The importance of measuring financial viability: the example of orange sweet potato processing in Uganda

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Processing agricultural produce can be a way for farmers to avoid fluctuating crop prices and improve the nutritional status of their households. For such processing to add value and increase farmers' incomes, there are a number of factors that need to be ascertained.

This paper puts forward a methodology for calculating the cost of capital equipment, raw materials, and processing costs on an annualized per kilogram basis. This enables producers to compare their production costs with the price offered for the final product, including the dried chips produced for sale by small-scale producers .

The key message is not that orange sweet potato processing should be abandoned but to highlight the areas that need to be addressed by implementing organizations, particularly given the extent that past root crop processing initiatives have relied on uncosted time and free financial inputs by the promoting organization. The true costs of processing should be identified, using a similar methodology to that suggested here, and discussed with groups who express an interest in processing. Markets, and all the quality requirements, must be established with a buyer before production is started.

This research is based on work undertaken as part of the HarvestPlus Reaching End Users project in Uganda to promote the uptake of vitamin A-rich orange sweet potato by small-scale farmers – a project funded by the Bill and Melinda Gates Foundation between 2006 and 2009 to reduce vitamin A deficiency.

Keywords: crop processing, orange sweet potato, annualized cost methodology, small scale producers,

Introduction

THIS RESEARCH IS BASED ON work undertaken as part of the HarvestPlus Reaching End Users (REU) project in Uganda to promote the uptake of vitamin A-rich orange sweet potato (OSP) by small-scale farmers – a project funded by the Bill and Melinda Gates Foundation between 2006 and 2009 to investigate ways to reduce vitamin A deficiency.

The purpose of the research was to investigate the financial viability of small-scale processing of vitamin A-rich OSP into chips for milling and for incorporation into commercially processed products, such as nutri-porridge mixes. It is based on information from several sites in Uganda to inform decisions on whether to support

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OSP processing. Peters and Wheatley (1997: 1) point out that although sweet potato roots can be processed into numerous products, 'in any given location the range is much more restricted' due to the costs involved. Research into the use of sweet potato flour in bread making was undertaken in the United States in the 1920s (Gore, 1928). More recently, numerous references can be found in sweet potato marketing literature to the production and use of sweet potato flour in noodles in China and in Indonesia (Peters and Wheatley, 1997) as well as to non-food industrial uses for sweet potato starch. The production of sweet potato flour from OSP in Eastern Africa has been the subject of considerable research and development effort. Numerous reports and newspaper articles from Kenya attest to the benefits of producing and using OSP flour in micro and small and medium enterprise (SME) commercial applications. The processing of agricultural produce is frequently encouraged in agricultural policy to add value, stabilize prices, generate increased rural income, contribute to industrialization and generate foreign exchange (World Bank, 2007). The drying of sweet potato chips and slices is a traditional food preservation method in Eastern Uganda.

The reason for promoting the addition of OSP flour to a product is to increase its vitamin A content, although the OSP flour's colour and sweetness may provide added benefits. It can substitute wheat flour in bread and cakes to a certain extent, thereby reducing foreign exchange costs of cereal imports. However, with the type of chip storage methods traditionally used, it is questionable whether the resulting products retain much beta-carotene.

A considerable amount of applied research into OSP processing has been undertaken in Uganda by the Post-Harvest Programme of the National Agricultural Research Laboratories at Kawanda (NARL). This has involved determining the best sizes of chipped root material to enable fast drying and the optimal designs for drying racks. In addition, numerous recipes have been tested for SME use of OSP flour in bread production and in a multi-flour/grain porridge mix known as nutri-porridge. This work also led to small-scale commercial production of small manual and mechanized chipping machines.

More recent work by the Department of Nutrition at Makerere University and by NRI at NARL has tested optimal chip drying methods for beta-carotene retention. Rapid sun drying was shown to be most effective for retaining maximum amounts of beta-carotene (Bechoff, 2010). Research into the best methods of chip storage and optimal storage periods to minimize the loss of beta-carotene – a very important issue considering the great claims that are made regarding OSP chip products' contribution to vitamin A availability and uptake – found that OSP chips should not be stored for more than three months (Bechoff et al., 2010).

