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CHAPTER 7

SWEET POTATO DEVELOPMENT AND DELIVERY IN SUB-SAHARAN AFRICA

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ABSTRACT

In sub-Saharan Africa, more than 40% of children under five years of age suffer from vitamin A deficiency. Among several interventions in place to address vitamin A deficiency is biofortification, breeding vitamin A into key staple crops. Staple crops biofortified with beta-carotene, the precursor to vitamin A, are orange in color. Given the natural occurrence of high levels of beta-carotene in many sweet potato varieties, breeding progress for biofortified orange sweet potato (OSP) has been much faster than for the other vitamin A enhanced staples. Nearly 3 million households have been reached with OSP. This paper reviews key factors influencing the uptake of OSP, the breeding investment, five key delivery approaches that have been tested in the region and efforts to broaden government and other stakeholder engagement.

Key words: Biofortification, Vitamin A, Orange Sweet Potato, Sweetpotato, Micronutrient Deficiency

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BACKGROUND

Overview

More than two billion people globally suffer from hidden hunger, which leads to negative health consequences, such as poor physical, mental, and cognitive development [1]. Undernutrition is a cause of 3.1 million child deaths annually, almost a third attributable to micronutrient deficiencies [2]. Vitamin A deficiency (VAD) adversely affects child health and survival by weakening the immune system even at sub-clinical levels, and more than 350,000 children become blind each year due to VAD [2]. Globally, 190 million preschool children and 19 million pregnant women are affected by vitamin A deficiency [3]. In sub-Saharan Africa (SSA), more than 40% of children under five suffer from VAD [4].

There are several interventions in place to tackle VAD: 1) providing young children (six to 60 months) with twice-yearly vitamin A supplements; 2) fortifying commonly eaten foods with vitamin A (for example, vegetable oil and sugar) [5]; and 3) breeding vitamin A into key staple crops (sweet potato, maize and cassava). The latter, known as biofortification, incurs an upfront cost in breeding but not the recurrent costs of the two other interventions [6]. Staple crops biofortified with beta-carotene, the precursor to vitamin A, are orange in color. Given the natural occurrence of high levels of beta-carotene in many sweet potato varieties, breeding progress for biofortified orange sweet potato (OSP) has been much faster than for the other vitamin A-enhanced staple crops.

Figure 7.1 shows the timeline for development and promotion of OSP in SSA. Efforts focused heavily in SSA, where high levels of VAD coupled with the widespread production and consumption of sweet potato. The dominant sweet potato varieties in SSA are white- or yellow-fleshed containing no or low levels of beta-carotene, respectively. Initial work began in the 1990s, when support for agriculture was falling, so initial efforts to improve child nutrition relied on selection of "best-bet" varieties often bred in other parts of the world. The period 2001-2009 produced the first strong evidence that an integrated agriculture-nutrition approach using OSP as a key entry point to introduce improved child feeding practices could impact vitamin A intakes and status [7, 8, 9]. It is worth noting that breeding within African environments for more adapted OSP varieties also began during this time. From 2009 onwards, significant investment in sweet potato began to address the bottlenecks which were preventing the full potential use and major breeding efforts. By this time, the potential contribution of OSP to reduce VAD was recognized and the Sweet Potato Profit and Health Initiative (SPHI) was launched in 2009 with the ambitious goal of improving the lives of 10 million African households in 17 SSA countries[1] by 2020 through access to improved varieties of sweet potato and their diversified use [10]. As of September 2016, 2.9 million households have been reached. This paper reviews the key factors influencing the uptake of OSP, the breeding

[1] These are Uganda, Kenya, Ethiopia, Rwanda, Burundi, DR Congo, Tanzania, Malawi, Zambia, Mozambique, Madagascar, South Africa, Angola, Nigeria, Ghana, Benin, Burkina Faso. There is a 0.75 positive correlation between production per capita of sweet potato and population density in these 17 countries.

