



**HarvestPlus**



From 2007 to 2009,  
HarvestPlus disseminated  
**orange-fleshed sweet potato**  
to more than 24,000 households  
in Mozambique and Uganda  
to see if we could reduce  
vitamin A deficiency—through food.

**This is what we found.**

## **UGANDA COUNTRY REPORT**



## 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).

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### Partners

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International Food Policy Research Institute, USA

International Potato Center (CIP), Peru

Natural Resources Institute, University of Greenwich, United Kingdom

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## INTRODUCTION

This report summarizes the outcomes of a four-year research project (2006–2010) led by HarvestPlus. The Reaching End Users (REU) Orange-Fleshed Sweet Potato Project disseminated orange-fleshed sweet potato (OFSP) to smallholder farmers in Uganda and Mozambique to reduce vitamin A deficiency (VAD) among children and women of childbearing age. This report summarizes the findings from Uganda. Please also see the report “Disseminating Orange-Fleshed Sweet Potato: Findings from a HarvestPlus Project in Mozambique and Uganda” (2012) for a summary of findings and comparisons across the two countries.

### What is Hidden Hunger?

More than two billion people in the world suffer from micronutrient malnutrition, or hidden hunger, putting them at greater risk of disease and death (Allen et al. 2006). Women and children are the most vulnerable (Bhutta et al. 2008). Hidden hunger is a severe problem throughout Sub-Saharan Africa. The burden of micronutrient malnutrition among children under five (using zinc, iron, vitamin A, and iodine deficiencies as a measure) are highest in Sub-Saharan Africa compared with other regions (Caulfield et al. 2006). The prevalence of vitamin A deficiency in Africa is especially high. Thirty-two percent of the under-five population in Africa is estimated to be vitamin A deficient. This rate is almost as high as that for South and Southeast Asia, at 33 percent (UN SCN 2004).

### The Biofortification Approach

The main interventions for reducing hidden hunger have been supplementation and fortification. Although these interventions are effective, they are limited in reach, especially in rural areas where the majority of the poor live, and often expensive. A new approach called biofortification could fill this gap in coverage among rural populations. Biofortification is the process of breeding staple food crops that have higher micronutrient content. This strategy is particularly suited to rural populations that consume mostly staple foods from local or self-production.

### Using OFSP to Combat VAD

Sweet potato is widely consumed in Sub-Saharan Africa (Woolfe 1992).

Conventionally bred OFSP with vitamin A was the first biofortified crop released by HarvestPlus and its partners. These new varieties are orange in color, unlike the white or yellow varieties that are traditionally consumed in Africa. Plant breeders have produced several OFSP varieties with beta-carotene contents of 30–100 parts per million (ppm), compared with the 2 ppm in local varieties (the body converts beta-carotene to vitamin A). If OFSP was incorporated into diets in Sub-Saharan Africa, the prevalence of vitamin A deficiency could be significantly reduced (Meenakshi et al. 2010).

A study from South Africa showed that daily consumption of OFSP, which provided about 2.5 times the recommended daily allowance (RDA) of vitamin A for four- to eight-year-old children,

improved liver vitamin A stores (van Jaarsveld et al. 2005).

A consumer acceptance study of OFSP carried out in Uganda showed that consumers liked orange varieties and were willing to purchase them, when accompanied by an information campaign about their nutritive value, but also in the absence of one (Chowdhury et al. 2009). In almost all areas of Uganda, the yields of OFSP compared favorably with the yields of white sweet potato.

Increasing availability and consumption of beta-carotene-rich sweet potato is not a magic bullet for the African continent. It is intended as a complementary strategy to accompany existing nutrition interventions in areas where it can be grown. An ex ante study by HarvestPlus estimated that consumption of OFSP could eliminate between 38 and 64 percent of the disability-adjusted life years (DALYs) burden of vitamin A deficiency in Uganda (Meenakshi et al. 2010).

Uganda was a suitable model country to implement the REU project because sweet potato is a major staple, and about 45 percent of farmers grow it for both consumption and commercialization. Uganda has a population of 35.8 million and an annual population growth rate of 3.6 percent. Agricultural households represent the majority (82 percent) of households (Index Mundi 2011).

Results from the 2006 Uganda Demographic and Health Survey (UDHS) indicate that 38 percent of children are stunted (low height-for-age) and 16 percent are underweight (low weight-for-age) (UBOS and Macro International Inc. 2007). Micronutrient-related deficiencies in children are also quite prevalent with anemia as high as 70 percent, suggesting that iron deficiency is widespread (UBOS and Macro International Inc. 2007). About 20 percent of children in Uganda are estimated to be vitamin A deficient (Aguayo et al. 2005; UBOS and Macro International Inc. 2007). On the other hand, maternal malnutrition, in terms of low Body Mass Index (BMI), is quite low (10 percent), but micronutrient malnutrition in mothers is quite high. The 2006 UDHS found that 49 percent of women suffer from anemia, and 19 percent are vitamin A deficient.

The Government has attempted to address these high levels of micronutrient malnutrition by conducting iron and vitamin A supplementation for children 6–59 months and for women. Food-based approaches through diet diversification are also being promoted through nutrition education, particularly at health facilities during antenatal and post-natal visits. However, more initiatives are needed to tackle micronutrient deficiency in a sustainable way.

### Project Goals, Objectives, and Strategy

The goals of this project were to:

- disseminate OFSP in Uganda using an implementation strategy that included three integrated components: (1) seed systems and farmer extension; (2) markets and product development; and (3) demand creation through behavior change communication;

- examine whether such an integrated agriculture-nutrition-market intervention results in improved vitamin A intakes among young children and their mothers or female caregivers;
- analyze alternative dissemination strategies that combined the use of extension personnel linked to community-based promoters for their cost-effectiveness; and
- outline factors key to the success of not only this effort but similar endeavors in the future, including in seed systems, markets and product development, and demand creation.

