Orange Fleshed Sweet Potato: Technology Toolkit Catalog

TAAT Clearinghouse

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Front cover photographic credit: Harvesting Orange Fleshed Sweet Potato (left) and close up of interior tuber color (right) (extracted from Clearinghouse Technical Report 001, originally from CIP).

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A Report by the Technologies for African Agricultural Transformation Clearinghouse, December 2020

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Purpose and Introduction

This catalog describes a suite of technologies related to the modernization of sweet potato production in Africa. It is based upon the combined efforts of the Project Platform for Agricultural Solutions (ProPAS), an information internet site, and the Technologies for African Agricultural Transformation, a large collaborative program that is deploying agricultural solutions across the continent. Both of these activities are based upon the imperative to better connect proven technologies to those who need them but each undertakes this goal in a very different manner. One of TAAT's priority commodities is the Orange Fleshed Sweet Potato (OFSP), a biofortified crop with huge potential to improve food and nutritional security across Africa. In the course of its development, ProPAS has accumulated several technologies that specifically address this commodity and we have compiled them into a "technology toolkit" designed to advance understanding and encourage adoption and investment into the proven agricultural solutions that advance this crop. This is the first of several catalogues that we intend to produce as a joint ProPAS-TAAT activity.

About ProPAS. The Product Platform for Agricultural Solutions (ProPAS) provides a mechanism to compile and access innovations, management technologies and products needed for Africa's agricultural transformation. The platform provides two pathways: it permits users to enter their proven and promising solutions into a database, and then encourages others to sort through its options to reveal the suite of opportunities that can assist their agricultural objectives. ProPAS results from the recognized need by the International Institute of Tropical Agriculture (IITA) to more systematically compile and access the full range of agricultural solutions available to modernize and transform African agriculture. Its overall goal is to accelerate the process of agricultural transformation in Africa. Many solutions are available to improve and modernize Africa's food systems but those who benefit from them most are often unaware of the best options at hand. In addition, more solutions are in the research and development pipeline that are best advanced through wider exposure and validation. Solution profiling is compiled and released in a systematic manner that involves submission by technology holders, entry into a user-friendly software platform, and use by an expanding base of clients. A small committee of agricultural experts oversees this process, but recognizes that its strength is through open-ended access to a marketplace of solutions. ProPAS is therefore managed through a three phase process that involves solution submission, database management, and client access. The database allows for solutions to be identified through selection of several search fields related to the form, type, commodity application and target beneficiaries of a given solution, sequentially narrowing the number of platform recommendations.

About TAAT. The Technologies for African Agricultural Transformation (TAAT) is a program led by the International Institute of Tropical Agriculture (IITA) that has pioneered new approaches to the deployment of proven technologies to African farmers. TAAT arose as a common effort of IITA and the African Development Bank (AfDB); and is an important component of the latter's Feed Africa Strategy. TAAT is currently advancing 106 carefully-selected technologies through 143 interventions in 27 countries. It is organized around 15 "Compacts" that represent priorities in terms of achieving Africa's potential in achieving food security and advancing its role in global agricultural trade. Nine of these Compacts relate to specific priority value chains of rice, wheat, maize, sorghum and millet, cassava, sweet potato, bean, fish and small livestock. Weaknesses in the production of commodities are viewed as responsible for Africa's food insecurity, need for excessive importation of food, and unrealized expansion of Africa's food exports. Together these Compacts design interventions in collaboration with national programs to introduce technologies and management innovations that are designed to meet targets for agricultural development. In many cases, these targets are addressed through the implementation of projects resulting from sovereign country loans awarded by development banks, and TAAT's role in the planning and execution of these loan projects is becoming a vital element of their success.

The TAAT Top 100 Technologies. The Clearinghouse developed a database of the Top 100 Technologies that are transforming African agriculture. It is based upon the approaches of the TAAT Commodity Compacts but also includes those from the CGIAR Collaborative Research Programs that are recently described as ready for next user. These technologies are divided between those involving improved genetics and plant and animal breeding (23%), those based upon the distribution of digital information (3%), production input products of proven efficacy (21%), crop and animal management technologies of utility within agricultural extension messaging and campaigns (27%) and the availability of appropriately designed labor-saving equipment (26%). These technologies have a direct role towards the achievement of the Strategic Development Goals in relationship to farm productivity, food security and hunger reduction, improved household nutrition and diets, economic growth, climate-smart innovation and improved human equity. These technologies form the basis for selecting entries into ProPAS, including those advancing Orange Fleshed Sweet Potato.

The Top 10 OFSP Technologies. This catalog presents ten technologies that modernize sweet potato production and processing in Africa. These technologies include: 1) OFSP as a more nutritive alternative to traditional "pale" varieties, 2) cultivation of selected drought and virus tolerant OFSP varieties where needed, 3) the newer Purple Sweet Potato that is higher in antioxidants, 4) community-based cutting production as a means to disseminate this vegetatively propagated crop, 5) tent-style greenhouse production of vines and cuttings as a means to make these propagules pest and disease-free, 6) raised bed production as a means of soil fertility and weed management; 7) use of specially blended fertilizers that are better adjusted to crop demand, 8) relay intercropping with legumes as a farm enterprise strategy, 9) silage production from sweet potato vines as a source of nutritious livestock feed, and 10) puree production as a means of value-addition for use in a wide variety of food products. Details on each of these ten technologies follow.

Technology 1. OFSP as a More Nutritious Alternative to Traditional Varieties

Summary. A range of improved orange-fleshed sweet potato (OFSP) varieties have been developed for African farming systems that possess locally important traits such as increased beta-carotene and iron content, virus and drought resistance, vine survival, high dry matter, low sugar, salinity tolerance, weevil resistance or avoidance, and early maturity. OFSP improves the nutritional security of communities by enhancing intake of provitamin A, and increasing productivity and stress resilience. Transitioning to orange-fleshed varieties is uncomplicated and highly acceptable to women, men and children because sweet potato is a key staple for many people in Africa. Sweet potato vines can also be used for mixing into animal fodder which enhances their protein content and quality. Planting materials for improved OFSP varieties are available in most countries. For more information contact Dr. Paul Demo of CIP by email at p.demo@cgiar.org

Technical Description. Sweet potato cultivars with orange flesh have more beta-carotene than those with light colored flesh. After eating OFSP, the beta-carotene is converted into vitamin A whereby providing essential nutrition and supplementing the diet of people. The nutritional value of OFSP varieties is among the highest for starchy staple foods. Surveys have shown that children and adults eating beta-carotene enriched sweet potatoes suffer less vitamin A deficiency, which is one of the most pernicious forms of malnourishment and hidden hunger. Many of the improved varieties of OFSP are early-maturing and achieve high tuber yields, producing on average 25 ton per hectare as compared to non-improved farmer's varieties that produce a tuber yield of only 3 to 7 ton per hectare.