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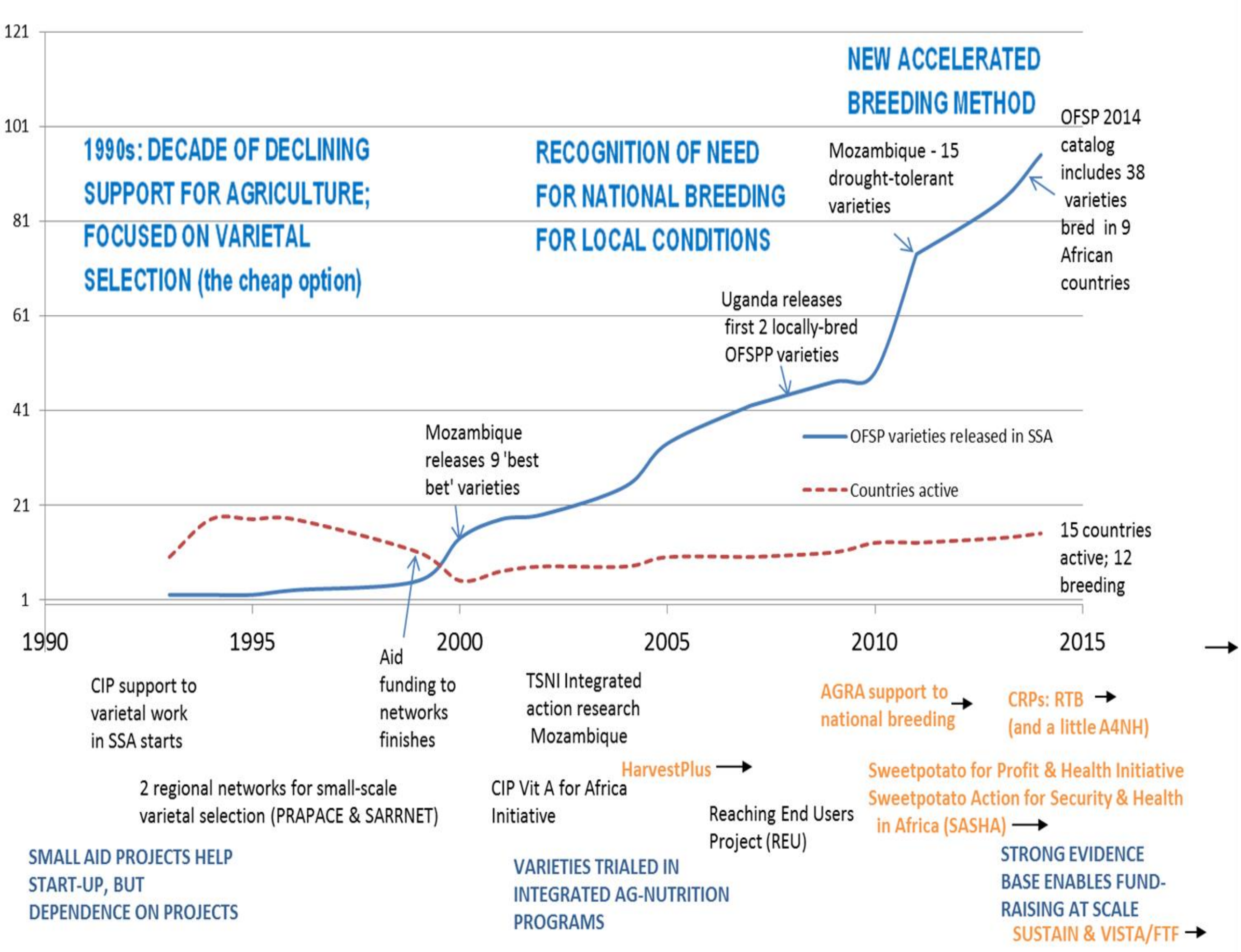
investment, five key delivery approaches that have been tested in the region, and efforts to broaden government and other stakeholder engagement.