Over the course of the project, 10,000 farming households in Uganda were targeted. After a one-year diagnostic study, project implementation was carried out over three seasons (two and a half years) in Uganda. By randomly selecting project and control villages and conducting pre-intervention baseline and post-intervention endline surveys, as well as other state-of-the-art methods, the project assessed OFSP adoption rates and whether adoption resulted in improved vitamin A intakes among young children and their mothers. The project also analyzed alternative dissemination strategies that combined the use of extension personnel linked to community-based promoters for their cost-effectiveness.

Running in parallel to the project, operational research studies were carried out mainly to monitor implementation and identify improved practices. In order to support these activities, three teams of staff were assembled: implementation, operations research, and impact evaluation.

The project had three primary components:

1. Develop an OFSP vine distribution system that included providing subsidized vines to households and providing agricultural extension services on OFSP production practices and marketing opportunities to men and women in farm households;
2. Provide nutritional information, in particular about vitamin A deficiency, to mothers in these same households; and
3. Develop markets for OFSP roots and processed products made from OFSP roots.

Components 1 and 2 were accomplished by using a pyramidal structure of paid extensionist trainers working for nongovernmental organizations (NGOs) and unpaid community volunteers called promoters who were trained by the extensionists. The promoters, in turn, instructed fellow members of community-based farmers' group organizations.

Because one key objective was to evaluate cost-effectiveness, the project developed and implemented two dissemination/extension models termed Model One and Model Two. Both models included all three components, but in Model One extension workers were expected to train and provide advice for two years, while in Model Two extension staff was present only for the first year. Both groups were exposed to information through mass media, community drama, and area-wide events such as

field event days and market promotion events. Model Two was less expensive to implement.

## Partners and Coordination

A number of partners and teams were required to achieve the project's goals. The project had a local "HarvestPlus" REU team (based in Uganda),

### Implementation

Implementation was carried out by NGOs that were responsible for disseminating OFSP in target communities. In Uganda, VEDCO (Volunteer Efforts for Development Concerns) and FADEP-EU (Farming for Food and Development Program – Eastern Uganda) were contracted to work in Mukono, Kamuli, and Bukedea Districts. NGO and extension staff were trained by Ugandan HarvestPlus specialists linked to the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). The project also worked with Namulonge Agricultural Research Institute from the National Agricultural Research Organisation (NARO) that was involved in sweet potato breeding and selection and vine multiplication.

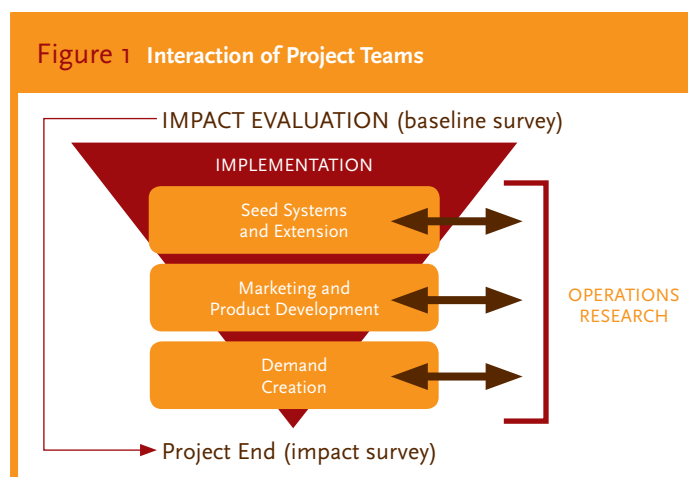
### Operations Research

An operations research team planned dissemination strategies, worked with the NGOs to modify specific implementation activities, and undertook background research during implementation in both countries. The International Potato Center (CIP) was responsible for vine systems and farm extension related to production of OFSP. HarvestPlus was responsible for demand creation and provision of nutritional information. The Natural Resources Institute, University of Greenwich was responsible for marketing and product development.

### Impact Evaluation

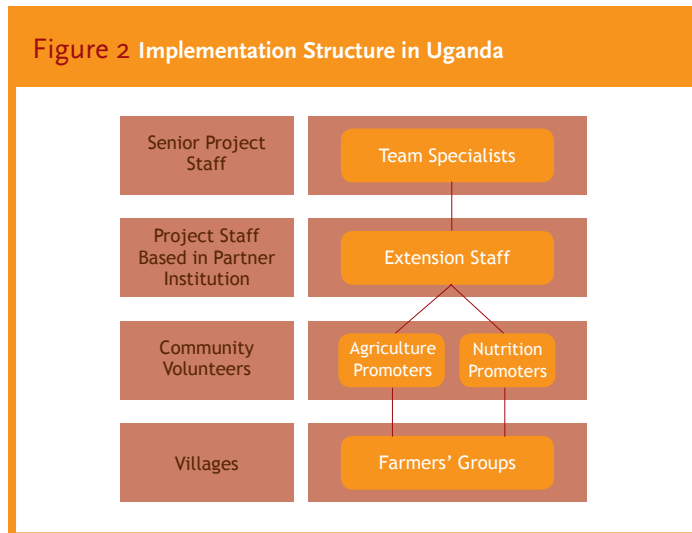
An impact evaluation team, led by the Poverty, Health, and Nutrition Division at the International Food Policy Research Institute (IFPRI), conducted baseline and endline surveys in Uganda in both participating and non-participating villages, which were randomly selected for participation. Figure 1 shows the interaction between the different project components.

Figure 1 Interaction of Project Teams



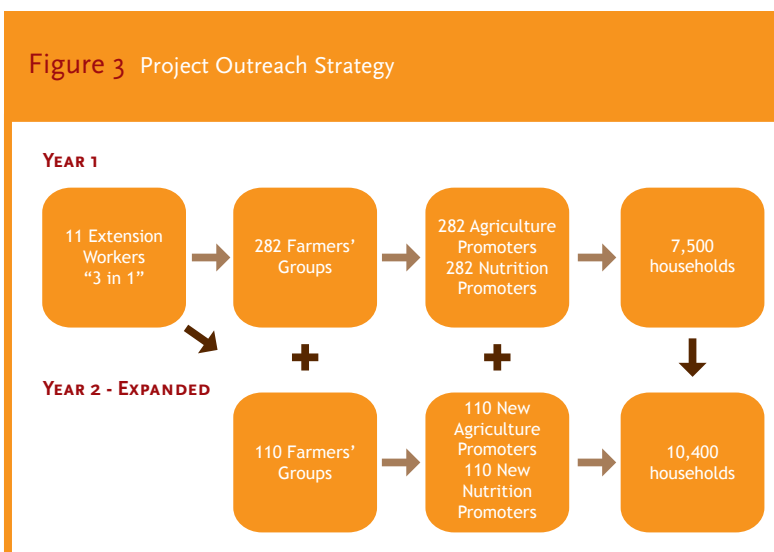
## PROJECT IMPLEMENTATION

Figure 2 illustrates the structure of the project with paid extension staff that were responsible for training the volunteer agriculture and nutrition promoters who in turn were responsible for training farmers' and mothers' groups in sweet potato agronomy and nutrition/child health.



The project outreach strategy is shown in Figure 3. Instead of forming new groups, which requires more resources, the project in Uganda targeted preexisting farmers' groups. The core team, in consultation with the extensionists in the implementing NGOs and selected farmers' groups, developed a set of criteria to guide the selection of promoters. Extensionists (11) oversaw a total of 20–25 promoters and were expected to take on responsibilities for training in all three components (agronomy, nutrition, and marketing)—3 in 1. Over the two years, 392 agriculture and nutrition promoters were trained in the three districts. The trainings were about the seed system, demand creation, and marketing product

**Figure 3 Project Outreach Strategy**



development components. Promoters were then responsible for training their respective farmers' groups, normally comprised of 25–30 members, in each of the three components over the course of the crop season. The modes of training included experience sharing, demonstrations, and field/home visits. Each year between 2007 and 2009, the number of farmers who benefited from training by the promoters reached 6,000 in average. The number of beneficiary caregivers at nutrition trainings was around 9,000. Regarding the training on marketing, the number of beneficiary farmers was around 4,000 and the number of traders around 30.

In Year 1, trainings were conducted on planting, quality OFSP production, and vine and fresh root conservation for both Model One and Model Two farmers' groups. Training topics followed the agricultural calendar. Refresher trainings were carried out in Year 2 (2007/2008) and 3 (2008/2009) for Model One farmers' groups only. Model Two farmers' groups did not receive any refresher trainings except the training on planting, which accompanied vine distribution and was considered by the project to be essential for all groups to ensure crop establishment.

### Site Selection

In order to maximize the impact, the project focused on specific sites where OFSP could be promoted. Potential production areas were assessed based on their high levels of vitamin A deficiency and importance of sweet potato in household diets and farming system. Other criteria were their proximity and potential to supply to prospective sweet potato markets. After consideration, it was decided to implement in three project areas: the districts of Mukono, Kamuli, and Bukedea (Figure 4).

The selection of suitable sites within each district was carried out with the objective of getting implementation sites that also fitted the requirements for an impact assessment baseline study. The criteria for suitable sites included:

- A history of no or negligible OFSP intervention;
- A suitable production environment for sweet potatoes including low lying areas for preservation of planting materials during the dry season;
- Existence of farmers' groups where the majority of households have children under five; and
- Willingness to participate in all the targeted interventions.

Local authorities were approached before the start of implementation to solicit their support and cooperation. Officials at both district and sub-county levels were sensitized regarding the project. They indicated interest and promised support of implementation activities.

## Seed Systems

### Selection of Varieties

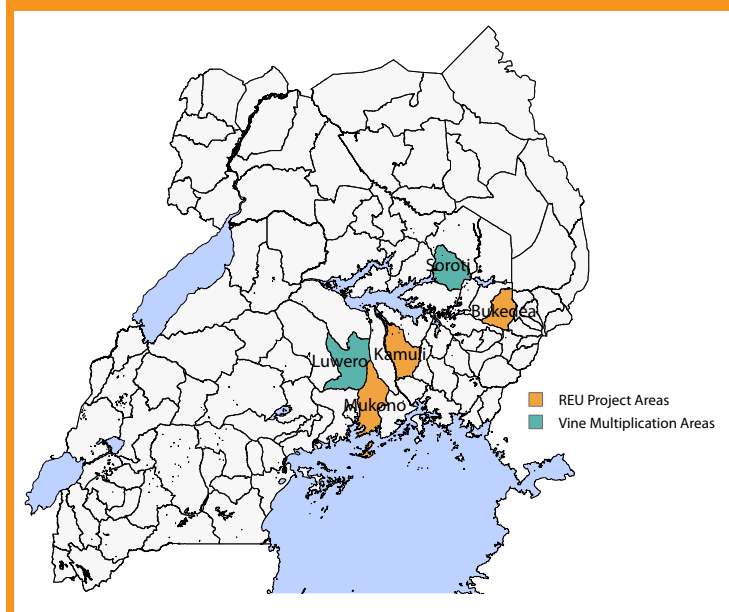
The operations research teams, in collaboration with the sweet potato breeder from NARO, promoted four locally grown OFSP varieties. In addition to the two dominant OFSP varieties in current use, Ejumula and Kakamega (SPK004), two new and improved OFSP varieties bred by the national program, NASPOT 9-O (VITA, SPK004/6) and NASPOT 10-O (Kabode, SPK004/6/6), were added (Mwanga et al. 2009). Varieties for inclusion in the project were selected on the basis of their high beta-carotene contents, adequate dry matter contents, and yield performance (Table 1).

Because of its high virus susceptibility, and hence lower than average yields, Ejumula was especially promoted in areas with low virus pressure. Kakamega has the same dry matter content and is higher yielding and more drought and virus resistant than Ejumula but has lower beta-carotene content. This means the use of Kakamega is appropriate for boiling and eating but not for processing into dried chips. The two newly launched varieties (Vita and Kabode) had high yield, acceptable dry matter content, and high beta-carotene content.

### Seed Multiplication, Distribution, and Planting

To ensure a continuous supply of healthy planting materials for implementation, the project set up a three-level multiplication system. Clean starter materials were produced at the Namulonge Agricultural Research Institute, NARO, which had the capacity to provide materials that are largely free of pests and diseases (primary multiplication). The second level involved using selected farmers' groups to bulk up materials received from the primary site. The project recognized the need to multiply a very large quantity of planting materials in order to reach all project households. As such, the vine multiplication strategy incorporated this second level of multipliers working in the central region (Luwero) with two farmers' groups and in the eastern region through the Soroti Sweet Potato Producers and Processors Association (SOSPPA). A tertiary level of multiplication centers was also identified to work with farmers in project areas with sufficient lowlands to enable their participation as vine multipliers. A total of 90 individuals in Bukedea and 30 each in Kamuli and Mukono were selected for this purpose and trained. Vine multiplication at this level was carried out using conventional, rather than rapid techniques, as farmers wanted to be ensured a

Figure 4 Map of Uganda Showing REU Districts



supply of roots in the event that no market was found for the vines. The strategy with the tertiary multipliers had less to do with commercial sales and more to do with ensuring ample vine supply at the community level.

### OFSP Vines Distribution

In 2007, 10,089 bags (of 30kg each) were supplied to partner organizations for the two seasons of 2007. In addition, 5,839 bags were distributed to target beneficiary farmers' groups in Kamuli, Mukono, and Bukedea (7,526 households).

In 2008, 3,161 bags were distributed to target beneficiary farmers' groups in Kamuli, Mukono, and Bukedea (3,205 households). The project distributed vines to the 110 new farmers' groups (2,863 households), in Bukedea in August and September and in Kamuli and Mukono in September and October. The new farmers all planted successfully and harvested on the same timetable as the farmers in the non-participating farmers' groups.

Each planting season (twice a year in 2008 and 2009), farmers used their conserved vines to plant at the beginning of the following agricultural season.

Table 1 Varieties Selected for Distribution in Uganda

Variety	Popular Name	Mean Yield (tons/acre)	Dry Matter	µg BC*/100 g fresh weight	µg all-trans BC*/g fresh weight	µg all-trans-BC*/g dry matter
SPK 004	Kakamega	9.5	35.0	4071	41	116.3
Ejumula	Ejumula	6.0	34.6	9062	91	261.9
NASPOT 9-O	VITA	10.4	30.7	9655	97	314.5
NASPOT 10-O	Kabode	8.5	30.3	7460	75	246.2

\*BC: Beta-carotene



In Bukedea, farmers knew how to conserve OFSP vines (in swampy lowlands) in the manner favored by the project. In Kamuli, OFSP yields were adversely affected by an infestation of mole rats. Fortunately, farmers were successful in finding a fumigant that was effective in eliminating most of the rats.

In 2009, control households (932) were given four varieties (Ejumula, Kakamega, Vita, and Kabode) after the project ended.

### Demand Creation

The main objective of the demand creation component was to promote the production and consumption of OFSP through nutrition education as well as through additional forms of communication targeting mothers, the wider community, consumers, and policymakers. In order to influence people's behavior, available and affordable channels of communication were selected for the delivery of messages, and training material was developed.

The various activities were conducted at different levels in the community, targeting different segments of the population. At the farmers' group level, the project worked with caregivers to encourage the OFSP consumption through nutrition education and cooking demonstrations. At the parish level, drama groups were used to re-enforce key messages in the various communities. At the sub-county level, field days were held to inform stakeholders, local leaders, and communities about the production of OFSP, its nutritional advantage, and products that can be made out of it.

Radio spots and programs were developed later on in the project after sweet potatoes were harvested and already in the market. This was because radio reaches such a large, widespread audience, and so radio promotions had to wait until the sweet potatoes were available in the communities. The radio programs developed were mainly talk shows, which were

divided into two parts, a presentation and questions and answers after the presentations. Most shows lasted 30 minutes. During talk shows, extension workers and promoters discussed their experiences growing, consuming, and marketing OFSP, and listeners called in with their questions.

Radio spots were aired two or three times a day for a month during specific periods and were timed to match the season or activities in the field. Planting messages were aired during the planting season and marketing during the harvest season, while nutrition messages were integrated with other topics. The media survey reported over 80 percent of the beneficiaries having heard messages on OFSP on the radio. These included messages on the importance of vitamin A and an encouragement to grow OFSP.

Community theater was also used to reinforce messages from the trainings and address barriers to behavior change in the community, as well as at the sub-county and parish levels. It gave the project an opportunity to pass on the various messages in an entertaining manner. Three drama scripts were developed, reviewed, and translated that focused on encouraging communities to grow and eat OFSP, as well as educating about the importance of vitamin A.

Pertinent nutrition messages were also incorporated in the songs, which were composed by the drama groups and were part of the drama presentations and dances.

Promotional materials developed for the project included logos, t-shirts, brochures, calendars, and wall murals. Development of the logo was done through a consultative process with the team in Kampala and other partners involved in promoting the OFSP. It was translated into the local language and used on t-shirts and other promotional materials. The promotional materials helped carry the message beyond the boundaries of the project areas.





## Marketing and Product Development

The project analyzed the existing market chains for white and yellow sweet potato in an attempt to understand the path that this crop takes from producer to consumer. Different market chains were identified in various geographic areas (i.e., from farmer to retailer to consumer or from farmer to broker to wholesaler to retailer to consumer). Concretely, the different marketing activities included:

- The development of “market link farmers” who were selected to look for markets for OFSP by linking with traders and schools and to provide market information to their fellow farmers. These were commercially minded, dynamic, and trusted individuals who served as liaisons between the farmers’ groups and the buyers.
- The development of a trader database, which consisted of the contact details of brokers, wholesalers, retailers, processors, and institution buyers. The trader database was given to the market link farmers so that they could contact traders in different markets.
- Exchange visits organized to facilitate market linkages between farmers and traders. Traders linked to farmers were instrumental in promoting OFSP to consumers.
- The engagement of commercial farmers involved in commercial production on various crops for domestic and export markets.

Connecting the various participants in the OFSP marketing chain was a key component of the overall strategy. A market link farmer from Luwero managed a kiosk at the Matugga trading centre made by the project to promote OFSP roots, vines, and products. In some markets, existing kiosks of retailers who were selling OFSP were painted orange to promote OFSP selling points. Other promotional materials were produced to create a reminder to consumers about OFSP. Promotional materials (i.e., boards, aprons, signposts) were produced for traders.

A training manual was designed to train market traders since they were buyers of the project farmers’ OFSP. Training of sweet potato traders was conducted to strengthen the farmer-trader linkages and reached an average of 20 traders per location. There were 24 different locations where training took place in the Mukono, Kamuli/Jinja, Bukeda/Mbale, and Kampala markets.

The project's operations research (OR) team discovered that processing OFSP, whether drying, crushing, or storing, led to substantial reduction of beta-carotene. As a result the project focused on promoting the production of processed foods from raw, boiled, or steamed OFSP roots. Extensionists, promoters, and farmers were taught recipes for different products, including doughnuts (*mandazi*),

pancakes (*kabalagala*), juice, sauce, cakes, porridge, chapatti, and crackers. Many farmers, especially the women, took up the business of making products using OFSP and sold to schools, in trading centers, and at exhibitions.



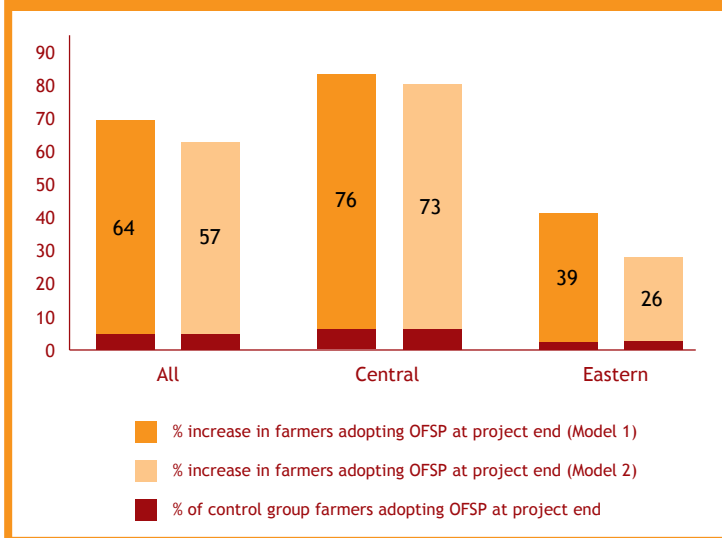
## KEY FINDINGS

### OFSP Adoption

The REU project successfully promoted OFSP in Uganda. It led to a 57–64 percentage point increase in the probability of OFSP adoption in Uganda (Figure 5). There were no significant differences in these estimates across Model One and Model Two.

The degree of success of OFSP adoption depended on underlying contextual factors. For example, impact on adoption was much lower in Uganda's Bukedea district, where sweet potato is not a major dietary staple, than in Mukono and Kamuli districts.

Figure 5 Impact on OFSP Adoption Rate in 2009, Uganda



### Yields

As shown in Table 2, the yields of OFSP compared favorably with the yields of white sweet potato in Uganda.

Table 2 Average Yields of Disseminated OFSP Varieties, Compared with Local Varieties, by District in Uganda (metric tons/acre)

	Kamuli	Bukedea	Mukono
Ejumula	2.0	3.0	2.8
Kabode	4.0	4.8	2.9
Kakamega	2.9	4.3	2.3
Vita	3.2	4.6	2.7
Local (non OFSP)	3.3	2.5	2.5

### OFSP Share

Adoption of OFSP resulted in substantial substitution of OFSP for other sweet potato varieties in terms of area under cultivation. As shown in Figure 6, the project increased the share of OFSP in total sweet potato area by 41–46 percentage points in Uganda (from a base of 0 percent). There were no differences between the two intervention strategies (Model 1 and Model 2).

### OFSP Intakes

The REU project resulted in a significant increase in the intake of OFSP among children and women in Uganda. Results from the follow-up survey at project end assessed total sweet potato intake and proportion of sweet potato consumed as orange, yellow, and white varieties; data are shown in Figure 7 for children 6–35 months and women.

The intake of OFSP in the intervention groups was more than 35 and 115 grams/day among children 6–35 months and women, respectively. There were no differences between the two intervention strategies (Model One and Model Two). This amount of OFSP represented from 30 to more than 50% of all sweet potato consumed by these age groups.

### Vitamin A Intakes and Dietary Sources

Compared to intakes at baseline, vitamin A intake in the intervention groups increased by two-thirds for younger and older children and nearly doubled for women (Figure 8). For the age group of greatest concern, children 6–35 months, OFSP contributed 52 percent of the total vitamin A intake in Uganda.

To put into context the impact of the REU intervention on vitamin A intakes, change in the proportion of children and women not likely to meet their daily requirement for vitamin A from the diet was also assessed, as shown in Figure 9. Results indicate that for the smaller group of young children that were no longer breastfeeding (12–35 months), the proportion with inadequate vitamin A intakes dropped from nearly half at baseline to around 10% at project end, while in women this dropped from about one-third to 10–15 percent. The impact was similar between Model 1 and Model 2 groups. We did not, however, see a significant impact among the group of children 5–7 years (not shown).

The OFSP and vitamin A intakes were recorded during the main postharvest periods. Home production of OFSP could be expected to provide these levels of intakes for four to five months a year in Uganda. However, piecemeal harvesting (sweet potato left in the field and harvested as needed for meals) extends consumption up to nine months in Uganda, on average.

Figure 6 Impact on Proportion of OFSP in Sweet Potato Area, 2006–2009, Uganda

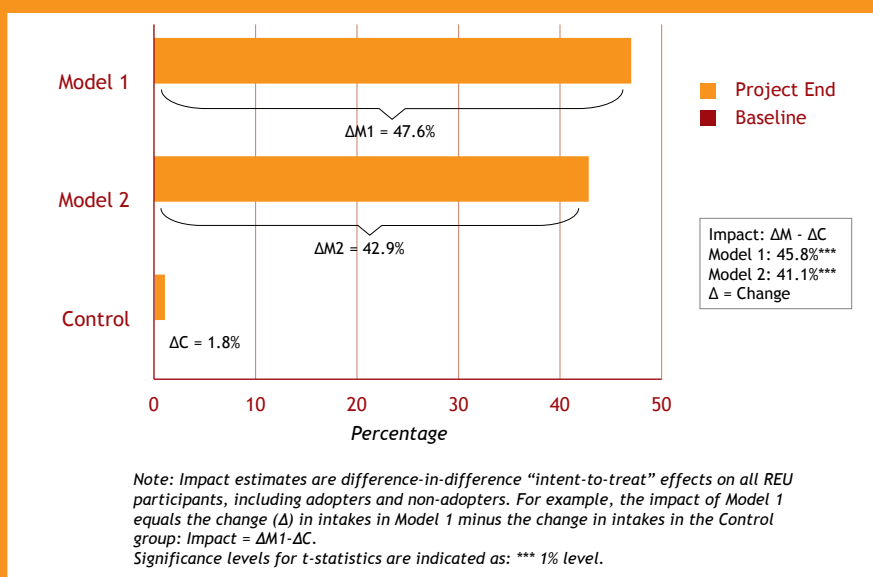
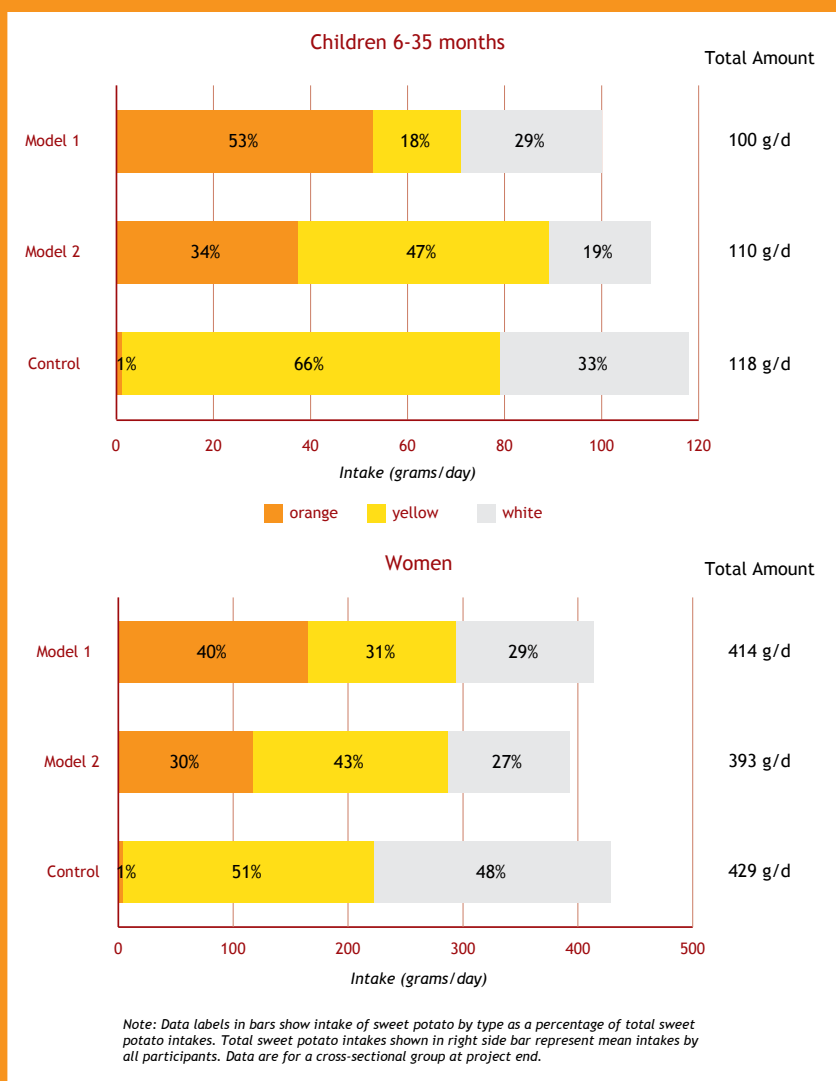
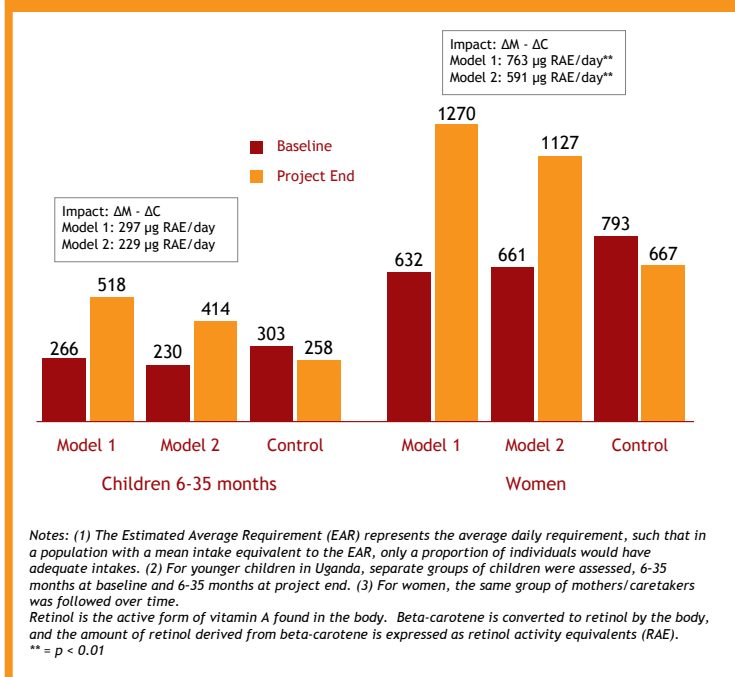