The importance of Orange Fleshed Sweet Potato

Uses. OFSP tubers can be consumed after cooking, or milled into flour or mashed into puree for use in a range of products including breads, chapatis, cakes, juices, porridge etc. OFSP can substitute wheat-based products and is gluten-free. Peels and tubers can also be made into feed meal for animal rearing, as well as for starch extraction. Suitable varieties of OFSP are available for all major growing areas in Sub-Saharan Africa that are ready to be scaled for addressing malnutrition and increasing producer's profits margins.


Bundles of OFSP cuttings ready for planting

Composition. Improved OFSP varieties contain high levels of beta-carotene, also called provitamin A carotenoid, that lends an orange color to the tuber. The beta-carotene inside the tubers is largely retained when processed, making it perfect for manufacturing healthy foods for consumers.

Application. Orange-fleshed sweet potato is propagated from seeds, tubers or vines. Cuttings from vines are most commonly used for planting and easy to prepare locally. Slips from tubers or cuttings from vines are started by planting them in beds or placing the bottom of the stem in water. The healthy slips or cuttings are planted by inserting these at an angle in the soil, using a spacing of 50 cm between rows and 30 cm from plant to plant (within row).

Commercialization. Commercially available including from national authotities.

Startup Requirements. 1) Awareness-raising with farmers and food processors about the nutritional benefits of orange-fleshed sweet potato over non-fortified types, 2) Acquisition of improved OFSP varieties, and 3) Training on propagation of healthy planting material and crop management

Production Cost. In Kenya, a bag with 10 kilogram of OFSP vines are usually sold for less than US $20, including transport costs. For planting a field measuring one acre (0.4 hectare) you need 20 bags of vines, making a total cost of US S400.

Customer Segmentation. Sweet potato farmers, sweet potato seed multipliers, community-based organizations and food processors

Potential Profitability. There is a high demand for orange-fleshed sweet potato within local and regional markets for fresh consumption, sold as snacks, or processed into puree or flour that is further sold to bakeries and other food manufacturers. In Rwanda OSFP tubers are sold at 25% premium over white and yellow fleshed sweet potato. Leftover vines and low-grade tubers from sweet potato can be turned into silage that provides a nutritious fodder for all types of ruminant livestock and pigs to supplement grass-based diets throughout the year. In general, for every dollar invested in enhanced nutrition there is a return of US $30 owing to better health, schooling and productivity. Farmers can earn an income by selling planting material. Surveys in eastern and central Uganda demonstrate a single farmer can earn about US $400 per month from the sale of planting materials and sweet potato products.

Licensing Requirements. There is need for certification to multiply and sell OFSP vines and cuttings.

Innovation as a Public Good. As a Regional public good, International Potato Center (CIP) assumes responsibility for breeding and distribution of this commodity through national programs.

Technology 2. Cultivation of Drought and Virus Tolerant OFSP Varieties

Summary. Cultivars of orange-fleshed sweet potato (OFSP) from Sub-Saharan Africa have been identified and bred that are more adapted to drought and heat stresses, and others that withstand infections by common viruses affecting the crop. A number of hybrid OFSP varieties were developed that reach harvest maturity within just 90 days and can escape the risk of tuber filling as affected by shortened duration of growing season where rainfall is more uncertain towards the end of the season. OFSP varieties that are resistant to a complex of stunt virus (SPCSV), mottle virus (SPFMV) and insects like weevils, aphids and whiteflies that damage crops in the field and stored tubers have also been released in different countries. For more information contact Dr. Paul Demo of CIP by email at p.demo@cgiar.org

Technical Description. Tolerance of OFSP to drought, heat, pests and diseases is achieved by cross-breeding various cultivars and land races with desired characteristics. Adaptations to drier and warmer conditions are made by selecting traits such as early maturation, deeper roots, narrower leaves, erect growth and high vine survival. Resistance of OFSP to virus and insect pests is accomplished by mass selection based on observation of symptoms in the field and genetic marker techniques.

OFSP Irene, a drought and virus tolerant variety

Uses. Drought tolerant OFSP varieties are especially suited for regions with semi-arid and dry tropical climates in Eastern, Western and Southern Africa, which face negative impacts of climate change of rainfall. Virus resistant OFSP cultivars are particularly useful for regions with high infestation rates to increase food security and prevent severe outbreaks. Like regular OFSP, tubers can be cooked and roasted fresh, or milled into flour and mashed into puree for use in a range of products including breads, chapatis, cakes, juices, porridge etc. OFSP can substitute wheat-based products are related imports and is gluten-free. Peels and tubers can also be made into feed meal for animal rearing, as well as for starch extraction.

SPCS Virus infected plant (left), SPVD infected plant (centre) and virus-free plant (right)

Composition. Tubers from OFSP varieties that are drought tolerant and virus resistant contain high levels of beta-carotene, also called provitamin A carotenoid, and gives its orange color. The beta-carotene inside tubers is largely retained when processed, making it perfect for manufacturing healthy foods for consumers in the region.

Application. Varieties of OFSP that are adapted to drought and resistant to viruses are propagated from seeds, tubers or vines, following the same procedures as non-adapted cultivars. Cuttings from vines are most commonly used for planting and easy to make yourself. Slips from tubers or cuttings from vines are raised by planting them in beds or placing the bottom of the stem in water. The healthy slips or cuttings are planted by inserting these at an angle in the soil, using a spacing of 50 cm between rows and 30 cm from plant to plant.

Commercialization. Commercially available, often through national programs.

Startup Requirements. 1) Awareness-raising with stakeholders about drought tolerant and virus resistant OFSP varieties, 2) Acquisition of specially-bred OFSP varieties, and 3) Training on propagation of healthy planting material for improved varieties under drier conditions.

Production Cost. Prices of planting material for drought tolerant and virus resistant OFSP are the same as regular cultivars. In Kenya, a bag with 10 kilogram of OFSP vines are sold for less than US $20, including transport costs. For one acre (0.4 hectare), a producer requires 20 bags of vines, making a total cost of US $400.

Customer Segmentation. Sweet potato farmers, sweet potato seed multipliers, farmer associations, and agri-food manufacturers.

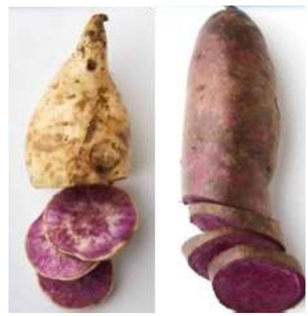
Potential Profitability. Drought tolerant and pest resistant varieties of OFSP ensure that crops reach harvest maturity in areas where production of regular cultivars is undermined by these factors. The lower productivity of drought and virus tolerant OFSP varieties is counteracted by the reduced risk of crop failure. Every dollar invested in nutrition returns US $30 in increased health, schooling and productivity. Farmers can earn an income by selling planting material. In eastern and central Uganda a single farmer can earn about US $400 per month from the sale of planting materials and sweet potato products at the beginning of the rains.

