Project Title: Improving the livelihoods of small-scale sweetpotato farmers in Central Uganda through a crop post harvest-based innovation system

R8273 (ZB0342)

COST BENEFIT ANALYSIS OF SWEETPOTATO-BASED ON- FARM ENTERPRISES IN CENTRAL UGANDA

ACRONYMS

CBA	Cost Benefit Analysis
FOSRI	Food Science and Technology Research Institute
g	Gram
KARI	Kawanda Agricultural Research Institute
Kg	Kilogram
L	Litre
ml	Millilitre
NGO	Non Governmental Organisation
NPV	Net Present Value
PI	Profitability Index
PRAPACE	Regional Network For The Improvement of Potato and Sweetpotato in Eastern and Central Africa
SP	Sweetpotato
UGX	Uganda Shilling
US $	United States Dollar

EXECUTIVE SUMMARY

A Cost/Benefit Analysis (CBA) was conducted to determine the viability of sweetpotato post-harvest technologies introduced by the Sweetpotato Coalition Project. This analysis was found important to determine if expenditure in the post-harvest technologies namely juice production, vine production, chips, flour, and storage structures is economically viable for the target communities. The study was undertaken in Luweero and Mpigi as the project target districts, and Mukono, a non-project district.

Both qualitative and quantitative data were collected using a pre-tested questionnaire. The data included costs and benefits (direct and indirect) met by farmers in undertaking the various technologies, input requirements, prices of inputs and outputs, availability of inputs, as well as qualitative information regarding the acceptability of the technologies by the farmers. The data collection techniques used included interviewing, observing farm records and accounts, and participatory techniques. The major study respondents were individual farmers and key stakeholders in the sweet potato project. In addition to individual interviews, focus group discussions were also carried out to capture vital qualitative information regarding the developed sweet potato technologies.

Results of the CBA show that sweetpotato production is a financially viable enterprise with regard to commercial production of tubers, vines, storage technologies and snack production, except for commercial juice production and chip making. As expected, the viable technologies generally require low startup capital and the products are highly demanded in most of the intervention districts. For every Uganda Shilling invested in the production of tubers, farmers can obtain Shs. 2.1, 2.1, and 1.5 in Mukono, Luweero and Mpigi districts, respectively from the sale in local markets. Commercial vine production is viable resulting into 2.4, 2.3 and 1.6 Uganda Shillings for every Shilling invested in production in Mukono, Luweero and Mpigi districts respectively. These results imply that commercial production of sweet potato tubers and vines is viable and so are worthwhile projects to the farmers. Investment in storage structures for sweet potatoes is also worthwhile in all the districts of intervention in that for every Uganda Shilling invested in the construction and management of storage structures for sweet potatoes, farmers can obtain Uganda Shillings12.7, 15.9, and 12.7 in Mukono, Luweero and Mpigi districts respectively. These benefits largely accrue from savings on food and easing of food security constraints at the farmers' level. Investing in processing sweetpotato to flour is also viable from the farmers' perspective in that for every Uganda Shilling invested, farmers can obtain Uganda Shillings 3.7, 2.0 and 1.1 for Mukono, Luweero and Mpigi districts respectively. Except for Luweero district, the investment in snack production out of sweet potatoes is viable resulting in a gain of Uganda Shillings 1.1 for Mukono and Mpigi districts. Commercial production of chips as well as juice is not worthwhile in all the intervention districts at 13% discount rate. With the unviable technologies, the present value of costs outweigh the present value of benefits largely due to large capital outlays required for production in a three-year period. Such investments may be worthwhile over a longer period of project life and a lower discount rate however.

Based on the findings, the following conclusions are made.

i. Sweet Potato has the potential of improving household incomes of rural people and can hence be instrumental in fighting rural poverty. Commercial production of fresh roots both for the local and export market is viable and the financial

indicators can improve when sale of fresh roots for either market is combined with sale of vines.

ii. Production of chips is not viable in the short term; but may be viable in the long term and if a lower discount rate prevails.

iii. Processing of flour is viable whether homegrown or purchased roots are used.

Recommendations regarding enhancement of sweet potato-based technology viability are made and these focus on increasing farmers' organization's negotiation skills and lead to better marketing of products, increased access to market information, and undertaking more research and awareness geared towards improving market access for sweet potato products.

