absorption in favor of the higher-iron variety over control grain. Median iron absorption from the biofortified pearl millet matches the estimated daily physiologic requirement for iron for this age group.
- X-ray fluorescence (XRF) technology was used to identify zinc and iron levels in pearl millet grain. This technology, typically used in the mining industry, allows crop samples to be screened more effectively than with existing methods.
- 21 hybrids were selected for further evaluation in field trials in 2012.
- The Rajasthan varietal adoption survey shows that informal networks, such as neighbors, family, friends, or other farmers in cooperatives, are crucial sources of information influencing adoption of new pearl millet varieties, particularly hybrids. These networks are difficult and expensive to influence on a large scale.

**Working Paper #7: A Latent Class Approach to Investigating Farmer Demand for Biofortified Staple Food Crops in Developing Countries: The Case of High-Iron Pearl Millet in Maharashtra, India** presents the results from a study to determine farmers’ preferences for iron pearl millet. We will use the findings to develop strategies for disseminating and marketing the new variety.
Six hours travel from Dhaka, Dr. Alamgir Hossain supervises the testing of HarvestPlus varieties at a Bangladesh Rice Research Institute (BRRI) research station. As the temperature creeps past hot and into the range of sweltering, he compares varieties and their performance under different agronomic conditions in a vast test plot. His assistants collect detailed data on each variety, double-checking that the test plots match the varietal tags, as children enjoy mixing these up.

At the end of the season, they will harvest the grain and use the newly-arrived x-ray fluorescence (XRF) machine to screen varieties for zinc content, providing near immediate feedback on which varieties are best in terms of agronomic performance and zinc content. While the researchers have come from Dhaka, these crops have traveled even further. The International Rice Research Institute (IRRI), based in the Philippines, developed the advanced varieties that are currently being tested in Bangladesh.

In 2011 five lines developed by BRRI displayed close to 100% zinc target levels and were submitted to official registration trials for evaluation and distinctness, uniformity, and stability testing during the 2011/12 Boro (winter) season. HarvestPlus is at least one year away from the release and large-scale commercialization of high-zinc rice, but the expected impact is great—the varieties submitted for release can contribute almost 40% of a woman’s average daily zinc requirement.
**Plans for 2012**

- Conduct a bioavailability study using candidate zinc rice lines.
- Analyze zinc target calculations to take into account new recommended zinc requirements for women and children.
- Perform larger-scale genotype by environment testing through our expanding regional partnerships.

**Research Highlights**

- Breeding in Bangladesh: More than 4,400 F3 to F5 generation lines and a set of more than 230 elite lines were deployed to Bangladesh for testing under local conditions during the 2011 Aman (monsoon) season from July to November.
- Breeding in India: More than 3,000 F3 to F7 pedigree lines were planted at the Directorate of Rice Research (DRR) and by HarvestPlus, Hyderabad for seed increase and evaluation from December 2011 to April 2012.
- XRF machines are up and running at IRRI and BRRI, which will speed up the screening and breeding process.
- Researchers conducted a study on the effects of alternate wetting and drying (AWD) irrigation, a water-saving practice that is being promoted by the Government of Bangladesh, on rice zinc content. Because zinc is more bioavailable in aerobic soils, AWD can lead to increased grain zinc.
**Wheat**

- **Goal:** Provide 40% of daily zinc needs for women and young children. In 2011 varieties that could provide 38% of daily needs were in field trials.

- **Target Countries:** India, Pakistan

- **Deficiency Rates:** 44% of children under 5 in India and 37% in Pakistan are at risk of zinc deficiency.

- **Agronomic Traits:** High yielding, disease resistant

“But will farmers grow them?” is a common refrain heard when people first learn about biofortified crops. Although zinc wheat is not expected to be officially released until 2013, farmers in India are already growing it. The acceptability of biofortified varieties to the target farmers is ensured through a process called Participatory Varietal Selection, or PVS.