Licensing Requirements. In some countries there is a requirement for certification to multiply and sell planting materials for drought and virus tolerant OFSP varieties.

Innovation as a Public Good. As a Regional Public Good, International Potato Center (CIP) assumes responsibility for breeding and distribution of new varieties to national programs.

Technology 3. Purple Sweet Potato is Higher in Antioxidants

Summary. Sweet potatoes with a purple colored flesh have been introduced from Hawaii and Japan into African farming systems and markets over the past decade. As compared to white or yellow sweet potatoes the purple-fleshed types have two to three times more antioxidant activity that boost the body's growth, immune system and brain activity. Eating purple-fleshed sweet potato (PFSP) is improving the dietary balance and tackles vitamin deficiencies that widely occur in subsistence farming and poor communities due to low intake of vegetables and fruits. The high levels of antioxidants in PFSP has advantages for people of any age, promoting early childhood development as well as keeping adolescents and elderly healthy and active. For more information contact Dr. Paul Demo by email at p.demo@cgiar.org



Purple sweet potato cvs. Okinawa (left) and Molokai (right)

Technical Description. The distinct color of purple-fleshed sweet potato is a result from its high levels of anthocyanins, a type of flavonoid with a strong antioxidant effect, neutralizing harmful compounds in the body that damage cells. Sufficient intake of these natural protective agents is of crucial importance to reduce risks of heart disease and cancer, and lead a healthy and active life. Purple-fleshed sweet potatoes have a rich, almost winey flavor with a creamy texture. They are denser and drier than regular sweet potatoes, which is why wetter cooking methods and longer cooking times are recommended. After cooking, tubers can be preserved for several months in airtight containers which allows for year-round supply of healthy food in rural and urban communities.

Bread prepared from purple fleshed sweet potato

Uses. Purple-fleshed sweet potato are prepared for eating in the same way as white and orange colored sweet potatoes by cooking and frying them fresh, or making them into puree or flour that can be stored or sold to bakeries or other food manufacturers. The tubers from PFSP have a lower glycemic index which means that blood pressure and sugar levels are not affected as much as other starchy staple foods, making them more suitable for people with diabetes and hypertension. Residues from vines and peels as well as deformed tubers of PFSP can be turned into silage that makes a nutritious fodder for all types of ruminants and pigs.

Composition. There are PFSP varieties with white and purple skins that both have the characteristic deep purple flesh inside the tuber. Pigmentation of the tubers comes from anthocyanins which is the same as found in blueberries, strawberries, purple carrots and blue tomatoes, among other vegetables and fruits. Next to providing a source of energy and anthocyanins, PSFP varieties also contain high levels of potassium, fiber, vitamin C and vitamin B6.

Application. The multiplication, planting, management and harvesting of PSFP varieties is exactly the same as for other types of sweet potato. Planting materials are propagated from seeds, tubers or vines. Cuttings from vines are most commonly used for planting and easy to make yourself. Slips from tubers or cuttings from vines are rooted by planting them in beds or placing the bottom of the stem in water. The healthy slips or cuttings are planted by inserting these at an angle in the soil, using a spacing of 50 cm between rows and 30 cm from plant to plant.

Commercialization. PFSP is just becoming commercially available, often through national programs.

Startup Requirements. 1) Awareness-raising with farmers and food processors about the nutritional benefits of purple-fleshed sweet potato over non-fortified types, 2) Acquisition of improved PFSP varieties, and 3) Training on propagation of healthy planting material and management of crops

Production Cost. When it first becomes available, multiplying or purchasing purple-fleshed sweet potato cuttings costs slightly more than other types of sweet potato; but these additional costs are offset by higher prices. For planting a field measuring one acre (0.4 hectare) you need 20 bags of vines, that may cost as much as US $500.

Customer Segmentation. Sweet potato growers, sweet potato seed multipliers, farmer associations, health stores, food manufacturers

Potential Profitability. There is a high demand for bio-fortified sweet potato on local and regional markets for fresh consumption or processing into chips, puree or flour that is further sold to bakeries and other food manufacturers. Tubers from orange-fleshed varieties are sold at 25% premium over white and yellow fleshed sweet potato, and PFSP may well be valued even higher. As with other types of sweet potato, leftover vines and off-grade tubers from sweet potato can be turn into silage that is providing a nutritious fodder for all types of ruminant livestock and pigs to supplement grass-based diets throughout the year. In general, for every dollar invested in enhanced nutrition there is a return of US$ 30 owing to better health, schooling and productivity. Farmers can earn an income by selling planting material.

Licensing Requirements. In some countries, **a** certificate is needed to multiply and sell planting materials for PFSP.

Innovation as a Public Good. As a Regional public good, International Potato Center (CIP) assumes responsible for breeding and distributing PFSP through a network of national systems.

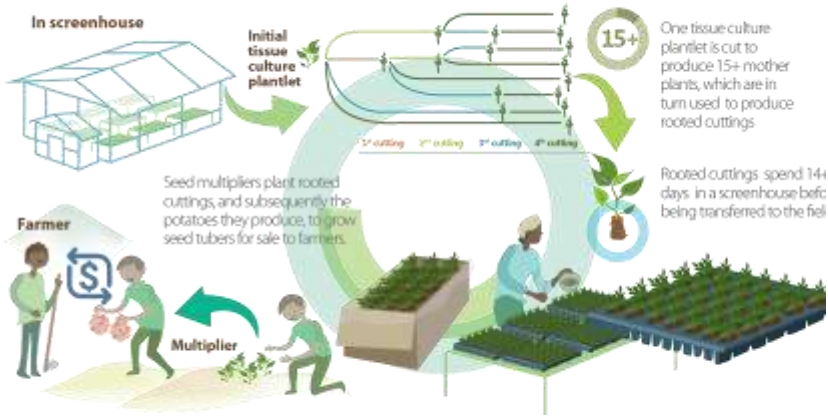
Technology 4. Community-Based Vine and Cutting Production

Summary. The availability, access and quality of sweet potato planting material in rural communities can be enhanced by organizing community-based multiplication of vines and cuttings at medium to large scale. Strong linkages between multipliers and sellers formed under this strategy are further giving rise to more reliable and cost-effective supply of vines and cuttings to farmers. Improving the multiplication of planting material through multi-stakeholder collaboration can offer major gains in the yield and resilience of sweet potato crops, if strategies are properly aligned with agro-ecological and socioeconomic factors. For more information contact Dr. Paul Demo of CIP by email at p.demo@cgiar.org

Technical Description. The advantages of community-based multiplication strategies for sweet potato are that they allow for substantial improvement in the quality control of planting materials and also lower its retail prices, particularly within smallholder situations with limited access to production inputs and markets. Multiplication of vines and cuttings at medium to large scale through joint investments enables specialists to be engaged, better maintenance of hybrid and resistant varieties, better protection against pests and diseases, and retention of

An OFSP multiplication site in Uganda

sufficient reserve stocks. Community-based approaches can result in marked cost savings for



A multiplication scheme for improved OFSP varieties based upon combined screen house and field field activities

production of planting materials through economies of scale while also generating income for members.