A4NH: Agriculture for Nutrition and Health; AGRA: Alliance for a Green Revolution in Africa; CIP: International Potato Center; CRPs: CGIAR Research Projects; FTF: Feed the Future; OFSP: Orange-fleshed sweet potato; PRAPACE: Regional Potato and Sweetpotato Improvement Network in Eastern and Central Africa; RTB: Roots, Tubers, and Bananas; SARRNET: Southern Africa Root Crops Research Network; SSA: Sub-Saharan Africa; SUSTAIN: Scaling Up Sweetpotato through Agriculture and Nutrition; TSNI: Towards Sustainable Nutrition Improvement; VISTA: Viable Sweetpotato Technologies in Africa

Figure 7.1: Timeline of Development of Orange Sweet Potato Technology & the Integrated Approach

Sweet Potato's Role, Production Patterns, and Nutrient Composition

Most sweet potato roots in SSA are consumed boiled, steamed, or fried, often as a breakfast food or snack as well as for lunch or dinner [11]. Among food crops, sweet potato has the highest edible energy per hectare per day [12] and it is a primary staple crop (>80 kg/capita/year production) in densely-populated Rwanda, Burundi, Malawi, and parts of Uganda. In other parts of East and Southern Africa, it is a secondary staple

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(15-60 kg/capita/year), while in West Africa, sweet potato roots are often consumed as a snack or breakfast food (<10 kg/capita/year).Consumption of sweet potato leaves varies widely, with leaves being considered animal feed (crude protein content 68 and 131g/ kg dry matter [13]) in Kenya and Uganda and human leaf consumption dominating root consumption in Liberia and Sierra Leone.

Most sweet potato production in SSA is rain-fed. In areas with two distinct rainy seasons, improved varieties with 3-5-month maturity periods can produce 2-3 harvests per year; in unimodal rainfall environments, supplemental irrigation is necessary for the second crop unless there are valley bottoms with sufficient residual moisture. A good soil moisture regime in the first two months after planting sweet potatoes is critical for its survival and productivity [14]; potato is thereafter considered drought tolerant. Most sweet potatoes are grown for home consumption, harvested “piecemeal” as needed, under the control of women in monoculture plots or intercropped with maize or cassava. In some areas, sweet potato is emerging as a cash crop [15], planted as a sole crop and usually accompanied by increased male involvement.

Sub-Saharan Africa’s sweet potato yields in farmers’ fields range from 5-25 tons/hectare compared to 50-60 tons/hectare in South Africa’s modern agriculture sector. Mixed cropping, with use of low quality vines (planting material), little to no fertilizer use, inadequate rainfall, inappropriate planting density and ineffective weeding regimes are some of the factors responsible for low yields observed in many farmers’ fields [16].

Orange sweet potato (OSP) roots are rich in bioavailable beta-carotene [17], and are also good sources of vitamins C, K, E, and several B vitamins as well as potassium and phosphorous (Table 7.1). Leaves have moderate amounts of beta-carotene after cooking (Table 7.1) but bioavailability has yet to be determined. Leaves are also an excellent source of lutein and a good source of calcium, vitamin K, and several B vitamins.

Consumer Acceptance

The success of biofortified staple crops with a visible trait, such as OSP, depends on whether they are accepted and consumed by target populations [18]. Consumer acceptance is measured in terms of sensory and hedonic evaluation and economic valuation of biofortified vis-à-vis conventional ones. These studies apply expert sensory panel and hedonic trait analyses methods, as well as various preference elicitation methods adopted from experimental economics literature. Studies also test the impact of various levers on consumers’ evaluation for OSP such as nutrition information [19]. The variation of the β-carotene content of OSP is genetically linked with changes in the dry matter content and attributes that relate to odor, appearance, taste and texture [20]. In SSA, adults prefer roots of OSP varieties with >27% dry matter content; whereas young children like low dry matter content (20-24%) OSP varieties [11].

Consumer preference tests indicate a high preference for OSP varieties [18]. In rural areas where OSP is a staple food, consumers are more likely to have a higher preference for all varieties. In urban areas, where OSP is not a staple food to the same extent, preferences are more mixed. Willingness to pay (WTP) results in Uganda indicate that even in the absence of information, consumers will pay for OSP [19]. However, the dissemination of nutrition information results in a significant price premium for OSP compared to traditional varieties. Therefore, information campaigns are needed to drive the demand for vitamin A varieties.