In HarvestPlus’s PVS testing, farmers in 10 locations, representing a range of growing conditions, grew promising varieties, collected data during their maturation, and provided feedback for the next round of PVS, which will double in size in 2012. These test plots give us on-the-ground information and also allow us to more accurately understand variation in zinc content under normal, on-farm conditions. PVS is considered such an important process that the data from two years of PVS trials, once published, can substitute for otherwise-required trials, to facilitate future release.

A dietary survey was conducted in Ludhiana district of Punjab in November and December 2011. During the survey, wheat and wheat flour samples were collected from 20% of the households and stored for further analysis of iron, zinc, and phytate content. Final results will be available in 2012 and promise to help us better understand the magnitude of zinc deficiency in rural Ludhiana, as well as how much wheat is eaten and in what forms by Indian households.
**Plans for 2012**

- Assess bioavailability and efficacy using high-zinc whole-wheat flour in northern India.
- Develop laboratory methods for more sensitive zinc biomarkers and transfer them to research institutions studying zinc nutrition.
- Perform second year of participatory varietal testing on candidate varieties in India for future release.
- Investigate use of hand-held XRFs to allow wheat to be screened for zinc content in the field.
- Submit at least three zinc varieties for the first official registration trial in Pakistan.

**Research Highlights**

- The 40 best high-zinc candidates were evaluated in the first HarvestPlus Yield Trial in 7 locations across South Asia. The four best lines were selected for further evaluation in PVS on-farm trials in India in 2011-12.
- A varietal adoption survey was completed in Punjab, Pakistan.
  Preliminary results found:
  - Social networks (family, friends, neighbors) are the main sources of information for most farmers.
  - One popular variety, Seher 06, is grown by two-thirds of sampled farmers. This is a relatively new variety that has become popular in a short time, suggesting that promising biofortified varieties have the potential to be adopted quickly by a large segment of farmers.
  - Most farmers (77%) used their seed from the previous year; for those who purchased new seed, input dealers were the most common source.
Radio in Africa is a lifeline for most people. Walk through any African village, and you'll hear a crackly voice blasting from windows, providing listeners with the latest weather report, a radio drama on the prevention of HIV, or news on crop conditions. In many cases, it is also one of the most trusted sources of agriculture and health information.

That is why HarvestPlus partnered with Agfax Radio and their team of African journalists to spread the word about nutrient-rich staple crops to farmers throughout rural Africa. Journalists examined the effect that nutrient-rich crops in Zambia, Nigeria, Uganda, and Rwanda can have on their local communities, both nutritionally and economically, with perspectives from scientists, NGOs, women’s groups, and farmers.

“I will also encourage my neighbors to grow biofortified beans, which will help to improve their health when they consume them.”

Agfax Radio’s story on iron-rich beans, for example, reached local farmers in remote areas of Rwanda with information about the agronomic and nutritional benefits of these new varieties. The story featured interviews with farmers who are currently growing iron-rich beans. One farmer, Celestine Nzabarirwa, told listeners, “Last season I grew biofortified beans and my production from my field was a lot compared to the local varieties that I had been using...I will also encourage my neighbors to grow biofortified beans, which will help to improve their health when they consume them.”

The series also shared the perspective of many of the organizations partnering with HarvestPlus to distribute biofortified crops in these countries. Mrs. Bolanle Adeyemo from SAWEC, an NGO working to empower women in Nigeria, shared her excitement about vitamin A-rich cassava in that country. “When I heard of vitamin A cassava, I was so excited, and I came on board...the major profit to me is to see that these children in the rural areas, the pregnant women, are well fed, and will produce a better population that can produce wealth for this nation.”
Global Spotlight Shines on Agriculture’s Role in Improving Nutrition and Health

In 2011 linking agriculture with nutrition and health rose to prominence. The momentum began with IFPRI’s 2020 Conference on Leveraging Agriculture for Improving Nutrition and Health held in February in New Delhi. International agencies, NGOs, and donor groups all pushed to break down silos and create partnerships to integrate agriculture into nutrition and health programs. Indian Prime Minister Manmohan Singh spoke about the benefits of biofortification. HarvestPlus director Howarth Bouis talked about the negative impact rising food prices have on dietary quality of the poor.