Uses. Community-based multiplication enables farmers to obtain hardened planting materials closer to the fields, and particularly effective for releasing and maintaining improved varieties, and controlling pest and disease infestations. The improvement in availability, access and quality of life sweet potato planting material that can be realized through the collaborative approach make it possible to distribute large amounts in a short period of time at the start of rainy seasons.

Composition. Multiplication of sweet potato through community-based organization can be done using basic materials that can be found locally, including tent-style greenhouse, fertilizers and disease control agents. Advanced multiplier set-ups involve assets like drip irrigation and other mechanized tools that reduce labor costs.

Application. Public and private sector breeders produce tissue culture plantlets from improved varieties inside the laboratory that are subsequently cut into more than 15 mother plants. Community-based multipliers obtain a small number of the certified cuttings or seed potato from breeders which they subsequently use to grow rooted cuttings and vines in the screen house, altogether taking just over 14 days. Sweet potato multipliers are organized across a community based on the cultivation area and road connectivity, usually having sites for planting material multiplication dispersed at distances of 1 to 20 km.

Distribution of OFSP vines to women farmers

Commercialization. This is an agricultural extension tool that offers commercial rewards.

Startup Requirements. 1) Dissemination of advantages from community-based multiplication to stakeholders, 2) Planning of multiplier sites according to material costs and transport distances, 3) Formation of joint enterprises and contracting among farmers and sellers, and 4) Constructing multiplication sites and acquiring rooted cuttings or seed potato from improved varieties

Production Cost. Capital investments for a screen house, irrigation system, fertilizers and disease control agents to set up a sweet potato multiplication site are amounting to US S10,000 per acre (= 0.4 ha) in the United States. Labour costs for land preparation, planting and harvesting in that part of the world are costing farmers another US S20,000 per acre. When land rent and overhead costs are included the total cost of producing 1,000 cuttings for multipliers in the United States amounts to US $33 (or about $0.03 per cutting). Lower cost production systems are also available.

Customer Segmentation. Farmer organizations, non-governmental organizations, women and youth groups and local entrepreneurs, often assisted through the public sector

Potential Profitability. Community-based multiplication of sweet potato reduces labour and input costs by increasing the scale of operations and offsetting various risks. By establishing multiplier sites close to farmer fields the collaborative approach will decrease costs of transportation for cuttings and vines, which is proportionally large. The shorter supply chain for planting materials allows for healthier cuttings to be acquired by farmers that in turn leads to greater survival rate of cuttings and vines; and consequently a greater the return on investment and harvested tuber yield.

Licensing Requirements. A certificate may be required to multiply and sell planting materials for sweet potato in some countries, but in others this service is unregulated.

Innovation as a Public Good. Further information of community-based OFSP multipliers is offered as a Regional Public Good by the International Potato Center (CIP).

Technology 5. Tent-style Greenhouse Production of Vines and Cuttings

Summary. Low-cost and easy-to-build greenhouse structures allow producers to multiply large amounts of healthy sweet potato vines and cuttings prior to the onset of the growing season. Tent-styled greenhouses combined with manual or drip irrigation enable optimal soil moisture, and the screen nets keep vines free of pests and diseases. Farmers can also use the greenhouses for retaining a stock of sweet potato vines as starter material and thereby avoid degeneration of planting stocks. For more information contact Ms. Elizabeth Mwikali of the Kibwezi Hortipreneur Youth Group (Kenya) by email at mwikali82@yahoo.com.

Technical Description. Tent-style designs of greenhouses minimize costs of construction as they can be built with less expensive screen netting and locally available building materials. Multiplying vines and cuttings for sweet potato inside the greenhouses enhances production of tubers because it ensures that sufficient planting material is available to farmers and allows them to plant a larger area of land with the crop. Sweet potato vines and cuttings that have been started in greenhouses are of high quality and free of pathogens that

Small "net tunnels" for localized production of vector-free sweet potato cuttings

Constructing a larger tent-style screen house involves 1) erecting posts, 2) installing cables, 3) sinking anchors, 4) connecting the posts, cables and anchors, 5) stretching the screening, 6) framing the antechamber (entrance), and 7) burying the edges; resulting in a finished greenhouse (8).

increases their survival upon planting, a critical stage in the production of the crop.

Uses. Net tunnels protect cutting from insect vectors and allow them to harden before transplanting to the open field. They are especially useful in regions with high pest and virus pressures and where dry/warm conditions are creating large risks of planting vines directly on farms. A tent-styled greenhouse is made of widely available screen nets and construction materials. The design of tents and net tunnels can be easily adapted in accordance to the need of farmers and their financial resources, with different sizes ranging from 2 square meters to an entire field. Under good management, the low-cost greenhouses can last more than 3 years.

Application. Constructing tent-styled greenhouses for multiplying sweet potato vines is not complicated and requires little training. The build involves erecting posts, installing cables, sinking cable anchors, connecting cables and anchors, stretching screen nets and burying edges of screen nets. A drip irrigation system connected to a water tank can be installed for maintaining optimal soil moisture.

Commercialization. Materials are commercially available with others offering construction expertise.

Startup Requirements. 1) Renting/buying land for constructing multiplication site, 2) Installation of screen house, supporting posts, anchors and cables, and 3) Purchase of drip irrigation system (optional)

Production Cost. Materials for constructing the tent-style greenhouse cost around US $3.40 per square meter. The total investment needed to set up a net tunnel for multiplication of sweet potato vines is amounting to about US $7.50 per square meter which includes building materials, purchase of vines, transportation, labor and training.

Customer Segmentation. Small-scale farmers and their organizations, commercial farmers, agro-input suppliers.

OFSP vine production in Kenya within a dedicated greenhouse

Potential Profitability. A pilot project for multiplication of sweet potato in tent-styled greenhouses in Kenya has demonstrated that farmers can earn US $4 per square meter from sales of vines, which can go up to US $9 per square meter under intensive production. At this return rate the sales of vines hence allows for the investments for greenhouse to be recovered within five months. In the United States it was shown that multiplication of sweet potato in tunnels yields two times more marketable cuttings in comparison to an open field system.

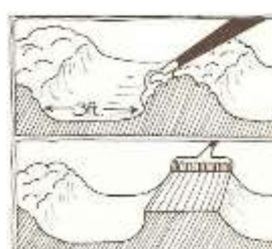
Licensing Requirements. In some cases a permit may be required to construct a permanent greenhouse.

Innovation as a Public Good. There are no specific agreements related to Regional Public Goods although some specific designs may be proprietary.

Technology 6. Producing Sweet Potatoes on Raised Beds

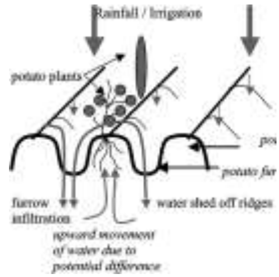
Summary. Growing sweet potato on raised soil beds is proven to enhance tuber yields and lessen weed encroachment of the crop in many farming system across Sub-Saharan Africa. Raised beds are made of loosened soil that create the right bulk density and moisture conditions needed for sweet potatoes, especially benefiting the survival of cuttings and vines when planted fresh, and the formation and filling of tubers. Soil inside the raised beds does not become hardened or get water logged which otherwise restrict the growth of sweet potato and cause damage to belowground parts of the crop by aggravating soil-borne diseases. By elevating the position of sweet potato crops on soil beds, farmers prevent weeds from rapidly overgrowing vines throughout the growing season. Raised soil beds can further be covered by mulching crop litter or plastic sheets that further improve soil moisture and weed control. For more information on raised bed culture contact Dr. Paul Demo of CIP by email at p.demo@cgiar.org

Technical Description. The installation of raised beds on a field starts by tilling and harrowing the soil to ensure it is not compacted and is kept free of weeds after planting. Soils beds are laid out in parallel lines at a distance of 90 centimeter (or 3 feet) that allow rainwater to freely drain from the surface. For constructing the beds, farmers heap soil into ridges with a height of 30 cm (or 1 foot) with a hoe and subsequently flattened the top with a rake. After watering, cuttings or vines are then planted at the desired spacing. These soil beds allowing for good aeration and drainage which are of key importance to make sweet potato crops grow vigorously, and also improve the water use efficiency of irrigation water. Reduced weed encroachment of vines on raised soil beds also stimulates uptake of nutrients and water, making the crop more resilient to episodic drought and pathogen attacks.



Hand preparation of raised beds using hoe and rake.

Uses. Cultivating sweet potato on raised beds is recommended for all types of agro-ecosystems in Sub-Saharan Africa because of widespread soil compaction and weed infestation that diminish the crop's yield. The lower weed encroachment that is achieved through soil bed cultivation is beneficial to farmers that have limited availability of labour and financial resources. Soil beds offer advantages when and where rainfall is high by ensuring water drains away so that diseases like root rots and leaf wilts do not damage the root system. Under low rainfall conditions the use of raised beds on a farmer's field will increase the retention of water in soils by lessening runoff.



Water relations with a raised bed system

Composition. Raised beds are usually made with soil from a farmer field that has been loosened to achieve the desired structure and drainage. Organic resources such as matured compost or crop residues can be added inside the soil beds or planting holes to improve the availability of nutrients and water retention to the crop. Soils may need treatment with chemical or biological agents to kill off root rots, nematodes and other common pathogens, or new soil needs to be brought from elsewhere to make the beds.

Application. Simple tools like a handheld hoe and harrow can be used for preparing raised soil beds on farmer fields, or if available animal- and tractor-drawn plows that mechanically loosen and heap up soils. The common type of beds that is made of soil only have to be renewed after every harvest, while permanent beds constructed with plastic sheets, or wood and metal skirting, can last for several years. Disinfection of soils for controlling diseases and pests requires chemical agents, or soil heating techniques. If continuously growing potato, then beds have to be replaced with soil from an area where no sweet potatoes or nematode susceptible crops have been grown.

Farmers planting OFSP cuttings onto raised beds

Commercialization. This is an important extension message not a commercial product although some ridging attachments are commercially available.

Startup Requirements. 1) Access to hand hoe and harrow, or mechanical plow, 2) Procuring mineral fertilizer, compost and chemical control agents (optional), and 3) Supply of mulching litter or plastic sheets (optional)

Production Cost. For potato growers in the United States, the installation of raised beds with a mechanized plow, disinfection of soil, fertilizer input and irrigation costs about US $584 per acre (= 0.4 hectare). Covering soil beds with plastic sheets costs an additional US $150 per acre, whereas mulch from plant litter can be less or more expensive than plastic depending on the type, hauling distance and spreading costs.

Client Segmentation. Small-scale and commercial farmers, and their extension agents.

Potential Profitability. A study in the Afar region of Ethiopia has found that growing sweet potato on raised beds resulted in a 7% increase of total fresh tuber weight compared to when flat seedbeds were used. The reduced weed encroachment of the crop on raised soils bed can substantially cut down on costs of labor and herbicides for producers, whereby increasing profit margins. Combined with mulching litter or plastic sheets the use of raised beds can reduce costs for labor, herbicide agents and irrigation.

Licensing Requirements. As an extension message, no license is required.

Innovation as a Public Good. As a Regional Public Good, International Potato Center (CIP) is responsible for messaging and scaling this technology.

Technology 7. Use of Specially Blended Fertilizers

Summary. Mixes of common inorganic fertilizers have been specifically developed for sweet potato and other root crops that create balanced availability of nutrients for the crop's belowground production. These kinds of fertilizers supply elements like nitrogen, phosphorus, potassium and sulfur that are insufficiently available in soils across many landscapes and farmer fields of Sub-Saharan Africa. Fertilizing sweet potato with the right nutrient formula at the right time and place can greatly enhance the productivity and quality of tubers, and strengthen resilience to drought, pests and diseases, while avoiding undesired losses to the environment. Readily accessible types of fertilizers and manufacturing facilities across Sub-Saharan Africa can be used to make appropriate blends of nutrients for sweet potato under different conditions. For more information contact Dr. Paul L. Woomer of the TAAT Clearinghouse by email at plwoomer@gmail.com.

Technical Description. Application of inorganic fertilizers that are specially made for sweet potato ensures the crop has adequate and balanced supply of essential nutrients that are needed for keeping a healthy stand and harvesting large tubers. Fertilizer regimes adapted for sweet potato ensure that nutrients are utilized efficiently and sustainably in the cropping system as such input usage balances and replenishes stocks in soils. Inputs of phosphate and potassium particularly benefit root development and tuber filling by sweet potato, and input of sulfate improves the regulation of photosynthesis and transpiration of crops. Specialty fertilizer that are appropriately blended and applied at the right time and place, often in conjunction with organic inputs, boost the crop's ability to withstand disease, pests and drought stress.

A fertilizer blend suitable for root crops

Uses. Specialty blended fertilizers applied at the rate of 100 to 150 kg per ha within the raised beds allow to address various nutrient deficiencies and imbalances in soils that are limiting the production of sweet potato crops, which are found all around growing areas in African as a result of low soil fertility, intensive cultivation and high population density. Inorganic fertilizers are best used on improved varieties of sweet potato as the yield effect and agronomic efficiency will be more stable and larger than for a non-improved crop.

Composition. Specific nutrient formulas can be made by blending a wide range of solid granular types of fertilizers like urea, calcium ammonium nitrate, potassium chloride, single or triple super phosphate and sulfate. Micronutrients like zinc, boron and cupper, amongst others can be added in solid form or impregnated as liquid.

Application. Information about the nutrient deficiency and imbalance in specific growing areas has to be collected from soil maps and strategic trials for developing appropriate blend formulations in line with the availability of fertilizers. Manufacturing of specialty blended fertilizer is done using a dry rotary system available in medium to large sizes. Fertilizers will be applied one or two times during the growing cycle of sweet potato depending on nutrient availabilities in soils and rainfall conditions.

Equipment used in smaller-scale fertilizer blending

Commercialization. Unfortunately, commercial blends specific to the needs of root crops are available across Africa but their composition is known to fertilizer blenders.

Startup Requirements. 1) Adapting the formula of blended fertilizers to the nutrient requirements in a specific growing area, 2) Setting up manufacturing protocols for mixing different sources of fertilizer, 3) Sensitizing growers about the benefits of specialty fertilizer blends, and 4) Providing access to fertilizers at affordable prices on local markets.

A commercial fertilizer blend for root crops

Production Cost. Developing specialty blended fertilizers bears a considerable start-up cost for carrying out agronomic surveys and testing to determine appropriate formulas, which is repaid by sales to farmers which get an increased marketable value of sweet potato at harvest. Manufacturers need to make capital investments on dry rotary systems for making the blends of fertilizers, aside from producing or purchasing the raw granular forms of fertilizers. Infrastructures for blending fertilizer can be used to make all types of formulations for sweet potato and other crops in a specific growing which allows reduce production costs of a specific fertilizer product, and get a faster repayment of investment.

Customer Segmentation. Fertilizer manufacturers, distributors and retailers, sweet potato growers, sweet potato seed multipliers.

Potential Profitability. Experiments in different areas of southwestern Ethiopia demonstrated that applying specialty blended fertilizer to orange-fleshed sweet potato at a rate of 160 kg per hectare increased marketable tuber yields by 16 to 26 ton per hectare as compared to unfertilized crops. The added sweet potato harvest by input of specialty blended fertilizer found in this study has a gross value of US S1980 to $3220 for farmers on local markets. Levels of carotene/pro-vitamin A in tubers also showed to be higher for orange-fleshed sweet potato that the received blended fertilizers.

Licensing Requirements. The formulations of fertilizer blends may be subject to licensing but are more often protected as trade secrets. Those with knowledge of fertilizer composition may easily calculate desired blend proportions from different primary fertilizer materials.

Innovation as a Public Good. Intellectual property connected with specialty fertilizer blends can be either public goods or owned commercially.

A Commercial Fertilizer Blend for Root Crops

RFC-Root is a fertilizer blend produced and marketed by MEA Fertilizers Limited specifically to suit the nutritional requirement of Root and Fruit Crops (RFC). It was designed in collaboration with the TAAT Clearinghouse Advisory team for the purpose of providing a needed specialized fertilizer for sweet potato and cassava, two crops given special attention by the African Development Bank. Currently, there is no commercial fertilizer blend tailored for root crops and fruit trees making the RFC-ROOT the first fertilizer in the market addressing this shortcoming in Kenya and across the region. The blend was formulated using locally available ingredients with the following nutrient ratio of NPK 5:13:21 with 4% CaO, 5.8% MgO, 3% S and 0.4% Zn. Root crops in particular require high levels of potassium during tuber fill. At the same time, it is difficult for most producers to obtain potassium fertilizers through local agrodealers. RFC-ROOT contains high levels of potassium, and the inclusion of calcium and magnesium provide a modest liming effect. Furthermore, the inclusion of the other nutrients ensures nutritional balance for proper root growth and tuber development. This makes RFC-ROOT fertilizer ideal in correcting the nutritional shortcoming of root crops in the region.RFC-ROOT fertilizer should be applied at the tuber initiation stage. At this stage, potassium is needed in high levels, essentially promoting tuber development. In sweet potato production, this stage falls at the 60th day after planting, or just before the closing of the vine canopy. A blanket application rate of 50 kilograms per acre is recommended. For cassava, RFC Root should be applied as a top dressing early in the second growing season, just before weeding. Hand or mechanical weeding then incorporates the RFC Root topdressing into the upper topsoil. RFC-ROOT is available from MEA Ltd, P.O.Box 44480 -00100, Nairobi, Kenya, Tel: +254-20-4453701/2/3, Email: info@mea.co.ke

Technology 8. Relay Intercropping with Legumes

Summary. Cultivating sweet potato alongside legumes on the same land offers multiple advantages as compared to when the two crops are grown separately as monocrops. The mixing of sweet potato and legumes gives rise to increased yields and total harvests for farmers because of it makes more efficient use of land, nutrient and water resources, improves microclimates inside the canopy, and reduce damage by pests and diseases. Legumes increase the availability of nitrogen in the soil during and after cultivation which promotes tuber production when intercropped with sweet potato, and saves on inputs of nitrogen fertilizer. Intercropping of sweet potato and legumes leads to a more nutritional and balanced diet for subsistence farmers, and also mitigates the risk of a hunger season when one of the crops fails because of drought or pest attacks. Many grain legumes tend to be shorter duration than sweet potato, allowing for relays of canopy coverage. For more information contact Ms. Elizabeth Mwikali of the Kibwezi Hortipreneur Youth Group (Kenya) by email at mwikali82@yahoo.com.

Technical Description. Sweet potato and legumes are well suited to be planted simultaneously or in relay with up to one month time between planting. Nitrogen fixation by legumes benefits companion crops more through residues rather than directly. When intercropping the mineral fertilizers applied to sweet potato and legumes are used more efficiently since both crops take advantage of dispersing and residual nutrients. Intercropping of sweet potato with legumes allows reducing weed infestation, soil erosion and run-off as the practice keeps more land covered and protected throughout the growing season. Erect and tall growing types of legumes help to better regulate the temperature of the soil and inside the canopy of sweet potato grown alongside through shading, which enhances crop water productivity and also optimize light use efficiency. Cultivating the tuber and legume crop on the same piece of land allows obtaining greater returns from labor, fertilizer and irrigation inputs as compared to their monocrop cultures. Crop diversification through intercropping of sweet potato and legumes strengthens the resilience of farming communities to unfavorable weather.

An example of improved land use efficiency obtained from intercropping sweet potato and soybean

Uses. Intercropping of sweet potato and legumes is suitable for all regions in Sub-Saharan Africa when the variety of sweet potato and type of legume are appropriately selected for prevalent conditions. Cultivation of a legume alongside with sweet potato is especially advantages in farming landscape areas or on individual farmer fields that suffer from low nitrogen availability in soils, which will be alleviated by the biological nitrogen fixation that takes place. In communities where available land and labor are limited the use of sweet potato and legume intercropping will increase the use efficiency of these resources and lead to greater returns.

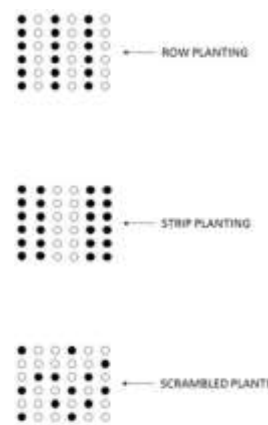
Composition. Sweet potato can be intercropped with all types of legumes such as common bean, soybean, pigeon pea, cowpea, alfalfa and green grams, allowing farmers to choose in line with agro-ecological conditions, food preferences and market conditions.

Application. The approaches for planting and managing an intercrop of sweet potato and legumes are the same like when these are grown separately as a monocrop culture. Intercropping is easiest when sweet potatoes are planted on top of ridges, with other crops planted between the rows. Different layouts can be used for intercropping and relay cropping, with sweet potatoes and legumes planted in alternating planting stations, on alternating rows, in strips of 2-3 rows or randomly scrambled across rows. In some cases, fast maturing legumes may be planted in the furrows. If mixed with common beans, soybeans or peas, the sweet potato crop can be planted at its usual density and the legume in between, for large growing legumes the spacing of sweet potato needs to be adjusted. The two crops can be planted simultaneously or in relay so their growth and harvest are aligned with farmer preferences and conditions. Legume crops should be inoculated with an elite strain of N-fixing rhizobium.

Alternate within-row intercropping of OFSP and bean (left); when beans are harvested the OFSP us forming a closed canopy (right)

Commercialization. This technology is suited to extension messaging although legumes often benefit from commercially-available rhizobial inoculants.

Startup Requirements. 1) Education for farmers about the benefits of intercropping sweet potato and legumes, 2) Selecting the right varieties to grown alongside each other depending on local contexts, and 3) Acquiring quality planting materials for sweet potato and legumes, and 4) Purchase of mineral fertilizer and legume inoculants.



Other examples of alternating row, strip and scrambled intercropping arrangements

Production Cost. The agricultural and labor inputs required to plant a sweet potato-legume intercrop are costing the same or slightly more than when the two crops are grown separately. Maintenance and harvest of intercropping or relay cropping systems are similar to when cultivating sweet potato and legumes as monocrop cultures.

Client Segmentation. Extension agents on behalf of combined sweet potato and legume farmers producing for household purposes or markets.

Potential Profitability. A higher land equivalent ratio is achieved by intercropping sweet potato and legumes than when growing the two crops separately owing to greater productivity per area of land. Studies have shown that high density intercropping of sweet potato with bush beans yields a higher profit than low density planting arrangements, and also give higher yields of vine herbage than monocrop sweet potato. In southeastern Nigeria is was found that intercropping sweet potato with soybean gave the highest total yield, but mixing with cowpea was most efficient in land use and gave the highest farmer income. Data from the Philippines demonstrates that tuber yields of sweet potato intercropped with inoculated legumes were 6.5% higher than when intercropped with uninoculated legumes.

Licensing Requirements. This technology is most useful when applied within extension messaging.

Innovation as a Public Good. This technology is too general to be considered a Regional Public Good but it is nonetheless and important component of this catalog’s technology toolkit.

Technology 9. Silage Production from Sweet Potato Vines

Summary. Processing sweet potato vines and unmarketable tubers into silage provides a high quality fodder for all class of ruminants and pigs. This silage can be stored for later use during gaps in fodder availability. This simple fermentation of feed stocks that takes place enhances digestibility and conserves both proteins and carbohydrates, making it an excellent supplement to fresh feeds. Adding silage to the normal rations of ruminants helps them to grow fast because it has a large nutrient content, and fills their stomachs so they do not feel the pangs of hunger and waste body reserves. For more information contact Dr. Paul Demo of CIP by email at p.demo@cgiar.org

Technical Description. Sweet potato silage is made by chipping residues of vines and off-grade tubers into small pieces and fermenting these under moist, air-free conditions. The process causes the breakdown of the trypsin enzyme that is found in fresh vines and improves its digestibility and nutritional value for ruminants. Putting silage into plastic sheets or containers has several advantages compared to traditional open pit systems because there are no losses of nutrients through drainage and degassing, as well as much lower risks of spoiling the silage during storage and feeding. Manual compacting drums and mechanized baling presses are available that enable to achieve optimal moisture contents and high storage densities for silage, suitable for subsistence and commercial farmers. These improved forms of silage can make sweet potato vines and tubers ready-to-eat for livestock in a minimum of three weeks and allows storage for up to a year whereby providing farmers and breeders various opportunities to better manage fodder supply.

Chipping OFSP vines prior to ensiling

Uses. Sweet potato silage is ideally suited to complement grass-based feeds like Napier cuttings and maize stover for beef and dairy cows, swine, sheep and goats, and can be fed to heifers and piglets of after three months of age. Farmers in Kenya have found that using this mixture of feed in silage lead to a 10% larger milk production compared to sole grass feed regimes. Proper conservation of sweet potato residues address the shortage of nutritious feeds during dry seasons and related price fluctuations that affect livestock farmers. It also provides avenues to reduce waste in rural and urban areas that can open up business opportunities for youth and women.

a) Digging a trench and lining it with plastic sheets

b) Filling the pit with material and compressing it for removing air

c) Closing the silage by wrapping and fixing the plastic sheets

Steps in silage small-scale preparation

Composition. Residues from vines and poor quality tubers from sweet potato are collected when harvesting the crop. Freshly gathered vines need to be chopped into pieces of 5 - 7 cm long (2 - 3 inches) and fresh roots need to be made into chips/chunks of less than 1 cm (0.4 inch). For the fermentation process to go on well, chopped vines and chipped tubers should be mixed in the right ratio (usually 70:30), and soaked in water containing molasses (10:1 ratio) and some salt (0.05 percent).

Swine feeding upon OFSP vine silage

Application. Cutting of vines and chipping of tubers can be done by hand but requires much effort, but an electric chipper can allow to process large amounts of feedstock into optimal sizes for silage. Sheet plastic with a thickness of 0.1 mm or plastic containers can be used in various ways to create air- and water-tight conditions; the most recommended being 'bag silos' where silage is compressed into tubes that are sealed on both ends, 'stack silos' where silage is piled up into mounds, and 'trench silos' where pits of up to 2 m length are dug and plastic-lined. Silage can be compacted using a metal drum fitted with tubes for displacing air and draining excess water, using human power and weight to compress the substrate. There are also medium- to large- sized, electric-powered, mechanized press systems available prior to fermentation. Once silage has been opened it needs to be fed to livestock in a short enough time to avoid its becoming spoiled, as for this the size and means of storage have to be adapted to the different demands of the livestock within the contexts of small-scale and commercial farmers.