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1.0 . PROJECT BACKGROUND

Sweetpotato is one of the major food crops grown and consumed by the majority of Ugandans. Like many developing countries, Uganda has embarked on value-addition and processing as part of the drive to modernize agriculture. Value-addition has been a promising tool that aids the linkage of smallholder farmers to markets. In response to the call for poverty reduction through increasing value-addition, the Regional Network comprising NARO, ASARECA, CIP, and other institutions have undertaken programs in Uganda to build capacity to add value to agricultural commodities. A coalition representing several institutions, farmers, the private sector, and schools came together and designed a project aimed at improving the livelihoods of small-scale sweetpotato farmers in Central Uganda through a crop Post- harvest based innovation system. This project is a response to easing constraints in sweetpotato production in Uganda, which include lack of access to markets and market information, marketing strategies, knowledge on processing and handling of sweetpotato, and the lack of viable associations for production and marketing. All these resulted in high post harvest losses that led to low incomes by small-scale producers.

The purpose of the project is to sustainably reduce post harvest losses of sweetpotato and increase incomes from sweetpotato-based products in Central Uganda. The project outputs include linking rural sweetpotato producers directly with markets like schools, processors and exporters; develop the post harvest capacity of rural farmers; create income generating opportunities for resource poor youth and women; and develop an institutional mechanism that empowers poor farmers and rural processors to participate in a sweetpotato technology and knowledge innovation system.

The project has increased awareness on the importance of sweetpotato as an income generating crop, increased knowledge and skills in post harvest handling, processing and storage of sweetpotato, improved attitude towards sweetpotato, increased incomes through the sell of sweetpotato and its derived products, improved food security, as well as establishing and strengthening of linkages between farmers and various service providers that has led to a process of farmer empowerment. Among the major achievements of the project is dissemination of several post-harvest technologies to end-users.

To justify expenditure in the post-harvest technologies, there is need to determine their economic viability, and whether the technologies lead to improvement of social and economic well-being of target communities. Thus a Cost Benefit Analysis (CBA) was sought to determine whether the areas of intervention by the coalition are worthwhile from the farmers' perspective. A consultant was hired to undertake the Cost/Benefit Analysis of the sweetpotato post harvest technologies namely juice production, vine production, chips, flour, and storage structure as areas of intervention by the coalition. The study took place in the target districts of Mpigi, Luweero and Mukono.

2.0 METHODOLOGY

2.1 Study Approach

This study utilized the Cost/Benefit Analysis (CBA) approach to assess the importance of project interventions in Sweetpotato production, post-harvest handling and value-addition that are introduced by the coalition. This is the most suitable approach for such a project because the design of optimum technologies that would improve the livelihoods of poor communities requires a comprehensive conceptualization and estimation of the level and distribution of private and social costs and benefits that accrue from alternative intervention strategies. The CBA was conducted on seven technologies that were introduced by the Sweetpotato Coalition Project # R8273 and ZB0342. The technologies are:

a) Improved production of sweetpotato roots for commercial purposes
b) Improved production of vines for commercial purposes
c) Commercial juice production
d) Storage structures for sweetpotato
e) Sweetpotato Chips
f) Sweetpotato flour
g) Sweetpotato snacks

The CBA was used to estimate the total equivalent money value of the benefits and costs to the communities of the various developed technologies out of the sweetpotato crop. This approach focused on establishing whether the developed technologies are worthwhile for the sweetpotato specific intervention sites representing the districts. By assigning costs and benefits to various items associated with the technologies, the CBA emphasized weighing the advantages and disadvantages associated with the various interventions regarding the community and the individual livelihoods. In assessing the advantages, the assumption made was that individual household decisions are concerned with private welfare effects on profits that accrue from sales of sweetpotato products rather than on wider social effects. The fact that individual preferences for the various technologies count, the CBA is useful in deciding whether the developed technologies are socially acceptable. Thus the evaluation of benefits and costs associated with the various technologies involve costs and benefits that accrue to individual households who chose to participate in the project. The decision as to whether the developed technologies are viable or not is based on the following computation:

$$B/C = \sum_{i=1}^{n}\sum_{t=1}^{T} B_{ti}/(1+r)^{t} \div \sum_{i=1}^{n}\sum_{t=1}^{T} C_{ti}/(1+r)^{t} \quad \text{.....(1)}$$