The topic of linking agriculture and health was also the focus of the High-Level Meeting on Nutrition held at the United Nations in September. This meeting emphasized the Scaling Up Nutrition (SUN) initiative that is working with 27 countries to improve nutrition in the critical first 1,000 days of a child’s life (from conception to 2 years). SUN lends support to agricultural interventions that can be used to improve nutrition. Dr. Bouis gave a presentation on the role the private sector can play in reaching millions of people with biofortified crops as part of this meeting.

In June the UK’s development arm, Department for International Development (DFID), co-convened a meeting of European stakeholders in Brussels to discuss biofortification and scaling-up of nutrient-rich crops. Participants were glad to hear that more evidence on the effectiveness of biofortification, including the cost-effectiveness of scaling-up, will be generated by HarvestPlus and its partners. The meeting resulted in a white paper to guide future discussions, including a recommendation to partner with key existing initiatives, such as SUN, the European Initiative for Agricultural Research for Development (EIARD), and the Comprehensive Africa Agriculture Development Program (CAADP), among others.

In response to these recommendations, Dr. Bouis visited Europe in the latter half of 2011, where he gave a presentation at the annual meeting of EIARD in France and met with the World Food Programme (WFP), International Fund for Agricultural Development (IFAD), and Food and Agriculture Organization (FAO) to discuss how biofortification could contribute to the development goals of these key UN agencies.

We will continue to build on this momentum and engage with more partners as we move forward with the release of nutrient-rich crops in target countries.
HarvestPlus supports country-led biofortification efforts in Brazil, China, and India. These countries have taken on ownership of developing biofortified crops and serve as models for other countries on how biofortified crops can be integrated into research and nutrition programs with the goal of improving health.

BRAZIL

BioFORT Brasil is coordinated through Embrapa (the Brazilian Agricultural Research Corporation). They are continuing their efforts to develop nutrient-rich varieties of eight different crops: rice, sweet potato, bean, cowpea, cassava, maize, wheat, and pumpkin. Biofortified varieties of several of these crops have already been released.

In addition, BioFORT established 20 demonstration plots in 2011 to distribute seeds and stems to small farmers. They also held 20 field days in several states and municipalities. BioFORT was approved to expand their reach into impact analysis, technology transfer, and nutritional impact assessment projects.

CHINA

In 2011 HarvestPlus China continued their efforts in breeding biofortified wheat, maize, and rice varieties. The vitamin A hybrid maize variety “YR506” was developed and performed well in multi-location trials. They observed a 10% yield increase compared to a control variety. At the HarvestPlus China biennial meeting in September, participants had the opportunity to visit vitamin A maize fields and see firsthand the orange maize cobs. A video of HarvestPlus China’s maize work can be viewed on the HarvestPlus website.

A wheat cultivar “Zhongmai 175” with high-yield and high-zinc was also released in five provinces after being approved by the Ministry of Agriculture. Following official release in 2010, a new rice variety “Zhongguangxiang 1” was planted on more than 6,500 hectares in Guangxi Province.

INDIA

HarvestPlus, the Indian Government’s Department of Biotechnology (DBT), and the Indian Council of Agricultural Research (ICAR) have joined efforts to achieve high-quality research and accelerate the development of biofortified varieties in India. This partnership will create synergy between the biofortification activities that these organizations are already undertaking.
In 2011 the group held a three-day meeting to mark the beginning of this multi-institutional effort, discuss the status of biofortified pearl millet, rice, wheat, sorghum, and maize in India, and set a course for future activities. Representatives from the major partners working on these crops were in attendance, illustrating that efforts to develop nutrient-rich crops are enhanced through collaboration.