Overall, OSP is liked by target consumers, even in the absence of information about its nutritional benefits. Results are generally specific to the country, owing to the heterogeneity, especially in culture and individual specific preferences, which shape food choices.

Factors Driving Farmer Adoption of New Varieties

Adoption by farmers of new crops or varieties depends on a number of selection criteria they might consider, including yield, resistance to diseases and pests, maturity period, growth type (spreading versus erect), taste, and nutritive value. Criteria may also include other factors including leaf shape, skin and flesh color, texture, and the likely current market demand [21].

It has been shown that where an "orange brand" is built around OSP, adoption will be increased [18]. There are many aspects to successful branding and these can include a number of awareness raising activities such as drama, radio messaging and training that links the orange color to the nutritional benefits of vitamin A, as well as on-farm demonstrations of agronomic practices and field days promoting project activities. Practically, adoption relies on the availability of vines as planting material [22]together with a reliable method to maintain and sustain vines between seasons in different agro-ecological conditions.

Control of land within the household has a significant effect on the probability of adoption, with one study in Uganda indicating the highest likelihood where land was jointly controlled between men and women but where the woman took the lead in decision making on which crops to grow. The lowest adoption was where plots were under exclusive male control [22].

Other studies also indicated that farmers who had access to processing techniques and those who were linked to OSP processors had extra income and were more likely to put a bigger proportion of their land under OSP [23], suggesting that market access increases the intensity of adoption and the amount of OSP cultivated. Increased rates of adoption can be expected where households have regularly consumed high amounts of white sweet potato suggesting that it is easier to adopt a new variety of a crop rather than a totally new crop [22].

BREEDING PROGRESS

There has been tremendous progress in sweet potato breeding globally during the past 20 years [24]. Sweet potato breeding efforts in SSA exploit the broad genetic diversity of sweet potato germplasm to produce new, locally-adapted varieties. Since 2009, three population improvement programs based at Sweetpotato Support Platforms in Ghana, Mozambique and Uganda. These programs are supported by the Sweetpotato Action for Security and Health in Africa Project (SASHA) and have been linked to 14 active

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national variety development programs, led by National Agricultural Research Systems (NARS) breeding programs. Ten of these NARS[2] receive financial support from the Alliance for a Green Revolution in Africa (AGRA). AGRA has also supported 10 African sweet potato breeders for PhD training and 3 for Masters level training. The breeding *in* Africa *for* Africa focuses on creating populations with three major traits, sweet potato virus disease resistance (Eastern and Central Africa); drought tolerance (Southern Africa), and high dry matter and low sweetness (West Africa). Farmers, as active partners, select materials to meet their conditions and preferences.

Traditionally, sweet potato breeding programs have taken seven to eight years to produce a new variety. Before 2009, most African countries had no real breeding program and relied on testing lines developed elsewhere. Strengthening conventional sweet potato breeding in SSA by producing varieties more quickly (4-5 years) through "accelerated breeding" and standardizing data analysis through the use of the CloneSelector software was critical for success. In accelerated breeding, multi-locational testing is conducted from the earlier stages of selection, in contrast to the conventional approach of using one site for two or more initial evaluations. Appropriate approaches to exploit heterosis ("hybrid vigor") have been developed through crossing distinct populations for systematic long-term yield boosting [24]. The infrared reflectance spectroscopy is used for the rapid, high throughput evaluation of quality attributes (micronutrients and sugars). Finally, SSA breeding efforts have been linked to the sweet potato genomic tools project that began in 2014. Since 2009, this SASHA-AGRA-NARS collaboration has resulted in 11 countries in East, Southern and West Africa releasing 56 varieties, of which 40 are orange-fleshed [25]. Storage potato root yield gains per year were 1.2% between 1992 and 2012 in Africa, compared to 2.1%, 1.4%, and 0.5% in USA, West Pacific, and South Asia, respectively [24].

Progress is also being made towards the goal of producing OSP varieties that are biofortified with iron (Fe) and zinc (Zn). On average, sweet potato roots contain 15.6 ppm (1.56 mg/100 gm) Fe, and 9.3 ppm (0.93 mg/100 gm) Zn [24]. The best sweet potato cultivars, as of 2016, are close to the targets established in 2005 by HarvestPlus at 60 ppm (6 mg/100 g) for Fe and 20 ppm (2 mg/100 g) for Zn. Currently the samples are being re-evaluated to confirm that there is no contamination from minerals in the soil. It is expected that the first iron-rich OSP variety to test for iron bioavailability will be ready by the middle of 2018.

DELIVERY STRATEGIES

Research conducted in Mozambique and Uganda that provided solid evidence (collected from 2002-2009) that an integrated agriculture-nutrition-marketing intervention using OSP as a key entry point could significantly and positively impact on young child vitamin A intakes is presented in Chapter 15. The three pillars of the integration [26] are 1) agriculture—with OSP providing a low cost, easy to grow bioavailable source of vitamin A; 2) nutrition—both producers and consumers need to be informed of the nutritional value of OSP (demand creation campaigns) and change agents need to work with

[2] Kenya, Uganda, Rwanda, Tanzania, Malawi, Zambia, Mozambique, Ghana, Burkina Faso, and Nigeria.

caregivers to ensure they have core, basic knowledge of good dietary and feeding practices and how to incorporate OSP effectively into the young child diet as well as their own; and 3) marketing—opportunities to commercialize OSP surplus stimulates OSP uptake and rates of permanent adoption. Managing the "seed system" based on vines that are easily shared among growers and hence, typically of limited interest to private sector seed companies, is critical to success. The five cases described below vary depending on whether the major outcomes are nutrition improvement (four of the cases) or cash generation (the Rwanda case study).

Integrated Agriculture-Nutrition-Marketing: Case Study of Uganda (2011 to date)
In Uganda, the going-to-scale dissemination strategy led by HarvestPlus has a three-pronged approach integrating agriculture, nutrition and marketing. Principal target groups are children under five years of age and women of childbearing age. This approach has involved establishing a self-sustaining seed system with trained vine multipliers, ensuring availability of vines to both smallholder farmers and other partners. Local laboratories propagate disease-free or "clean" pre-basic cuttings (planting material) and train multipliers receiving the cuttings on agronomy, post-harvest handling, pest and disease control, and vine conservation.

HarvestPlus is targeting 310,000 farm households by September 2016 through direct distribution and "payback" [27]. Payback means that farmers receiving vines do not pay cash for them but give back twice as much to two other farmers in the subsequent season.

Farmers also receive nutrition training with cooking demonstrations on how to incorporate the biofortified crops into the diets of farmers. "Lead mothers" in the community have been selected and supported to further share this information within the communities and foster the adoption of recommended feeding practices. Promotional activities, including community dramas, field days, and radio campaigns, have been conducted to increase the level of awareness of nutritional benefits of the crops, and thus increase demand and uptake by both government and non-governmental organizations (NGOs). An increasing number of NGOs (for example, World Vision, Save the Children, and Finnish Refugee Council) are purchasing the cuttings.

In addition, farmers with surplus production are trained in post-harvest handling and value addition and linked to traders and markets. Commercial farmers are engaged to increase production of OSP and the volumes marketed. HarvestPlus also supports off-season production where possible to enable a reliable and robust supply to markets and institutions (such as schools and prisons).

Integrated Agriculture-Nutrition-Health: Case Study of Kenya (2010 to 2016)
The proof-of-concept Mama SASHA action research project in Western Kenya focused on the "first thousand days," that is, pregnant women and their children up to two years of age, with the goal of improving vitamin A intake and status and improving public sector ante-natal care (ANC) service utilization [28]. The intervention incorporated nutrition education counseling into the regular ANC services, providing training and flipcharts with key messaged graphics to ANC nurses. Nurses offered vouchers for 200 vines of two OSP varieties. Community health workers (CHWs) aligned with the health facility encouraged women to start going to the clinic early in their pregnancy and each held a monthly Pregnant Woman's Club at the community level. When the pregnant

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women were ready to plant OSP, they redeemed their voucher with a trained decentralized vine multiplier (DVM) in their catchment area. The project reimbursed DVMs for each voucher received. The DVMs provided guidance on how to plant the sweet potato and public sector agricultural personnel assisted in providing further technical guidance.

Between April 2011 and August 2013, over 5,900 pregnant or lactating women had received 7,159 pairs of vouchers, 63% of which were redeemed for vines; 2,765 women attended pregnant women's clubs established by CHWs. The CHWs working with agricultural extension held several field days to demonstrate the production and consumption properties of OSP to the wider community. Critical to success was the holding of monthly meetings at each intervention health facility, which brought DVMs, nurses, CHWs, and government extension personnel to review progress and solve any problems. The CHWs emerged as a critical link for reaching pregnant women and connecting them to antenatal health care services and their community DVMs. Special sessions were held for male leaders in the community, as men in the household controlled how crop land was allocated. The OSP varieties were widely accepted. Results indicate that there was significant uptake of OSP among those participating in the intervention and increased frequency of intake of all vitamin A rich foods by children under 2 years of age. Overall, only children of women who fully participated in the intervention experienced significant improvements in vitamin A status and stunting.

Integration of Orange Sweet Potato into Homestead Food Production: Case Study of Burkina Faso and Cote d'Ivoire (2009 to date)

Enhanced Homestead Food Production (EHFP) is an approach that promotes year-round, nutrition-sensitive agriculture and good nutrition and hygiene practices with the aim to improve nutritional status of women, children and their families [29]. This multi-sectorial approach may contain many components such as the promotion of nutritious irrigated vegetable crops, nutritious rain fed crops, fruit trees, poultry production, fish farming, good nutrition practices, good hygiene and Water and Sanitation for Health (WASH) practices, women's empowerment, improved storage and processing of foods and marketing of surplus production. Key is the establishment of a village model farm (VMF), which is a physical and organizational platform for learning about improved practices around nutrition and nutrition-sensitive agriculture, as well as a means for beneficiaries (mainly women) to access inputs such as seeds, seedlings and saplings, veterinary products and services and other products [30].

The VMF has been essential for successful introduction of OSP varieties and subsequently as an accessible source of vines for women. In both Burkina Faso and Cote d'Ivoire, white-fleshed sweet potatoes are common; OSP was present, but rare. Therefore, it was essential to introduce improved varieties of OSP. The VMF provided training for production techniques, processing, preparation, and storage. During the last six years, Burkina Faso has had about 3,000 direct and 30,000 indirect beneficiaries test and learn about OSP and access over 175,000 vines. Currently, the VMF acts as a vine multiplication site and individuals come and pay about 0.1-0.2 USD per OSP vine. In Cote d'Ivoire, OSP is being tested by about 2,600 women and their families for a second year (2015).

Enhanced Homestead Food Production (EHFP) has been reported to increase vegetable and field crop production, poultry production, dietary diversity and the consumption of nutrient-rich foods including OSP [30]. This in turn has, in some cases, improved nutritional status of women and children, particularly through reductions in anemia levels [31]. In addition, EHFP has been shown to increase women's income and decision-making power in the household and increase their empowerment[31].

The role of OSP is crucial to the success of the EHFP approach in Africa, because it is nutritionally superior to other staple root and tuber crops, and it can be grown on large plots during the rainy season without irrigation. However, due to EHFP's multi-sectoral nature, it is difficult to attribute the results to any one individual component.

Processed Product Value Chains: Case Study of Rwanda (2011 to 2015)

The Rwanda Super Foods project explored building a gender-aware value chain for processed OSP bakery products produced by a private sector agro-processing company, Urwibutso (SINA) Enterprises, Rwanda's largest agro-processor [32]. The project examined two ways to link 516 smallholder farmers to the agro-processor, either as individual growers having agreements with the company (Urwibutso's existing approach with its fruit producers) or organized into groups backstopped by NGOs. The target groups were female and male sweet potato smallholder farmers, with a goal of increasing their production and cash sales as well as consumers, with a diverse communication campaign creating demand for OSP processed products. Since sweet potato is a woman's crop in Rwanda, a target was set that 75% of the direct beneficiaries must be women. Bakery products using OSP purée (steamed and mashed) to substitute a 20-50% of wheat flour were superior in terms of cost and quality to those using sweet potato flour. Two OSP products developed were widely commercialized: Golden Power Biscuits and doughnuts. From November 2012 through June 2014, Urwibutso earned $364,410 from sales of OSP products and in the year after the project's close, sales were $403,559.