Commercialization. Silage bags are commercially available, as are hand and mechanical equipment to prepare vines and tubers for fermentation. Silage may be sold to others for profit.

Startup Requirements. 1) Sensitization of farmers and fodder producers on the comparative advantages of sweet potato silage systems, 2) Identifying the right mixtures and set-ups for silage production depending on feedstock availability and demand, 3) Rental or purchase of chipper, and compacting drums or press systems (optional), 4) Investment in plastic sheets or tubes, sealing materials and digging of trenches (optional), 5) Collection or buying of fresh vines and tuber wastes from sweet potato, and 6) Organize on-farm use of silage fodder or sales on local markets.

Production Cost. Piloting projects in Uganda have estimated that the materials and labour required for making 500 kilogram of sweet potato silage using the plastic bag method cost less than US $30, next to a one-time capital investment for a compacting drum for US $50. Using the trench silo method costs US $55 in materials and labor for 500 kg of sweet potato silage.

Customer Segmentation. Sweet potato farmers, livestock farmers, fodder manufacturers and feed traders.

Potential Profitability. Making silage from sweet potato residues after the crop has been harvested enables farmers to reduce purchases of livestock fodder from external sources and thereby increases profit margins of animal rearing activities. The gains in milk and meat production, as well as nutritional health of livestock, which are achieved by complementing diets with sweet potato silage allow repayment in investments in materials and labor for generating the fodder, or its purchase from local sources. A survey of smallholder pig farmers in Uganda with a majority of women farmers identified the willingness-to-pay price for sweet potato silage is US $0.20 per kilogram. Indeed, production of silage from sweet potato silage has potential at a variety of scales and may be regarded as a value-adding process within sweet potato production enterprise.

Licensing Requirements. No license required to produce silage.

Innovation as a Public Good. Ensiling sweet potato is regarded as a Regional Public Good advanced by CIP that assumes responsibility for its further development and scaling.

Technology 10. Puree Production as a Means of Value Addition

Summary. Processing sweet potato tubers into puree and its utilization for baked and fried products may be conducted as a year-round activity and offers an avenue for commercialization and local business development. Orange-fleshed sweet potato puree provides a cost-effective and healthy alternative to wheat flour as it can substitute for 30-60% of the flour in a wide range of processed foods, whereby reducing production costs and increasing nutritional value. For more information contact Dr. Paul Demo of CIP by email at p.demo@cgiar.org.

Technical Description. Fresh tubers of sweet potato tubers perish rapidly, but when turned into puree the food becomes stable for longer periods. Making puree from sweet potato tubers can be done with commonly available small industrial food processing equipment. Vacuum-packed storage technology with preservatives furthermore permits the puree to be stored at room temperatures for up to four months, enabling widespread use of the processed food by bakeries and vendors.

Extruding OFSP puree from cooked sweet potatoes

Uses. Puree can be used for baking breads, muffins, cup cakes, cookies and chapatti, or fried products like doughnuts, as well as concentrated products such as baby food, porridge, soups and smoothies.

Composition. Puree of orange-fleshed sweet potato has a high pro-vitamin A content, and food products that are made with puree are more nutritious than common wheat-based foods. Sensory testing of processed purees and their manufactured end-products has demonstrated a high public acceptance of appearance, aroma, texture and taste.

Application. The process to make sweet potato tubers into puree is relatively simple. It requires quality roots from local farmers, cleaning the fresh tubers and steaming them, removing the peels, and mashing or pureeing the flesh.

Commercialization. The equipment for producing puree is commercially available, and the product has commercial value.

Startup Requirements. 1) Availability and continuous supply of quality OFSP roots, 2) Good supply chain management from farm to

OSFP puree offered for sale as a nutritious food ingredient processing plant, 3) Information sharing with producers and processors to align expectations and roles, 4) Technical backstopping to factory staff and extension service providers, 5) Training of farmers in quality standards and post-harvest handling, and 6) Consumer awareness and demand creation among farmers, producers, and consumers.

Production Cost.A study in Kenya found that the cost of producing OFSP puree amounted to USD 0.53 per kilogram in a cottage sized facility, which is below the current production cost of wheat flour at USD 0.61 per kilogram. Increasing the boiler equipment could decrease the manufacturing costs of sweet potato puree to USD 0.36 per kilogram.

Bread prepared with blended wheat flour and OFSP puree

Customer Segmentation. Farm cooperatives and industrial food processors.

Potential Profitability. In Kenya it was found that an additional net profit margin of 18% can be achieved in a simple processing facility, and increase to 42% when processing capacity is expanded. Trade projections suggest that Sub-Saharan Africa will import 35.4 million MT of wheat by 2050, or about 80% of its demand. Sweet potato puree technology is creating large opportunities to replace these imports with locally produced ingredients, generating additional income and jobs.

Licensing Requirements. Food processors require licenses from local authorities but community-level operations often do not.

Innovation as a Public Good. Regional public good, International Potato Center is responsible for development and scaling.

Conclusions

This catalog provides a wide variety of options for modernizing sweet potato production and processing in Africa. It identifies means to improve nutritional value of sweet potatoes, and to grow varieties that resist drought and disease. It provides better options for vegetative propagation of these new varieties, particularly by raising cutting materials under vector-free conditions within affordable protective structures. It advances field production by signaling the importance of raised bed cultivation, better mineral nutrition from specially-blended fertilizers, and the advantages of intercropping sweet potatoes with grain legumes. Sweet potato residues are also valuable, particularly as animal feeds and the catalog provides a means to preserve feeds by ensiling its vines. While sweet potatoes are an important human food, it may also be processed into a wide variety of products and the preparation of puree is one means to add value to this crop.

This catalog was prepared with a variety of users in mind whether they be producers, agents of agricultural development or private sector investors. Farmers can use many of these catalog items as production guidelines. Those from the public sector can utilize the catalog as a whole and design agricultural projects involving sweet potato around its toolkit of modernizing technologies. Members of the private sector, including propagators, input manufacturers, processors and investors also benefit from the contents of this catalog. Indeed, The Technologies for African Agricultural Transformation Program's Clearinghouse welcomes feedback on its contents.

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Back cover photographic credit: Youth belonging to the Kibwezi Hortipreneur Youth Group harvesting vines of improved OFSP varieties in Kenya (Photograph by Ms. Elizabeth Mwakali).

Orange Fleshed Sweet Potato: Technology Toolkit Catalog

In collaboration with