Did you know that plants can be micronutrient deficient too? When plants lack zinc, for example, their productivity and nutrient content can also go down. The HarvestZinc Fertilizer Project uses agronomic biofortification to improve the micronutrient content of food crops. This approach combines both breeding and fertilizer application to increase the uptake of minerals like zinc in crops such as wheat and rice.

HarvestZinc conducted field experiments with wheat in seven countries and found that the amount of zinc in grain increased as much as two-fold when zinc fertilizers were applied to the plant’s leaves through foliar spraying but were less effective when applied to soil. Field trials also showed that the timing of foliar zinc application is a critical issue in maximizing the zinc content in the grain. Spraying the leaves after flowering, rather than before, resulted in greater increases in zinc content. So far, wheat is proving to be the most promising cereal crop for foliar zinc fertilization.

In 2011 HarvestZinc organized “Zinc Days” throughout Africa, Asia, and Latin America to spread the word about how fertilizers can further increase the zinc content in biofortified crops. The audiences were diverse—whether farmers in China, agronomists in Brazil, or students in Zambia—and all came away with a new appreciation for the role zinc fertilization can play in improving health, as well as contributing to crop vigor and farmers’ profits.
Financial Summary

2011 HarvestPlus Disbursements by Category (In thousand US dollars)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop Development</td>
<td>9,133</td>
</tr>
<tr>
<td>Human Nutrition</td>
<td>2,722</td>
</tr>
<tr>
<td>Impact &amp; Policy Analysis</td>
<td>1,212</td>
</tr>
<tr>
<td>Delivery</td>
<td>3,451</td>
</tr>
<tr>
<td>Communications &amp; Development</td>
<td>793</td>
</tr>
<tr>
<td>Administration</td>
<td>1,887</td>
</tr>
<tr>
<td>Country Program Support</td>
<td>519</td>
</tr>
</tbody>
</table>

Total Unrestricted: 19,727

Feed the Future Uganda: 100
GC9 Project: 1,581
HarvestZinc Project: 300
Other Restricted Projects: 119

Total Restricted: 2,100

Total Disbursements: 21,827
HarvestPlus Staff

Representing more than 20 countries, HarvestPlus staff bring many years of experience from both the public and private sectors to address the problem of hidden hunger. HarvestPlus staff are employed by the International Center for Tropical Agriculture (CIAT) in Colombia or the International Food Policy Research Institute (IFPRI) in Washington, DC. Many staff are posted in countries where we are releasing nutrient-rich staple crops. A complete list of staff with photos and biographies can be found on the HarvestPlus website at www.HarvestPlus.org.

Publications & Media

In 2011 HarvestPlus staff and collaborators published numerous peer-reviewed journal articles, book chapters, briefs, blog posts, and other materials. We also updated and expanded our brochures to reflect our transition from research to delivery.

HarvestPlus received extensive media coverage in 2011, including coverage in the Economist and Hindustan Times, as well as on Voice of America. We also grew our following substantially on Facebook and Twitter.

All HarvestPlus publications and media coverage can be found on the HarvestPlus website at www.HarvestPlus.org.

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CASSAVA
CGIAR Partners:
International Center for Tropical Agriculture (CIAT)
International Institute for Tropical Agriculture (IITA)
International Food Policy Research Institute (IFPRI)
International Potato Center (CIP)

Partners in DRC:
Association pour le Développement Endogène de Matadi (ADEM)
Centre de Développement Rural (CEDER)
Ferme de Sarah
LaYuca
Ministry of Health National Nutrition Department (PRONANUT)
National Institute for the Environment and Agricultural Research (INERA)
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SISI Trading
University of Kinshasa

Partners in Nigeria:
Cassava Growers Association of Nigeria
Development Dynamics
ENVOY Agricultural Services
Federal College of Agriculture - Akure
Forward Africa
Ministries of Agriculture, Education, and Health
Justice Development and Peace Commission (JDPC)
National Orientation Agency
National Root Crops Research Institute (NRCRI)
Niji Farms
Obafemi Awolowo University
Senator Adeyemo Women Empowerment Cooperative (SAWEC)
Women in Agriculture

Other Partners:
Brazilian Agricultural Research Corporation (Embrapa)
Delhi School of Economics
Greenwich University
SEED Solutions, SEED Infotech Ltd.