OSP chip production was introduced in two districts, Soroti and Luwero, by a Crop Post-Harvest Programme (CPHP) project funded by the Department for International Development (DFID) between 1997 and 2000. Indigenous sweet potato processing technology was found to be unprofitable, due to high labour costs and lack of adapted tools. The project introduced a sweet potato slicer that reduced the labour requirement by 10 times and increased the profitability of processing sweet potatoes into dried chips by four times. More than 500 sweet potato slicers were manufactured by a local private company and sold to farmers and processors in the Soroti area. Three OSP groups were established to undertake chip making and between 2006 and 2008 they sold chips to two grain milling companies in Kampala. A partial financial analysis was given in the manual on sweet potato integrated production (Stathers et al., 2005).

The objective of this research was to determine the circumstances under which OSP processing was financially viable for small-scale producers, particularly where they were being supported by an external agency. The study uses a break-even approach and applies a sensitivity analysis to key variable factors to ascertain the break-even costs of batch processing. These key variables include the value of roots; root to chip conversion rates; losses; number of drying days; chip buying prices; and transport costs.

The aim is to provide implementers with a guide to the particular issues they should investigate with a producer group considering investing in chip production. A limitation to the application of the methodology is knowing how to capture the value of the amount of labour required. In many groups, the necessary labour may be provided free as part of a group activity, or unpaid family labour may be used. However, it is important to include a realistic value for this so that processors appreciate the amount of time input needed and how they might otherwise use this time, or what the cost would be if they had to employ someone.

A further issue is the price of the fresh sweet potatoes. Small quantities of OSP can command a high price but demand for OSP may be quite low, as it was at the time of this research when OSP was still relatively unknown. It was difficult for farmers to find a market willing to pay more than the going price for white- and yellow-fleshed sweet potatoes.

The study draws on reported experiences of NRI research undertaken at the National Agricultural Research Laboratories at Kawanda and by OSP processing groups – the Bagyabasaga group and the Bulabakulu group in Luwero district in Central Uganda, and the Soroti Sweet Potato Producers and Processors Association (SOSPPA) in Soroti district in Eastern Uganda. Information relevant to the three REU project districts of Kamuli, Mukono, and Bukedea is also provided.

Key cost centres in OSP processing

Information on the costs involved in processing – raw materials, capital equipment, processing inputs – is given here along with respondents' views of sales opportunities, quality requirements, wastage, total production costs, and sales income.

Raw materials

The key cost in processing is the cost of the roots, but it is not always easy to ascertain this. Depending on the location and the time of year, non-OSP varieties varied between 3,000 Ugandan Shillings (Ush) and Ush 35,000 per sack (the exchange rate in March 2008 was US$1 to Ush 1,650). If there is a ready market for OSP then the relevant price is the price at which they could be sold minus any transaction

Table 1 Farm-gate prices of sweet potatoes (Ush per sack; average weight 184 kg), 2006–07

	Kyere (Soroti)	*Bukedea*	*Kamuli*	*Mukono*
September	8,000	12,000	10,000	16,000
October	5,000	10,000	10,000	16,000
November	3,000	9,000	9,000	16,000
December	3,000	8,000	8,000	20,000
January	5,000	12,000	10,000	20,000
June	15,000	20,000	20,000	35,000
July	12,000	16,000	15,000	30,000
Average	7,285	12,428	11,714	21,857

costs. This may not be the maximum retail price obtainable for a small quantity but a realistic price for a larger quantity. Table 1, based on fieldwork undertaken in 2006–07, summarizes the prices of sweet potatoes (non-orange varieties) in three locations, for the months in which chip processing is likely to be feasible.