Where
B_{ti} = Benefits associated with technology i in time t

C_{ti} = Costs associated with technology i in time t

t=Life span of the project

n= number of technologies developed

r = Discount rate

For technologies that require investment in capital assets such as dryers, chippers, cutters and so on, the CBA is conducted as follows

$$B/C = \sum_{i=1}^{n}\sum_{t=1}^{T} B_{ti}/(1+r)^t \div \sum_{i=1}^{n}\sum_{t=1}^{T} C_{ti}/(1+r)^t + K_{ti} \quad \text{.....(2)}$$

Where K_{ti} refers to initial capital outlays required for the appropriate technologies

Depreciation of simple equipment such as hoes, pangas, knives was also included in the computation of costs and the Declining Balance method was used to attach value to depreciation of equipment.

It can however be noted in equations (1) and (2) above that the magnitude of the C/B is heavily influenced by the magnitude of the discount rate used to calculate the present value of the costs and benefits. A high discount rate would reduce the present value of benefits and thus the numerator in the B/C ratio. This feature has implications in that a smaller number of technologies would be worthwhile in the sweetpotato specific intervention sites. Conversely, a low discount rate increases the present value of benefits, justifying a larger number of technologies as worthwhile for the target communities.

In conducting the CBA, the following conditions held:-

i) The benefits and costs that are associated with each developed sweetpotato product did not increase or decrease over the project life
ii) The discount rate was regarded as the real interest rate of capital. This put into consideration the time value of money and was computed as follows

Real rate of interest = Nominal rate of interest – Inflation rate

The value of 13% real rate of interest was used for discounting. This rate is also the average rate of interest charged on commercial loans in Uganda (BOU, 2004). Therefore the present value of the stream of benefits and costs was obtained by discounting at 13% interest rate. Again this condition implies that the prevailing macroeconomic conditions heavily influence the viability of projects.

When all these conditions are considered, a worthwhile project is determined as one for which the discounted value of the benefits exceeds the discounted value of the costs associated with the various sweetpotato technologies, i.e. the net benefits are positive. This is equivalent to the benefit/Cost ratio being greater than one.

2.2 Sample Selection

To obtain the data needed to conduct the BCA, a survey was undertaken in the districts of Uganda where sweetpotato intervention program is being carried out. These districts include Mpigi, Luweero, and Mukono found in Central Uganda (Table 1). At the district level, the farming communities that are actively participating in the sweetpotato program were targeted for the survey. Thus the sample selected for the survey was purposive to facilitate easier access to more accurate information about the status of the different

technologies, easier access to data and effective mobilization of sweetpotato respondents. It was easy to locate participants from the program documentation and guidelines. The program participants are also organized in farming groups so mobilization was done through group leaders, which made the data collection exercise cheaper. Twenty-three participants in the sweetpotato program were interviewed.

Table 1: Districts, Counties and Sub-Counties surveyed

District	County surveyed	Sub-County surveyed
1. Luweero	Bamunanika	Zirobwe
	Katikamu	Nyimbwa
2. Mpigi	Mawokota	Nkozi
3. Mukono	Mukono	Goma

2.3 Data Collection and Analysis

Both qualitative and quantitative data were collected using a pre-tested questionnaire. The data needed for the exercise included costs and benefits (direct and indirect) met by farmers in undertaking the various technologies, input requirements, prices of inputs and outputs, availability of inputs, as well as qualitative information regarding the acceptability of the technologies by the farmers. The data collection techniques used included interviewing, observing farm records and accounts, and participatory techniques. The major study respondents were individual farmers and key stakeholders in the sweetpotato project. In addition to individual interviews, focus group discussions were also carried out to capture vital qualitative information regarding the disseminated sweetpotato technologies.

In addition to the questionnaire, a checklist was developed to help collect data from key informants such as researchers, project implementers, and processors. This was vital to cross check the information obtained from the farmers and seek clarification on arising issues.

The collected data were analyzed using excel to come up with Cost/Benefit ratios that represented the financial comparative analysis of the technologies under study. In analyzing the technologies a 3- year period was assumed as the project's life span. Because of differences in economic and social conditions that exist in the different parts of the country, these cause variation in the viability of the technologies that are introduced in the various locations to the extent that some may be unprofitable. To take care of these differences, the CBA captured data on similar projects using the prevailing district-specific information. To ease comparisons across districts and the technology interventions, the C/B ratios were entered in tabular form for ease of visibility.