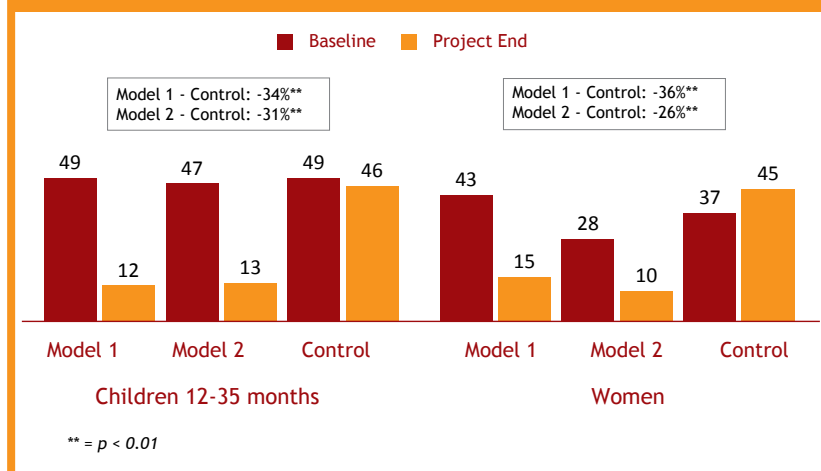
Figure 7 Sweet Potato Intakes of Children 6–35 Months and Women, Uganda



**Figure 8** Impact of REU Intervention on Mean Vitamin A Intakes ( $\mu\text{g}$  Retinol Activity Equivalents (RAE) /day), Uganda



**Figure 9** Impact on Proportion of Children 12–35 Months and Women with Inadequate Vitamin A Intakes, Uganda



### Vitamin A Status

The REU intervention had a small impact on the adequacy of vitamin A in the body (estimated from amounts in the blood) among children 5–7 years that had lower levels of vitamin A in the body at baseline. The proportion of women with vitamin A deficiency was found to be very low in this population, even at baseline, and any further improvement in vitamin A levels could not be observed. At project end, however, more vitamin A obtained from eating OFSP was associated with higher amounts of vitamin A in the blood in children and a lower likelihood of having marginal vitamin A deficiency in women. Vitamin A

stores in the body were not measured in the young children 6–35 months because of many design challenges that would have been necessary for this age group.

### Lessons Learned

During the project, several lessons were learned regarding the different components of the project.

#### Seed Systems

- Selecting the appropriate varieties with desired agricultural traits is the top priority in any sweet potato project.
- Having a well-organized system for vine multiplication (i.e., free-disease planting material, access to irrigation), transport, and delivery is critical. In Mozambique, for example, using trained decentralized vine multipliers (DVMs) and a voucher system for accessing planting material emerged as a success.
- Seed system design is driven by agroecological conditions. In Uganda, the single-shot delivery system was effective in areas that had two growing seasons a year or where farmers had considerable experience conserving vines during a more extended dry season. Also, two of the four varieties being distributed had high tolerance against viruses and thus were likely to maintain their high-yielding ability for a number of years.
- Commercially oriented vine multiplication schemes are preferable because the profits they generate make them more sustainable. Selling vines was a good strategy to increase incentive and promote a sustainable system.

#### Extension

- The project chose to work with pre-existing groups for trainings, which had its advantages and disadvantages. Working with pre-existing farmers' groups in Uganda as an entry point was more effective than working with church groups as was done in Mozambique.
- The frequency, content, and type of trainings, as well as their relevance, are very important in influencing knowledge retention.
- Transmitted messages should be clear, straightforward, and communicated in a simple manner. Extension staff should be trained in adult education accordingly.
- All the members of an implementation team should engage in an informative monitoring and evaluation system, which implies that they should have good skills in recording data, managing data, and reporting progress on project implementation.

#### Demand Creation

- To have an impact on child health, it was not

enough to focus solely on the production and consumption of OFSP. Implementers found that mothers needed information on child health and nutrition, in general, as well as hygiene and sanitation.

- The most effective, most preferred, and most trusted source of information among farmers is the direct contact between project extension workers, promoters, and mothers.
- Drama is an effective communication tool for getting messages to a broader community. It is important, however, to monitor messages so that they are accurate and consistent.
- Radio is an important source of information. Uganda has high radio coverage and listenership, but because of the large number of radio stations, there is some audience fragmentation.
- In order to have significant impact, it was critical that the unit of intervention was the household rather than just men or women because culturally defined gender roles clearly indicate that mothers bear responsibility for childcare and feeding, but fathers play a key role in providing resources.

#### *Market and Product Development*

- More OFSP tended to be sold where there were existing marketing channels for consumers and traders since OFSP could be easily substituted for other varieties of sweet potato.
- A marketing approach for OFSP is more likely to be sustainable if many market actors are involved. The project could have saved costs in Uganda by making the marketing training messages simpler and more visual and by providing training only to groups who were keen to sell OFSP.
- Key drivers of adoption were availability of OFSP in the market and consumer awareness of the health benefits of consumption. One of the key challenges in market development for OFSP was availability since quantities were not very high.
- Conducting a consumer acceptability study of OFSP as a new product was essential to the project success.
- OFSP chips should not be stored for months because they lose their vitamin A content.