The main harvesting periods for sweet potato are between November and January and June to July. The main drying periods are mid-October to mid-February and June and July, although there is a slight regional variation. Groundnuts, millet, rice, and maize are harvested between July and September so drying racks may be in use then for these crops. The optimal drying season is between the second half of September and the end of January. Although sunny conditions prevail in February, sweet potatoes are usually scarce then and prices are higher. The sunny conditions that occur in June and July could allow drying but the price of sweet potato roots is usually high in July, making chipping unattractive.

The number of batches that can be completed per week and per month affects the profitability of chip processing. Table 2 gives an estimate of the maximum number of batches it is possible to produce during the months when it is most feasible to

Table 2 Estimates of feasible drying periods and batch production per week and per month

Maximum no. of drying weeks per month		*Maximum no. of batches per week*	*Maximum no. of batches per month*
November	4	1	4
December	4	2	8
January	4	2	8
February	2	1	2
June	1	1	1
July	1	1	1
September	2	1	2
October	3	1	3

dry sweet potato chips. Although it may be physically possible to dry chips in these months, it may be uneconomic due to the high price of fresh roots, particularly in June and July when demand is high due to food shortages.

During the eight months, there are 13 weeks when chipping is most viable due to the dry weather: two weeks in September, three in October, and four in November and December. In December and January, the driest months, it is possible to get two batches dry in one week. If a total of 20 batches were undertaken a year, using a quantity of 670 kg of fresh roots per batch, it would be possible to produce four tonnes of dried chips a year. These quantities are used as the basis for our calculations (see Tables 3 and 4).

The size of each batch depends on the availability of roots, the available labour for washing and peeling, the throughput of the chipper, and the amount of space on the drying racks. Stathers et al. (2005) suggest the use of 350 kg of fresh roots per batch. In Luwero, the Bagyabasaga group had four drying racks (each measuring 1 m × 12 m = 12 m^2). Each rack can dry 50 kg of chips, giving a total of 200 kg of dried chips per batch. For this, an average of 550 kg of fresh-chipped sweet potato is required, which equals 670 kg of washed roots (to take account of 20 per cent wastage from peel and bruised flesh). Sweet potato is sold by the sack (often referred to as a bag) rather than by weight and sack weights vary. We have assumed an average of 184 kg per sack.

Sweet potato contains a lot of water. The aim of drying is to reduce this water content to between 6 per cent and 10 per cent. The conversion rates from sweet potato to dried chips vary with OSP variety. The REU project distributed four varieties of OSP to farmers – Ejumula, Kakamega, Kabode, and Vitaa. Drying rates obtained under trial conditions also vary from those obtained by farmers. For the Ejumula variety, conversion rates under research trial conditions at Kawanda varied between 30 per cent and 32.5 per cent: that is, for every 1 kg of fresh chipped roots, 300 g to 325 g of dried chips were made. For Kakamega, with its higher level of dry matter, each kilogram of chipped roots made 350 g of dried chips.

In Luwero district, the Bagyabasaga group reported that for each kilogram of Ejumula and Kakamega, they obtained 470 g of dried chips (47 per cent), while for Kabode and Vitaa varieties (mature roots) they obtained 750 g of chips (75 per cent). In Soroti, SOSPPA reported that Kakamega needed only 2.75 kg of roots to make 1 kg of chips (1 kg of roots produces 364 g of chips) and that it dries faster, while Ejumula needed 3 kg of roots to make 1 kg of chips (1 kg of roots gives 330 g of chips) but had a much darker colour, indicating a higher beta-carotene content.

Roots need to be trimmed and insect-damaged sections removed before chipping. At Kawanda, between 25 per cent and 37.5 per cent of the roots were unsuitable for chipping. SOSPPA experienced wastage of between 6 per cent and 20 per cent. Their relatively low losses are attributed to the training in crop management that they received during the Farmer Field School. As growers of the roots, they may also take more care with their field and harvesting practices, which reduces damage.