3.0 RESULTS

Results of CBA and the qualitative information largely based on primary data are presented. Detailed results of the CBA are presented in Table 2 and a summary in Table 3.

3.1 Production technologies and economic importance

The survey showed that different sweetpotato varieties are grown in different areas for different purposes. The major purposes include food consumption, sale, and vine production. The yields varied with variety. The farmers on average reported a yield of 12 tons per acre per annum if the yields are high but this can reduce to as low as 2 tons during the drought season. The major varieties grown are *NASPOT* 1, *New Kawogo*, *Dimbuka, Kala, Kakamega, Ejumula* and *Kakamega (SPK* 004).

The production process for which costs are computed involves land clearing, ploughing, making ridges or mounds, planting, weeding, harvesting, and marketing. The tools involved are generally simple and of low cost and include hand hoes, knives, and slashers. There is no specialized sweetpotato production skills required since production is done in a traditional way.

The production of sweetpotato has several advantages which include early maturity, availability of cheap labour and planting materials, it is easy to grow and its ability to improve both household and community food security. For farmers who already have farm land it does not require heavy start up capital and hence it is suitable for rural people with low incomes.

Sweetpotato fresh roots are mostly sold on the local market and the price ranges between 10,000-20000 UGX per 100Kg sack (equivalent of US $ 5.8-11.6) depending on the availability of the crop. The major buyers are traders who normally come to the farm gate or sometimes go to collection centres in near-by trading centres on specified days. The traders supply the local market especially in urban centers. The demand for sweetpotato is growing due to the hiked prices of the traditional staple food-"matoke"(cooking bananas), the introduction of post harvest processing technologies, the increasing population, improved cross boarder trade with neighboring countries like Rwanda and the Democratic Republic of Congo and improving penetration of the export market. Despite the increasing demand there are times when the supply exceeds the demand and as a result farm gate prices drop to less than US $ 2 per 100Kg sack.

Sweetpotato vines are a major bi-product of the sweetpotato enterprise. With the recent introduction of improved sweetpotato varieties, vines have become a source of income especially to the early adaptors of the improved varieties. The Government of Uganda is implementing an agricultural –based "Plan for Modernization of Agriculture(PMA)"; which encourages farmers to adopt improved production methods. The large quantities of vines needed to introduce the improved varieties in different geographical areas has created a "new" market although traditionally sweetpotato vines were given free of charge.

There are challenges associated with marketing of sweetpotato (i) The farmers generally have low bargaining power compared to other market participants such as the middlemen leading to lower farm gate prices that are offered for the crop (ii) There is

lack of sustainable supply of the produce due to rain-fed agriculture, for which farmers cannot assure constant supplies throughout the year. (iii) Due to lack of contractual arrangements in the sweetpotato market, farmers are never sure of the buyers, prices, and quantities to be transacted. These conditions make farmers uncertain makes farmers uncertain of the business inflows and outflows during the harvest season. Thus farmers suggested that the major focus of any future intervention should directly address market access through the establishment of sustainable and reliable farmer-market linkages.

For the surveyed farmers, sweetpotato, either as tubers or vines is generally profitable. At the real interest rate of 13%, the B/C ratio is greater than one for commercial root production in all the districts surveyed (Tables 2 and 3). Mukono and Luweero districts have a higher Benefit/Cost ratio of 2.1, followed by Mpigi district with 1.5. With commercial vine production, Muko district has the highest B/C ratio of 2.4, followed by Luweero with 2.3 and then Mpigi with 1.6. These results show that the enterprises are worthwhile. Although the figures indicate that the commercial root and vine production are worthwhile in all the districts of intervention, they are mostly recommended for Mukono district.

The socio-economic benefits include the fact that sweetpotato greatly improves community and household food security as the surveyed households treat sweetpotato as a staple food crop. Secondly, the orange-fleshed sweetpotato varieties are rich in Vitamin A, which improves the nutritional status of vulnerable people like children under five and lactating mothers. Thirdly, sweetpotato production and trade have been a major source of employment in the communities especially to women and the youth through providing labor for ploughing, ridge making, weeding, planting and harvesting. Fourthly, the sweetpotato vines are used as protein-rich feed for animals mainly for cows and goats. This is particularly important given the mixed farming practice and the serious land shortage problem in the study districts.

3.2 Post-harvest technologies

Innovations in food processing have led to the spread of utilization methods for sweetpotato. The crop produce can now be processed as chips, juice, and snacks. Although the demand for such processed products is still low, it is increasing especially where public awareness is emphasized. Depending on the post harvest processing technology, additional activities like washing, peeling, chipping, milling, and packaging may be done before marketing.

3.21 Sweetpotato Juice

Juice is produced from orange-fleshed varieties such as "*Ejumula*" and "*Kakamega*". The orange-fleshed varieties have a bright orange-like colour. This natural bright colour enables farmers to produce juice without adding food colour. The sweetpotato is also rich in sugar and this minimizes the quantity of sugar added. Sweetpotato juice provides a substitute for fruit juice when fruits are not readily available. Sweetpotato juice production is a relatively new technology on the local market and there is very little public knowledge about it. The scale of production is still at the trial stage and it is not yet operating as a business enterprise, though farmers sell the processed juice. The involved activities to which costs are attached include acquiring the tubers (either harvesting the fresh roots or buying), cleaning, peeling, steaming, mashing, weighing and mixing with water (normally in the ratio of 3 L of water to 1Kg of fresh roots), filtering and boiling the juice, adding sugar while boiling (at least 500g per 20L) and fruit flavors like orange, lemon, and pineapple, and packing and finally cooling the containers in cold water

Juice is packed in 300 ml, 1L and 5L plastic containers. Currently marketing of juice is done locally. A 300ml container goes for 300- 500 UGX depending on location. In general, there is low public awareness, usage and consumption of sweetpotato juice. There are also challenges in meeting the quality control standards set by the Uganda Bureau of Standards and meeting the high packaging costs. There is still no appropriate equipment for medium scale production towards commercially oriented production.

The profitability of sweetpotato juice is still low. As Tables 2 and 3 show, at the real interest rate of 13%, the B/C ratios are 0.98, 0.9, and 0.99 for Mukono, Luweero and Mpigi districts respectively. These results show that currently the present value of costs is greater than the present value of benefits, thus making the enterprise unviable.

3.22 Storage structures for fresh roots

The storage technology involves digging a pit in the ground preferably under a shade, burry the sweetpotato and then cover the pit with grass to reduce the atmospheric temperature. An average sized pit can hold between 200 and 500 Kg of fresh roots; this means that at an average yield of 6000 Kg per acre (and each pit is used three times a year) a farmer will need to have a minimum of 10 pits to store produce from an acre. This storage technology was introduced in a bid to improve food security by storing fresh roots for a longer time. This technology is aimed at easing the scarcity constraints of sweetpotato. The fresh root technology is a simple technology that can be easily adopted by farmers and the capital outlay is relatively affordable to a local farmer. The profitability of this sweetpotato storage technology is generally high due to its potential of reducing post-harvest losses and easing the food insecurity constraints. As Tables 2 and 3 show, at the real rate of interest of 13%, the B/C ratio is greater than one for storage

structures in all the districts surveyed. Luweero district has the highest B/C ratio of 15.9 followed by Mukono and Mpigi districts with a B/C ratio of 12.7. These results show that the enterprise is worthwhile in the study districts.

3.23 Sweetpotato chips

Sweetpotato can be processed into chips, which can be sold off at this stage or further processed by the farmers to make flour. Preparation of chips involves washing, slicing or chipping, drying and finally packing. The drying process determines the quality of the product; the chips should dry in one day without direct exposure to sunlight, if the product quality is to be good. Currently farmers rely on the fluctuating weather to dry the chips and as a result, the quality of chips keeps fluctuating. The process requires a chipper, which can be manual or motorized.

If a farmer uses a motorized chipper with a chipping capacity of 500 Kg per hour, a farmer can chip fresh roots from an acre (with estimated yield of 6000 Kg) in 12 hours. This implies that a chipper is suitable for commercial production; for example if the chipper is to operate only two hours a day for 5 days a week, 40 acres of sweetpotato would be needed per annum to meet this production capacity. After drying, chips are packed in 100 Kg bags and are sold to millers mainly located in urban centers. The marketing challenges are basically associated with insufficient quantities and low quality standards of dried chips supplied by the farmers, the major production related challenges associated with this technology include low availability of chipping equipment, and lack of weather independent drying facilities. The production of chips is advantageous in that it reduces post harvest losses and the farmer can avoid low prices by adding value through chipping when the price for sweetpotato is low.

The profitability of sweetpotato chips is generally low for the farmers surveyed. At the real interest rate of 13%, the B/C ratio is less than one for commercial chips production in all the districts of surveyed. Mukono district has the Benefit/Cost ratio of 0.9, Luweero district has 0.66, and Mpigi district has 0.89 (Tables 2 and 3). These results show that the enterprise is currently not worthwhile in the study districts. The low viability of chips is largely associated with a low market price given high costs associated with production and marketing. For instance, farmers are paid 500 Uganda Shillings per Kg yet they are required to transport the chips to the miller's factory among other costs. The production of chips requires heavy start up capital in the form of chippers and construction of drying racks. The required start up capital is over US $ 1000.

3.24 Sweetpotato flour

The process is the same as for the production of chips, but here chips are milled into flour for sale. Every Kg of dry chips yields about 950 g of flour. Flour is either sold to millers, who mix it with other products to make porridge and snacks. A kilogram of flour costs 1000 Uganda Shillings on average, which is almost twice as much the income earned from the sale of chips. The biggest marketing challenge that farmers face is quality assurance of the flour. This is mainly due to two key factors (i) farmers cannot determine the required moisture content of the chips and often mill chips that are not properly dried and (ii) since farmers use public mills the sweetpotato flour is often mixed with impurities from other products such as maize, sorghum, and millet. The other important challenge is the fact that sweetpotato products like flour, cakes, porridge, and others are new on the local market and their demand is low due to limited awareness.

Flour processing is viable among the surveyed respondents. The B/C ratio is highest in Mukono with 3.7, followed by Luweero with 2.0 and then by Mpigi with 1.7 (Tables 2 and 3). These results show that the present value of benefits is greater than the present value of costs, making the enterprise worthwhile in the districts surveyed.

3.25 Sweetpotato snacks

Several snacks can be made from sweetpotato flour. The sweetpotato flour can be mixed with wheat to make cakes, scones, mandazi and chapatti. The CBA basically looked at the making of snacks for local markets. The production process involves mixing sweetpotato flour with wheat in the ratio of 1:1, add water and make a fine thick paste. The paste is moulded into balls, and flatten to make them thin. This is fried in a thin layer of hot cooking oil to form a local snack called chapatti. For a Kg of sweetpotato flour and a Kg of wheat flour one can get 25 chapattis.

Chapatti is usually served as a snack with tea. Chapattis can also be served with a thick sauce for lunch or dinner. The major customers in the study area included school children, individual households and institutions which buy chapatti during tea break and lunch/dinner time. The current technology does not allow commercial large scale production and currently only small-scale production is practiced.

The technology requires little start up capital though with relatively high working capital requirements, yet the price of chapatti is almost fixed at 100Uganda Shillings (approximately US $0.058). The enterprise is viable but the performance would be better if combined with other on farm technologies like sale of fresh roots and vines. Except for Luweero district, the profitability of sweetpotato chips is generally high in the study sites. At the real rate of interest of 13%, the B/C ratio is greater than one for commercial snack production in Mukono and Mpigi districts, but less than one in Luweero districts. These results show that the enterprise is currently worthwhile in Mukono and Mpigi districts, but not in Luweero district.