Rwanda is densely populated, with average landholding size of 0.60 ha in the study area. Sweet potato is the most important food crop in the system. Increasing yields was requisite for farmers to have surplus for sale. Sweet potato output per hectare on average was twice as high for participating women farmers compared to non-participating women farmers; for the men, six times higher. The national program produced and distributed 8.1 million cuttings of quality planting material. Subsequent yield increases were 30-300% higher. Trained individual and group vine multipliers received net tunnels so that they could maintain their own stock of basic, disease-free starter material. More agro-processors are beginning to use OSP and increased root market demand has led to the emergence of willingness-to-pay for quality vines. A follow-up project (SUSTAIN) is monitoring sales, with DVMs selling 1.3 million cuttings valued at US $8,908 from July 2015 through June 2016 [33].

Emergency Response with Nutrition Awareness Creation: Case Study of Mozambique

Because of the time needed to multiply large quantities of planting material, sweet potato usually cannot be used for immediate emergency response, but has repeatedly served as a key crop for disaster mitigation in Eastern and Southern Africa. For example, farmers from the war-torn districts of Lira and Apac in Uganda preferred this "hardy" crop

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because it thrives in rough environments. High-yielding, early maturing OSP contributed significantly to food security and human nutrition enhancement in the flood- and drought-prone areas of central and southern Mozambique [34]. For the latter, rapid multiplication sites provided cuttings to 122,616 families in Gaza, Maputo, Inhambane, and Sofala provinces from 2000 to 2002 in response to devastating floods. This undertaking also included a one-visit nutrition awareness campaign at the village level, and social marketing to educate those getting the vines of OSP cultivars. In 2009/2010, a severe drought in Southern and Central Mozambique resulted in the loss of 32% of planted area, with 92,000 households affected. The next year (2011/2012), some of those same areas were hit by floods. In just two years, a USAID-funded Disaster Mitigation project reached 134,919 households with new drought-tolerant varieties of OSP (released in 2011) in the five target provinces by collaborating with government extension services and 44 other organizations [35].

Emergency efforts require going-to-scale as fast as possible with numerous partners. In the 2000-2002 campaign, the International Potato Center (CIP) coordinated government extension personnel and personnel from 16 NGOs in multiplication and distribution at the village level and collecting and analyzing dissemination forms. The nutrition campaign consisted of two visits. The first sensitized community leaders who, in turn, sensitized their constituencies to prepare the plots in advance. On the day the vines arrived, village leaders called all targeted beneficiaries to attend a community theater performance focusing on the benefits of OSP. Promotion materials grounded in the color orange and branded with the slogan *O Doce que dáSaúde* (the Sweet that Gives Health) were widely employed (via t-shirts, *capulanas* [skirts for women], painted billboards and market stalls). Radio broadcasts carried the messaging to consumers as well as producers.

In the 2012-2013 effort, the mass distribution approach described above was compared to another approach using vouchers that recipients redeemed for vines from trained multipliers within walking distance of their homes. With vouchers, farmers determine when they wanted to plant and where quality vines are obtained. A national coordination committee with all major partners met regularly to plan and coordinate. Over twice as many farm households were reached using the mass distribution compared to the voucher method, but losses during handling are higher with the mass distribution approach [35]. Large-scale dissemination required good planning with timely labor and transport coordination so that massive amounts of vines can be cut, labeled and delivered within 24 hours, and transported in bags so that they do not dry out [36].

OTHER STAKEHOLDER ENGAGEMENT

The SPHI is the major mechanism for stakeholder engagement that meets annually to review progress. Co-led by CIP and Forum for Agricultural Research in Africa (FARA), ten organizations (including four NGOs) and five donors have committed to work towards the SPHI's ten million household goal. As of September 2016, there were 25 sweet potato-focused projects under the SPHI umbrella. Technical information is shared through annual meetings and virtual contact through four Community of Practice groups (Breeding and Genomics; Seed Systems and Crop Management; Marketing, Processing, and Utilization; Monitoring, Learning, and Evaluation). Any interested party can contribute to the Sweetpotato Knowledge Portal (www.sweetpotatoknowledge.org) and

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that site houses a kit of briefs to use for advocating investment in OSP, a thirteen-module learning-by-doing manual on *Everything You Ever Wanted to Know About Sweetpotato* (available in English, Portuguese, French, and Swahili), Investment and Implementation Guides for designing and conducting a sweet potato intervention, and many tools for community level trainings and monitoring and evaluation. Many of the training materials were developed by the Reaching Agents of Change Phase 1 Project (2011-2014), which included building the capacity of eleven regional African champions to engage and influence key decision makers, governments, private companies, foundations, and donors to invest in OSP projects along the value chain. In addition, 55 national advocates and 4,000 change agents have been trained in Mozambique, Nigeria, and Tanzania [37]. Major regional policy documents on food security, nutrition, and agriculture recognize the need for diversified health diets [38, 39] and OSP has been cited in particular as a cost-effective, nutrition-sensitive investment [40-43].

WAY FORWARD

Among the 17 SSA countries targeted under the SPHI, ten have adapted varieties bred in country and can go to scale using or modifying delivery system models described above. Among these, six have significant going-to-scale projects underway. The other seven countries will be releasing better adapted sweet potato varieties within the next few years. Given that sweet potato is an easily shared, vegetatively propagated crop, significant subsidies are required for initial distributions of new varieties. In subsequent years, if market demand for roots exists or there has been a major loss of planting material due to droughts or floods, willingness to pay for quality vines can emerge. Climate-resilient sweet potato can be integrated into multi-crop food security projects, community-based nutrition projects, crop diversification programs in the face of climate change, and market and post-harvest efforts aiming to raise incomes. Having some community-level nutrition education effort is essential for integrating OSP effectively into the young child diet. Efforts will be intensified to get more mainstreaming of sweet potato into agriculture and nutrition programs managed by local and national governmental bodies. Moreover, OSP aligned with enhanced nutrition education should be integrated into primary and secondary educational programs, as well as training institutes, as permanent behavioral change [44] is typically more successful among youth than adults.

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Table 7.1: Nutrient Composition of Boiled OSP Root without the Skin and Steamed Leaves

Nutrients	Unit	Boiled Root Without Skin Value per 100 g	Steamed Leaves Value per 100 g
Proximates			
Water	g	80.13	89.20
Energy	Kcal	76	41
Protein	g	1.37	2.18
Total lipid (fat)	g	0.14	0.34
Fiber, total dietary	g	2.5	1.9
Sugars, total	g	5.74	5.48
Minerals			
Calcium, Ca	mg	27	33
Iron, Fe	mg	0.72	0.63
Magnesium, Mg	mg	18	48
Phosphorus, P	mg	32	40
Potassium, K	mg	230	312
Sodium, Na	mg	27	7
Zinc, Zn	mg	0.2	0.26
Vitamins			
Vitamin C, total ascorbic acid	mg	12.8	1.5
Thiamin	mg	0.056	0.112
Riboflavin	mg	0.047	0.267
Niacin	mg	0.538	1.003
Vitamin B-6	mg	0.165	0.160
Folate, DFE	µg	6	49
Vitamin B-12	µg	0	0
Lutein and zeaxanthin	µg	0	11.449
Vitamin A, Retinol Activity Equivalent (RAE)	µg	400-950	147
Vitamin E (alpha-tocopherol)	mg	0.94	0.96
Vitamin K (phylloquinone)	µg	2.1	108.6

Source: United States Department of Agriculture, National Nutrient Database for Standard Reference; Release 28 Software v.2.3.2; website: http://ndb.nal.usda.gov/ndb/foods/show/3209?manu=&fgcd=

Note: g (grams); mg (milligrams); µg (micrograms); OSP: orange sweet potato

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