MAIZE
CGIAR Partners:
International Institute of Tropical Agriculture (IITA)
International Maize and Wheat Improvement Center (CIMMYT)

Partners in DRC:
Association des Cultivateurs et Éleveurs (AJCEDEKI)
Catholic Relief Service (CRS)
Centre d’Adaptation et de Production des Semences Améliorées (CAPSA)
Centre de Développement Rural de Rutshuru (CEDERU)
DIOBASS
GIZ
Ministry of Agriculture
Ministry of Health
Ministry of Health National Nutrition Department (PRONANUT)
National Institute for the Environment and Agricultural Research (INERA)
SARCAF
Syndicat pour la Défense des Intérêts des Paysans (SYDIP)
Université Evangélique en Afrique
University of Bukavu
University of Goma

Partners in Rwanda:
Développement Rural Durable (DRD)
Health and Development Initiative (HDI)
IMBARAGA Rwanda Farmer Federation
Kigali Institute of Science and Technology (KIST)
Ministry of Agriculture
Ministry of Education
Ministry of Health
National Laboratory
National University of Rwanda
Rwanda Agriculture Board (RAB)
Ugama
Win-Win Agrotech

Other Partners:
Cornell University
East and Central African Bean Research Network
Flinders University, Australia
Institut des Sciences Agronomiques Du Burundi (ISABU), Burundi
Kansas State University
Michigan State University
National Crops Resources Research Institute/ National Agricultural Research Organization (NaCRRI), Uganda - Bean Program

BEAN
CGIAR Partner:
International Center for Tropical Agriculture (CIAT)
International Food Policy Research Institute (IFPRI)

Partners in DRC:
Association des Cultivateurs et Éleveurs (AJCEDEKI)
Catholic Relief Service (CRS)
Centre d’Adaptation et de Production des Semences Améliorées (CAPSA)
Centre de Développement Rural de Rutshuru (CEDERU)
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Kansas State University
Michigan State University
National Crops Resources Research Institute/ National Agricultural Research Organization (NaCRRI), Uganda - Bean Program

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Indaba Agricultural Policy Research Institute (IAPRI)
Kamano Seed
Micronutrient Malnutrition Taskforce
National Food and Nutrition Commission
National Institute for Scientific and Industrial Research
Programme Against Malnutrition
SeedCo
Tropical Disease Research Center
University of Zambia
Zambia Agriculture Research Institute
Zambia Consumers Association
ZamSeed

Other Partners:
Iowa State University
Johns Hopkins Bloomberg School of Public Health
Michigan State University
Purdue University
SEED Solutions, SEED Infotech Ltd.
University of California-Davis
University of Wisconsin-Madison

ORANGE SWEET POTATO
CGIAR Partners:
International Food Policy Research Institute (IFPRI)
International Potato Center (CIP)

Partners in Uganda:
Africa 2000 Network
Caritas - Hoima Diocese
Community Enterprise Development Organization (CEDO)
Farming for Food and Development Eastern Uganda (FADEP-EU)
Makerere University
Millenium Village Project
National Crops Resources Research Institute/ National Agricultural Research Organization (NaCRRI) - Sweet Potato Program
Northern Rwenzori Rural Agricultural and Conservation Linkages
Samaritan’s Purse
Volunteer Efforts for Development Concerns (VEDCO)
World Food Program
World Vision Uganda

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University of California, Davis
Virginia Tech