Capital equipment

Hand-operated chippers made by Tonnet Agro Engineering Co. Ltd in Kampala were selling at Ush 500,000 (approximately US$300) while 5 horsepower petrol-operated mechanized chippers ranged from Ush 1,500,000 to Ush 1,700,000 (US$900 to US$1,000). The chippers are said to last more than 10 years if well maintained but would normally be amortized over a period of five years, giving an annualized cost of Ush 138,705 for a manual chipper and Ush 416,115 to Ush 471,597 for a motorized machine at a 12 per cent real interest rate, which is the interest rate minus the cost of inflation. In 2008, the bank lending rate was around 19 per cent per annum and the inflation rate was 7 per cent.

The throughput of the manual chipper is 50 kg to 120 kg of roots per hour, while the motorized version can chip 500 kg to 800 kg per hour. SOSPPA indicated that they were able to chip 720 kg per hour and work for three hours per a day. The limiting factor is likely to be chip-drying space.

Mechanized and manual chipping machines are readily available at Tonnet and the company exhibits its equipment at most of the national agricultural shows. Access to the machines is constrained by the ability to raise the required capital for their purchase. Although several credit schemes operate, very few are tailored towards the needs of rural farmers and processors. SOSPPA was loaned a 5 horsepower motorized (petrol) Tonnet chipper by the International Potato Centre (CIP) , although this may have been to encourage the commercial production of OSP vines and chips.

The costs involved, particularly in acquiring a chipper and a drying rack, are too high for most small-scale farmers to afford on their own. One option is to form farmer groups or associations through which resources can be pooled and the inputs acquired collectively. Farmer groups tend to be more successful when the groups have worked together in the past; transparent, consistent, and innovative leadership is in place; activities in which they are engaged yield satisfactory returns to the individual members; the group's profits and losses are shared in a transparent way; and external 'facilitation' is available to catalyse innovation.

The DFID CPHP project constructed five drying racks at the SOSPPA chairperson's compound, which were estimated to cost Ush 250,000 each. They were constructed using bamboo poles, cement, nails, and polythene sheeting. However, this technology is not popular with the farmers because the cement used to anchor the poles affects the quality of the soil, making it unsuitable for farming. Well-constructed racks can last for at least two years. The racks take up a relatively large area of land or homestead space, given the average landholding size of 3 acres. As a result, most farmers still dry their sweet potatoes on raised platforms on top of rocks, although they have adopted the use of polythene sheets. Drying chips on top of the rocks leads to decolouring, contamination from birds and animals, and higher losses especially when strong winds blow across the drying area.

At a density of 4 kg of fresh chips per square metre, a 10 square metre (1 m × 10 m = 10 m^2) drying rack dried 40 kg of chips in four to seven hours during NRI field trials at Kawanda.

In Luwero, fresh chipped sweet potato needs to be on the drying rack between 9 a.m. and 10 a.m. in order for it to dry in one day. In Soroti, a batch of chips can dry in two to four hours at peak drying periods, but usually between four and six hours of sunshine are needed for complete drying of the chips in November and December. However, at other times, the chips may be covered up overnight and the drying continued into a second day. To ensure that drying is completed in one day, chipping should start by 6 a.m. and be completed by 9 a.m.

It takes a minimum of two days to prepare, chip, and dry a batch of sweet potato roots. The first day is taken up with root harvesting, trimming, and washing; the second day with chipping and drying. A third day will often be needed to finalize the drying, especially of the thicker offcuts, and for packing the chips.

Processing costs

Chip production is a labour-intensive activity. Labour is required to dig up the roots and bring them from where they have been grown to the processing and drying area; sweet potatoes are head-carried from the field to the homestead, mainly by women and children. Depending on the quantity harvested and the availability of labour and technology, sweet potatoes may also be transported on a bicycle or by ox cart or sledge. In Soroti, the cost of head-carrying two sacks of sweet potatoes, approximately 375 kg, from a relatively nearby garden (0.5 km) was given as Ush 1,000.

The sweet potatoes have to be washed, which is arduous and time-consuming. The task is affected by: distance to the water source; availability of water, especially in the dry months of December and January; the shape of the sweet potato roots; and soil type and texture. In Soroti, it was often difficult to find people who were willing to wash sweet potatoes, particularly for more than one day.

Labour is then required to trim roots and remove damaged portions; to operate the chipper to grate the roots; to lay the fresh chips out on the drying racks; to periodically turn the chips and check on the drying rate; to bag the dried chips; and to carry the sacks to a store. The chips need to be taken to a pickup point for transport to the processor. The Bagyabasaga group estimates that it takes two people one day for each of these operations, at a rate of Ush 3,000 per day.

To wash one sack of sweet potatoes (184 kg) needs approximately 9 jerrycans of water (a total of 180 litres) costing Ush 200 per jerrycan of 20 litres, a total of Ush 1,800. The cost of water to wash a batch of 670 kg of roots is Ush 6,700.

Equipment required includes washing bowls, knives, tarpaulins or plastic sheets, rakes, and chip storage sacks. Ordinary storage sacks cost Ush 800 each. However, they are likely to be very poor in retaining the beta-carotene content. A modified packing bag with a black lining costs Ush 4,000. This type of bag reduces decolouring and may enhance pro-vitamin A retention.

The motorized chipper can chip 750 kg of roots using 1 litre of petrol. It uses smaller quantities of engine oil as well. The cost of a litre of petrol is Ush 3,000.

Transport costs to the buyer vary according to the location of the farmer group or producers. Given the quantities of chips produced per batch and the demand for processed chips, it is unlikely that any particular group would transport more than 2 tonnes per trip. An estimated cost of Ush 5,000 per 50 kg sack of chips has been included in the analysis.

An amount should be allowed for the cost of phone calls and for record keeping, and a storeroom will be needed for storing processed chips prior to selling. A 5 per cent contingency is included to cover this and other expenses.

Sales

At the time of the study, the market for dried OSP chips in Uganda was limited to one or two buyers: Maganjo Grain Millers and Kasawo Grain Millers, both located in Kampala. Employees from these two companies had been involved in developing and testing orange sweet potato-based nutri-porridge recipes with the NARL Post-Harvest Programme.

Maganjo Grain Millers is a large commercial milling company. They first produced a nutri-porridge meal from OSP (20 per cent), groundnuts (10 per cent), soya (20 per cent), and maize (50 per cent) in 2004 after working with Constance Owori from NARL and continued making it until 2006. The product was sold to Shoprite, Embassy, Quality, and Payless supermarkets.

A major Kampala supermarket complained that the nutri-porridge had a 'flat' taste and that it was 'sticky' – an indication, apparently, that it was not made with OSP. The flour was not tested for vitamin A content although it was promoted as being rich in vitamin A. Product acceptability testing was done with Maganjo staff and then with people in shopping areas. The OSP nutri-porridge was popular with customers but production was halted as farmers stopped supplying OSP chips. This was reported to be due to their not receiving a high enough price, considering the price they could obtain from selling fresh roots. The managing director expressed her willingness to negotiate with the farmers as the company was very positive about OSP chips and in providing a market outlet. Maganjo had spearheaded the use of OSP chips in its nutri-porridge but had run into problems due to the unreliability of OSP chip supply; farmers' complaints about the price of chips (Maganjo paid Ush 370 per 450 kg, delivered to Kampala); and the poor quality of chips due to poor drying.

Maganjo expressed interest in working with organized groups of farmers, so that they could take care of quality control and could supply larger amounts: 500 kg every two weeks (1 tonne per month), as had been supplied previously, increasing to 2 tonnes per month. The milling company expressed a willingness to enter into contracts with such organizations if issues relating to quality and product consistency were addressed. Storage and moisture content would not be a problem as Maganjo has its own storage and drying facilities. Also, the chips could be transported as a backload when the company's delivery vans returned from trips to Soroti. Maganjo's main quality requirements were that the chips should be clean, with an orange colour, and dried to a moisture content of not more than 14 per cent. Food quality aspects and freedom from contaminants, particularly faecal coliforms, would need to be ascertained and producers trained in good hygiene practices. As of March 2008, no standards for nutri-porridge have been developed by the Uganda National Bureau of Standards (UNBS). In theory, all products sold in a package should meet Ugandan labelling requirements.

Kasawo Grain Millers Ltd is a small milling company that produced a nutri-porridge flour, advertised as being 'Rich in vitamin A and protein: good for your health'. This was made from soya beans, OSP chips (30 per cent) and groundnuts. It was sold in the company's trading store at Nateete in western Kampala. The company has a long history of producing and supplying a range of grains and flours, and the director worked with NARL staff to develop a production system. Customers bought the flour for their children and reported noticing an improvement in their children's appearance – 'children look better' – after consuming the OSP porridge. Demand was greatest in school holidays. Kasawo sold 10 cartons per week (each containing 12 boxes weighing 400 g = 48 kg) in December 2006. However, by March 2008, the director felt that demand had increased and that she was confident of selling 1 tonne of the mix per week, which, with 30 per cent OSP chips, would mean a market for 300 kg of chips a week for each week of the year. In 2007, she had been able to sell 1 tonne of the OSP porridge mix each term for three terms to a boarding secondary school.

The price paid for the chips varied slightly according to the season. During peak OSP production, which coincided with the best drying weather, Kasawo paid Ush 500 per kilogram. The director recognized that farmers need to be trained on quality, particularly to maximize beta-carotene content, as she required chips with a good orange colour. In November 2006, the porridge mix was sold in clear plastic sachets, which exposed the OSP flour to light. Subsequently, a CIP-supported sweet potato innovation platform – the Participatory Market Chain Approach (PMCA) – worked on a new packaging design. This consisted of a multi-coloured design printed onto a white paper packet in place of the transparent cellophane bag. These bags helped sell the product, despite the price having to be raised to cover the increased cost of the new packaging. A 1 kg bag of nutri-porridge sold for Ush 2,000 in 2007.

Kasawo did not have formal contracts with its OSP chip suppliers but via the PMCA developed good relationships with other farmer members who supplied the chips. When poor-quality chips were supplied, the supplier was told to take them to a poultry-feed producer, who paid around Ush 200 per kilogram for them in 2007. In March 2008, Kasawo did not have any OSP flour for sale. The last time the mix had been produced was in January 2008 because there had been a lack of OSP chips and a shortage of soya.

SOSPPA started making OSP chips and selling them to Maganjo Grain Millers in 2002. They initially negotiated a price of Ush 700 per kilogram of chips but the price came down to Ush 500 and then to Ush 300, and eventually down to Ush 270 per kilogram. They then started supplying Kasawo Grain Millers in 2007, who offered Ush 500 per kilogram. Given the prevailing price of roots in November 2006, it appeared that they may have been producing and supplying OSP chips at a loss. In 2003, SOSPPA made 12 tonnes of chips but did not sell them as the price offered was too low. There was no alternative market for the chips. They mixed 5 tonnes of chips with maize and milled this to make composite flour for distribution to internally displaced people. Some chips were purchased by Kasawo Grain Millers but, due to poor storage, the colour was pale. The remaining chips were kept for two years and mixed with cassava. In 2004, no market was found so chip production stopped after 3 tonnes had been produced. One tonne of composite flour made from

OSP chips (30 per cent), maize (30 per cent), soya (3 0 per cent), and cassava (10 per cent) was supplied to Health Link Uganda at Ush 1,000 per kilogram. Production costs included the milling charge plus milling loss (1 kg of OSP chips produces 800 g of flour). Drying rack space was their main limiting production factor.

SOSPPA felt that OSP flour could be supplied to boarding schools and day schools for lunch dishes. In 2007, the group started making composite flour called 'Porridge Special' made from the Epuripur sorghum variety (50 per cent), OSP (30 per cent), groundnuts (15 per cent) and cassava (5 per cent). It was milled at a cost of Ush 70 per kilogram. Other costs included transport to the mill (Ush 3,000 per person and Ush 2,000 per bag) and the milling loss of 4 per cent. The PMCA supported SOSPPA to acquire 10,000 1 kg retail packs, of which 5,000 were delivered. The composite flour was priced at Ush 2,500 per kilogram and it is estimated that 1 tonne was sold in 2007. The main customers were local health sector NGOs and projects such as Health Need and the American Medical Research Foundation (AMREF). Health workers in the nearby health centre occasionally referred patients to the group for OSP flour. The flour was exhibited at the national agricultural show, where it attracted a lot of enthusiasm from a number of people.

The Bagyabasaga group in Luwero said that its key problem was that the chips go mouldy. The group did not own its own chipping machine and relied on borrowing one from the Zonal Agricultural Research and Development Institute (ZARDI) at Mukono and having it transported from Mukono to Wobulenzi, a journey of several hours. This restricted the time when they could make chips and limited the possibility of using optimal drying weather. The Bulabakulu group in Luwero has a manual chipping machine, which it thought cuts chips to a good size. In November 2006, the group planned to make a new drying rack with a black polythene cover to protect partially dried chips. They had a ready market with Kasawo Grain Millers for chips; the company initially bought them for Ush 700 per kilogram but later reduced this to Ush 500. Maganjo Grain Millers used to pay Ush 1,000 per kilogram when supply was scarce. Kasawo was looking for 3,000 kg per week from February 2007. The group had an agreement with Kasawo to be paid Ush 500 per kilogram if chips were collected from Zirobwe and Ush 700 if the group supplied them to the factory in Kampala. The group prefers Kasawo to collect the chips from them; the 700 kg they supplied to the factory incurred a high transport cost.

Discussion

The key costs outlined above are put together in Table 3 to estimate the production cost per kilogram of dried OSP chips. A number of assumptions have been made about prices and quantities that could easily be changed to reflect local realities.

At a price of Ush 12,000 per sack weighing 184 kg for fresh OSP roots, the total costs of production per kilogram, based on 20 batches per year, were similar to the price offered for dried chips in Kampala. The total cost per batch comes to Ush 499 per kilogram while the price offered is Ush 500 per kilogram. With these unit costs, it would not be profitable for chips to be made if the average price of OSP during the six to eight months when drying is feasible exceeded Ush 12,000 per sack.

Effect of raw material cost on the break-even point

In Uganda, the best time for drying coincides with the lowest prices paid for roots, but the price paid per sack did not fall below Ush 8,000. At that price, the estimated difference between the cost per kilogram of producing the chips and transporting them to Kampala and the buying price in Kampala was only Ush 78 (or US$0.05), which is very little considering the management and risk involved.

If the average cost of roots falls to Ush 3,000 per sack – the lowest price in the peak of the season – and all other costs remain the same, then chip processing becomes more financially viable (see Table 4) as a Ush 173 surplus per kilogram is generated, or

Table 3 Break-even cost of OSP chip processing (Ush per kg of dried chips), based on 20 batches of 670 kg of roots

Costs	*Amount*		*No.*	*Unit*		*Rate/unit*	
Roots	43,680	Ush/batch	3.64	sacks	@	12,000	Ush/sack
Washing water	6,700	Ush/batch	670	litres	@	10	Ush/litre
Labour	9,000	Ush/batch	3	work days	@	3,000	Ush/day
Fuel	3,000	Ush/batch	1	litres	@	3,000	Ush/litre
Sacks	3,200	Ush/batch	4	sacks	@	800	Ush/sack
Fixed costs	5,386	Ush/batch					
Transport to mill – Kampala	24,000	Ush/batch	4	sacks	@	6,000	Ush/sack
Contingency @ 5%	4,748			(5% of variable and fixed costs)			
Total costs	99,714	Ush/batch					
Total costs per kg	**499**						
Fixed costs							
Chipper	1,750,000	Ush		(includes Ush 50,000 for transport from factory)			
Useful life	5	years					
Real interest rate	12%						
Annualized capital costs	485,467	Ush					
Annual production	4,000	kg	200	kg/batch		20	batches/yr
Cost per batch	2,427	Ush/kg		dry chips			
Dryers	100,000	Ush	4	dryers	@	25,000	each
Useful life	2	years					
Real interest rate	12%						
Annualized capital costs	59,170	Ush					
Annual production	4,000	kg	200	kg/batch		20	batches/yr
Cost per batch	2,958			dry chips			
Total fixed costs	5,386	Ush/kg					
Revenue	500	Ush/kg					
Break-even point	1						

just over 50 per cent return on costs. However, it should be noted that no managerial costs are included in the analysis – only the direct cost of labour. According to field research, sweet potato prices only fall to this level in Soroti during the main production months of November and December and this does not occur every year.

Effect of reduced capital costs on the break-even point

If the number of batches is increased to 24 from 20, this reduces the annualized capital cost per batch; however, this makes virtually no difference to the cost of production.

Table 4 Viable costs of OSP chip processing (Ush per kg of dried chips), based on 20 batches of 670 kg of roots with significantly lower root prices

Costs	*Amount*		*No.*	*Unit*		*Rate/unit*	
Roots	10,920	Ush/batch	3.64	sacks	@	3,000	Ush/sack
Washing water	6,700	Ush/batch	670	litres	@	10	Ush/litre
Labour	9,000	Ush/batch	3	work days	@	3,000	Ush/day
Fuel	3,000	Ush/batch	1	litres	@	3,000	Ush/litre
Sacks	3,200	Ush/batch	4	sacks	@	800	Ush/sack
Fixed costs	5,386	Ush/batch					
Transport to mill – Kampala	24,000	Ush/batch	4	sacks	@	6,000	Ush/sack
Contingency @ 5%	3,110			(5% of variable and fixed costs)			
Total costs	65,316	Ush/batch					
Total costs per kg	**327**						
Fixed costs							
Chipper	1,750,000	Ush		(includes Ush 50,000 for transport from factory)			
Useful life	5	years					
Real interest rate	12%						
Annualized capital costs	485,467	Ush					
Annual production	4,000	kg	200	kg/batch		20	batches/yr
Cost per batch	2,427	Ush/kg					
Dryers	100,000	Ush	4	dryers	@	25,000	each
Useful life	2	years					
Real interest rate	12%						
Annualized capital costs	59,170	Ush					
Annual production	4,000	Kg	200	kg/batch		20	batches/yr
Cost per batch	2,958			dry chips			
Total fixed costs	5,386	Ush/kg					
Revenue	500	Ush/kg					
Profit	**173**						

Conclusions

Processing agricultural produce, such as OSP, can be a way for farmers to avoid fluctuating crop prices and improve the nutritional status of their households. For such processing to be a sure way of adding value and increasing farmer incomes, there are a number of factors that support organizations should advise farmers to investigate or should ascertain on their behalf. The two main costs are the costs of the OSP roots and the cost of the necessary equipment. This paper puts forward a methodology for calculating the cost of capital equipment, raw material, and processing costs on an annualized per kilogram basis. This enables comparison with the price offered for the final product.

The key message is not that OSP processing should be abandoned. Rather, the aim is to highlight the issues that need to be addressed by implementing organizations, particularly the extent to which past root crop processing initiatives have relied on substantial time and financial involvement by the promoting organization. Improved yields and greater surplus production may bring down the price of OSP to make processing financially viable.

The true costs of processing should be identified and discussed with groups who express an interest in processing their OSP. Markets, and all the quality requirements, must be established with a buyer before production is started.

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