#### *Project Management*

- Diagnostic research was a key element for the success of the project. The suggested duration of diagnostic phase is one year.
- The advantage of contracting work out to local NGOs is that they usually are already established in the implementation districts, or they have procedures for opening up

new work quickly. It is possible that using the government extension system could have generated a cost savings, but the project's effectiveness and efficiency would have been compromised. The disadvantage of contracting out to NGOs is that this approach introduces an extra layer of management between the core technical team and the field teams, requiring the core team to relinquish a certain level of control over implementation.

- Project designers should think about exit strategies as early as inception. They should consider how each of the activities conducted and structures established can continue after the project closes so that the beneficiaries are able to continue on their own. Emphasis should be put on components that can continue after the intervention ends.

#### *Gender*

- Designing the project intervention with a gender perspective from the beginning is crucial since the role women played not only as caregivers of young children but as producers and retailers was critical to the success of OFSP dissemination.
- Our data show that a higher percentage of nutrition promoters were women (75%), and this was preferred because many of the activities they were involved in were typically "women's activities," such as cooking demonstrations and child feeding practices. Sixty percent of farmers' group members in Uganda were women, and they played a vital role in crop diffusion; 75 percent of people who were given vines through diffusion were women.
- It is important to reach women with materials and messages on agricultural production, as well as on practices to improve nutrition in the household. At the same time, men control family resources and are key decisionmakers regarding allocation of land and crops, so their role cannot be ignored.

## Reducing Costs

To be viable, the cost of delivering vitamin A through biofortified foods must be lower than the cost of other interventions. Because there were no significant differences in impact between the two models in either country, the less-intensive Model Two would be cheaper to implement (by about 30 percent).

In villages in the central district of Uganda where sweet potato was a major staple in diets before the project and where adoption rates were high, the equivalent marginal and average costs were US\$22 and US\$56 (Table 3).

**Table 3** Average and Marginal Costs per Target Beneficiary and Savings Estimate (US\$)

Type of cost	Actual cost	Reduced cost	Savings
Marginal	22	10	12
Average	56	26	30

Average costs include the fixed costs of overall management of implementation. Marginal costs represent the additional cost of increasing the number of extensionists and target households under the overall management structure of the present size. Cost savings are estimated from (i) reducing the number extensionists/promoters, (ii) eliminating the market component of the project, and (iii) factoring in the number of non-target households who received vines from target households (an estimate of diffusion).

These costs could have been reduced through the following modifications:

1. The project could have improved knowledge retention by focusing on a few key messages directly related to how OFSP can alleviate vitamin A deficiency and eliminating modules on other nutrition practices and agronomic practices. The number of modules per topic could also have been better aligned with the agricultural calendar, reducing the number of extensionists and promoters needed.
2. Farmers reported selling OFSP at the same rate as other types of sweet potato, but we found no evidence that small-scale farmers chose to grow OFSP due to the project's marketing efforts. However, given the relatively short two-year duration of the project, this finding might not be surprising, as developing markets and products usually takes longer. Since markets may be critical for long-term sustainability of OFSP adoption and production, costs could be kept low during the initial phase of an OFSP project by focusing on seed systems, extension, and demand creation and introducing a marketing and product development component at a later stage.
3. Once a critical core mass of OFSP adopters and vine producers has been established in a region (at a relatively high cost per household), it should be possible to implement extension activities in neighboring villages to encourage more rapid diffusion at lower costs. During this project,

diffusion was actively discouraged because of research concerns about not contaminating control households. Encouraging diffusion as an integral part of the dissemination strategy and accounting for indirect beneficiaries through the sharing of vines (diffusion) can significantly reduce dissemination costs by creating a group of secondary beneficiaries.

Because this was a research project, it imposed additional demands on NGO supervisors. For example, intervention villages had to be located at some distance from each other, which increased travel time. In a non-research context, managerial capacity could be freed up to operate at a larger scale, which is why it is important to cite marginal costs (the cost of adding an additional beneficiary) in Table 3.

Ultimately, these costs must be considered in terms of the benefits provided. A commonly used metric of benefits is disability-adjusted life years (DALYs) saved. The approximate calculations given here, which use mean values rather than the distribution of intakes, show that the intervention cost about US\$15–20 per DALY saved (US\$18–24 per DALY saved without the cost savings cited). This cost puts the project in the “highly cost-effective” category of interventions as described by international agencies such as the World Health Organization.

## Scaling Up: The Way Forward

Although this pilot project was implemented in small, focused areas, scaling up at the country level is feasible if costs per beneficiary are kept as low as possible. Support from national policymakers and stakeholders are required for a larger-scale project to be sustainable. The following points should also be considered:

1. In regions identified for scaling up, OFSP yields or profitability should be equal to or greater than that of white sweet potato. Sweet potato should also be an important staple in diets of target households; if it is a secondary staple, at least 50 percent of households should be producing sweet potato.
2. Farmers should be trained in viable methods for vine conservation, especially when OFSP can be grown for only one season a year. A minimum amount of subsidized vines (say, 5 kilograms) should be distributed to target households to enable timely planting.
3. Nutrition messages should focus on how OFSP reduces risk of vitamin A deficiency. It is also critical to convey both nutrition and agronomic messages to women. Building an “orange brand” to raise awareness of vitamin A and OFSP as part of a marketing campaign is also very effective.
4. Once OFSP has been adopted by a critical mass of core households and a base of community knowledge on OFSP has been developed, complementary activities that encourage diffusion to other non-adopting households should be undertaken. Developing markets for OFSP and other related food products will also encourage diffusion and adoption in the long term.



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