HarvestPlus
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Oklahoma State University
Pan-Africa Bean Research Alliance (PABRA)
Penn State University
SEED Solutions, SEED Infotech Ltd.
Selian Agricultural Research Institute (SARI), Tanzania
Swiss Federal Institute of Technology (ETH-Zurich)
United States Department of Agriculture, Agricultural Research Service (USDA-ARS), North Atlantic
Waite Analytical Laboratory, Australia

PEARL MILLET

CGIAR Partner:
International Crops Research Institute for the Semi-Arid Tropics (CRISAT)
International Food Policy Research Institute (IFPRI)

Partners in India:
Ajeet Seeds Limited
All India Coordinated Pearl Millet Improvement Project (AICPMIP)
Bayer BioScience Pvt. Ltd.
Bioseed Research India Pvt Ltd
CCS Haryana Agricultural University-College of Home Science, Department of Food and Nutrition
Delhi School of Economics
Desert Medicine Research Center, Rajasthan
DevGen Seeds and Crop Tech Pvt. Ltd.
Dhule College of Agriculture
Ganga Kaveri Seeds Pvt. Ltd.
Haryana Agricultural University
Hytech Seed India Pvt. Ltd.
Institute of Development Studies, Jaipur
JK Agri Genetics Ltd.
J Nehru Medical College
Junagadh Agricultural University
Kaveri Seeds Co. Ltd.
Kesar Enterprises Ltd.
Maharashtra State Seeds Corporation
Mahatma Phule Krishi Vidyaapeeth
Metahelix Lifesciences Pvt. Ltd.
Ministries of Health and Agriculture
MS Baroda University, Gujarat
National Agricultural Research Project (NARP)
National Institute of Nutrition
Nirmal Seeds Pvt. Ltd.
Nuziveedu Seeds Pvt. Ltd.
Pioneer Overseas Corporation
Pearl Millet Hybrid Parents Research Consortium
SEED Solutions, SEED Infotech Ltd.
SNDT Women’s University, Maharashtra
St. Johns Medical Research Center
Swarni Keshwanand Rajasthan Agricultural University
Vibha Seeds Pvt Ltd

Other Partners:
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Flinders University
North Dakota State University
Oklahoma State University
Swiss Federal Institute of Technology (ETH-Zurich)
University of Colorado-Denver
United States Department of Agriculture, Agricultural Research Service (USDA-ARS), North Atlantic
Waite Analytical Laboratory

RICE

CGIAR Partner:
International Food Policy Research Institute (IFPRI)
International Rice Research Institute (IRRI)

Partners in Bangladesh:
Bangladesh Agricultural Development Council
Bangladesh Agricultural University
Bangladesh Rice Research Institute (BRRI)
BRAC
International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b)
Mymensingh University
University of Dhaka

Partners in India:
Bidhan Chandra Agricultural University
Biswa Agricultural University
Directorate of Rice Research-India
India Biofortification Program
Indian Council on Agricultural Research
Indira Gandhi Agricultural University
National Institute of Nutrition
Ministries of Agriculture, Health, and Education
Samridhi

Other Partners:
Children’s Hospital Oakland Research Institute-CHORI
Commonwealth Scientific and Industrial Research Organization
Flinders University
Harvard School of Public Health
University of California-Davis
Waite Analytical Services
Western Human Nutrition Research Center

WHEAT

CGIAR Partner:
International Food Policy Research Institute (IFPRI)
International Maize and Wheat Improvement Center (CIMMYT)

Partners in India:
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Directorate of Wheat Research-India
India Biofortification Program
Indian Agricultural Research Institute
Mahyco
Nuziveedu Seeds Pvt. Ltd.
Punjab Agricultural University
SEED Solutions, SEED Infotech Ltd

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Pakistan Flour Millers Association
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University of California-Davis
University of Colorado-Denver

HarvestPlus
HarvestPlus leads a global effort to breed and disseminate staple food crops that are rich in vitamins and minerals to improve nutrition and public health. We work with public and private sector partners in more than 40 countries. HarvestPlus is part of the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH). It is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI).