# Delivering Nutrients Widely through Biofortification: Building on Orange Sweet Potato | *Howdy Bouis and Yassir Islam*

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The biofortification strategy aims to reduce the prevalence of vitamin and mineral nutritional deficiencies that are widespread in low-income populations by developing nutrient-rich varieties of staple food crops that the poor consume habitually. Biofortification is potentially a cost-effective and sustainable means of delivering more micronutrients to the poor. Since biofortification aims to increase the daily micronutrient intakes from improved staple foods, two factors—scaling up (to reach larger populations) and sustainability (to ensure long-term public health benefits)—are integral to its success.

## Scaling up an innovation: Orange sweet potato

Orange sweet potato (OSP), rich in vitamin A, is the first biofortified crop to be released. OSP varieties that are suited to African tastes and environments have been developed and distributed in parts of Africa where prevalence of vitamin A deficiency is high and where white or yellow varieties—which provide little or no vitamin A—are traditionally consumed. Lessons learned from OSP delivery can be applied to the scaling up of other biofortified crops to ensure that target groups (primarily women and children) are consuming adequate amounts of biofortified crop foods to improve their nutritional status.

From 2007 to 2009, HarvestPlus and its partners distributed OSP to more than 24,000 households in Uganda and Mozambique as it scaled up pilot projects. In Mozambique its precursor was a program called Towards Sustainable Nutrition Improvement (TSNI). TSNI had 1,094 direct beneficiaries who received OSP, but the total cost per beneficiary was considered too high for the program to be sustainable. Lessons from TSNI were applied to a bridging project called Eat Orange that attempted to reduce costs per beneficiary while maintaining impact: adoption and consumption of OSP by farming communities. In Mozambique, HarvestPlus built on Eat Orange by horizontally scaling up its project to two more districts and increasing the number of beneficiaries to 10,800.

An operations research component was tasked with monitoring implementation activities, in part to draw lessons that could be applied to scaling up. A parallel impact evaluation team worked with the implementation team to carry out a prospective randomized control study—perhaps the first time this has been conducted on such a large scale with an agriculture-nutrition intervention. Despite differences between Uganda and Mozambique, in both countries the project led to increases in OSP adoption by farmers and consumption of OSP by households. As a result, vitamin A intake as much as doubled for both children and women.

## Lessons from the OSP experience

For biofortification to be a viable strategy, the cost of delivering nutrients through food crops must be lower than the cost of interventions, such as supplementation and fortification. Factors that could have reduced delivery costs without affecting impact were identified. For example, the educational component of the project could have focused on key messages directly related to OSP and eliminated modules on complementary nutrition or agronomic practices. Diffusion was identified as a viable mechanism for spreading the innovation and reducing costs. Once a critical core mass of OSP adopters and producers has been established in a region (at a relatively high cost per household), complementary activities encouraged diffusion of OSP at lower cost to neighboring villages, thus creating a group of secondary beneficiaries. Adoption was highest among households that previously had regularly consumed high amounts of white sweet potato.

In Mozambique, the lowest marginal and average costs per target beneficiary (children 6–59 months and mothers) were US$17 and $52, whereas in Uganda they were as low as US$10 and $26, respectively. Costs were lowest in Ugandan villages where the diffusion rate of OSP vines to nonproject households was highest: 1.4 households received vines through diffusion per project target household.

Disability-adjusted life years (DALYs) are a commonly used metric for measuring the cost-effectiveness of health interventions. In Uganda, preliminary calculations (after taking cost reduction factors into account) suggest that the intervention cost US$15 to $20 per DALY saved, which by World Bank standards is considered highly cost-effective.

No evidence has yet emerged that small-scale farmers chose to grow OSP due to the project's marketing efforts. A lack of evidence is not surprising, given the short two-year project duration, as developing markets and products usually takes longer. Since markets may be critical for sustainability, costs could be kept low during the initial phase of an OSP project by focusing on seed systems and demand creation, with marketing and product development introduced at a later stage.

Gender roles as they relate to household production, consumption, and marketing of biofortified foods must be understood and carefully leveraged. A key factor in the success of OSP was the critical role played by women, both as caregivers of young children and as producers and retailers of OSP. It is thus important to reach women with messages on better agricultural production techniques as well as nutrition education. At the same time, men control family resources in the project areas and are the key decisionmakers regarding allocation of land and crops, so their role must be also considered. The issue of gender also extends to other actors. For example, in Mozambique female nutrition extension workers were significantly more successful than their male counterparts in conveying messages to the nutrition volunteers in target communities.

Successful branding of biofortified crops and determining whether visible traits (such as color) impede or facilitate acceptance and diffusion is an area for further research. Contrary to a priori assumptions, building an "orange brand" around OSP (traditional sweet potato varieties are yellow or white) was effective in both countries. Other similar research has shown that Zambian consumers are undeterred by the orange color of vitamin A maize once the nutritional benefit linked to the color has been explained.

Biofortified crops with "invisible" nutrients that do not change color or taste, such as iron or zinc, will require a different marketing strategy. Combining high mineral and vitamin content with yield, other desired agronomic traits, and profitability will be crucial. Agronomic superiority can drive adoption of a nutrient-rich crop that is otherwise indistinguishable from the varieties that farmers already grow and consume. This strategy requires less investment in behavior change communication than do crops with visible traits, particularly if a high percentage of the total market can be captured by newly introduced higher-yield and higher-profit biofortified varieties. If this is not successful, the more costly alternative is to (i) insert high iron and zinc staple food varieties into public food distribution and income generation programs (for example, the World Food Program's Purchase for Progress) and/or (ii) brand and target these varieties to malnourished communities as a means for them to improve their nutrition.

## Conclusion: Truly getting to scale

Efforts are under way to scale up OSP to reach a million more households in sub-Saharan Africa over the next five years. Lessons from OSP may be most applicable to other crops with visible traits, such as "yellow" cassava and "orange" maize, both with enhanced vitamin A. But they should also be relevant to invisible-trait crops being developed. At this point one can only posit what some of the elements of such a delivery and scaling-up pathway might be.

The first level of scaling up requires that a critical mass of poor farmers adopt the biofortified crop and feed it to their families. Evidence generated at this level will help convince stakeholders that biofortification does have a public health impact. At this level informal diffusion is a pathway by which the food is introduced to others in the community. At the second level, markets for the biofortified crop need be developed to provide farmers with an outlet for marketable surplus, thus reaching nonfarming or rural households that are net buyers of food. This second level is driven by further expansion through diffusion and complementary activities, reaching out to medium-scale producers, and developing local markets and demand for products made from biofortified foods, still largely in rural areas. At the third level, the private sector becomes the main driver of the diffusion process. As sufficient surplus is generated to reach urban consumers, including the urban poor, value chains for biofortified crops can be developed to produce value-added tradable products in order to mainstream biofortification. However, the nutritional benefits of these foods must be assessed, as nutrients are lost during storage and processing.

Actors at many levels are needed to lead the scaling up of biofortification, once they are convinced by evidence from initial target countries that biofortification is a cost-effective, sustainable, and complementary strategy to improve nutrition for the poor. Investments must also be made in other arenas, such as better sanitation and education, to maximize the benefits of consuming biofortified foods. Improving nutrition—and health—must remain high on the agenda of the donor and policymaking communities, and the agriculture sector must assume more responsibility for improving nutrition. The global research communities should also make "better nutrition through food" a core component of their research and product development portfolios. Frameworks seeking to improve nutrition (for example, the UN's Scaling up Nutrition) or to improve regional planning (for example, the Comprehensive Africa Agriculture Development Program) can also do much to mainstream biofortification.

**For further reading:** H. E. Bouis and Y. Islam, "Biofortification: Leveraging Agriculture to Reduce Hidden Hunger," in Reshaping Agriculture for Nutrition and Health, ed. S. Fan and R. Pandya-Lorch (Washington, DC: IFPRI, 2012); H. E. Bouis, C. Hotz, B. McClafferty, J. V. Meenakshi, and W. H. Pfeiffer, "Biofortification: A New Tool to Reduce Micronutrient Malnutrition," Food & Nutrition Bulletin 32 (supplement 1): 31S–40S; HarvestPlus, Disseminating Orange-Fleshed Sweet Potato: Findings from a HarvestPlus Project in Mozambique and Uganda (Washington, DC: 2010).

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