Table 2: COST/BENEFIT ANALYSIS OF VARIOUS S.POTATO PROJECT ENTERPRISES

1. Mukono District				
A. SWEETPOTATO Roots/Acre[1]	Cost/benefit item	Year 1	Year 2	Year 3
	Discounted costs	392920.4	346875	308333.3
	Discounted benefits	836283.2	738281.3	656250.0
	B/C = 2.1			
B. Improved Vine production/Acre				
	Discounted costs	392920.4	346875	308333.3
	Discounted benefits	929203.5	820312.5	729166.7
	B/C = 2.4			
C. Juice				
	Discounted costs	200123.2	197221.1	174020
	Discounted benefits	192307.9	195312.5	173611
	B/C = 0.98			
D. Stored S.Potatoes				
	Discounted costs	67121.5	65682.1	60024
	Discounted benefits	920354	812500	722222
	B/C = 12.7			
E. **S.Potato Chips**				
	Discounted costs	240147.8	236665.3	208824
	Discounted benefits	211538.7	214843.8	190972.1
	B/C = 0.90			
F. S.Potato Flour				
	Discounted costs	483185.8	426562.5	379166.7
	Discounted benefits	1769911.5	1562500	1388888.8
	B/C = 3.7			
G. S.Potato Snacks				
	Discounted costs	1161946.9	1025781.2	911805.6
	Discounted benefits	1265486.7	1117187.5	993055.5
	B/C = 1.1			
2. Luweero District				
A. Roots/acre		Year 1	Year 2	Year 3
	Discounted costs	309734.5	273437.5	243055.6

[1] It is assumed that along with tuber production, a farmer can harvest 10% of the vines for sale.

	Discounted benefits	707965	625000	555556
	B/C = 2.1			
B. Improved Vine production/acre				
	Discounted costs	309734.5	273437.5	243055.6
	Discounted benefits	707965	625000	555556
	B/C = 2.3			
C. Juice				
	Discounted costs	220135.5	216943.2	191422
	Discounted benefits	192307.9	195312.5	173611
	B/C = 0.90			
D. Stored S.Potatoes				
	Discounted costs	53697.2	52545.7	48019.2
	Discounted benefits	919854	812000	721722
	B/C = 15.9			
E. S.Potato Chips				
	Discounted costs	264162.6	260331.8	229706.4
	Discounted benefits	168077.1	165390.7	163680.5
	B/C = 0.66			
F. S.Potato Flour				
	Discounted costs	531504.4	469218.8	417083.4
	Discounted benefits	1061946.9	937500	833333.3
	B/C = 2.0			
G. S.Potato Snacks				
	Discounted costs	1278141.5	1128359.3	1002986.1
	Discounted benefits	1265486.7	1117187.5	993055.5
	B/C = 0.9			
3. Mpigi District				
A. SWEETPOTATO Roots/acre		Year 1	Year 2	Year 3
	Discounted costs	517699.1	457031.3	406250
	Discounted benefits	840708	742188	659722
	B/C = 1.5			
B. Improved Vine Production/acre				
	Discounted costs	517699.1	457031.3	406250
	Discounted benefits	840708	742188	659722
	B/C = 1.6			

C. Juice/litre

Discounted costs	198119.5	196304.5	174799.4
Discounted benefits	192307.9	195312.5	173611
B/C = 0.99			

D. Stored S.Potatoes

Discounted costs	67121.5	65682.1	60024
Discounted benefits	920354	812500	722222
B/C = 12.7			

E. S.Potato Chips

Discounted costs	240347.8	237765.3	213824
Discounted benefits	211038.7	214543.8	190472.1
B/C = 0.89			

F. S.Potato Flour

Discounted costs	507345.1	447890.6	398125
Discounted benefits	1327433.6	1171875	1041666.6
B/C = 1.7			

G. S.Potato Snacks

Discounted costs	1160446.9	1024281.2	910305.6
Discounted benefits	1264986.7	1116687.5	992555.5
B/C = 1.1			

Table 3: Summary of Cost/Benefit Analysis

Enterprise	**Mukono**	**Luweero**	**Mpigi**
Sweetpotato Fresh roots	2.1	2.1	1.5
Improved Vines production	2.4	2.3	1.6
Juice production	0.98	0.9	0.99
Storage structures	12.7	15.9	12.7
Sweetpotato chips	0.9	0.66	0.89
Sweetpotato flour	3.7	2.0	1.7
Sweetpotato snacks	1.1	0.9	1.1

4.0 CONCLUSIONS AND RECOMMENDATIONS

Sweetpotato technologies introduced by the Coalition Project (Project #R8273 and ZB0342) as interventions in the districts of Mukono, Luweero and Mpigi have varied economic viabilities. Production technologies that include production of tubers and vines are all profitable at a 13% discount rate. However, post-harvest technologies introduced to the same communities are not all viable. While storage structures and sweetpotato flour are profitable in all the districts of intervention, juice production and chip making are not viable. Snack production is viable in Mukono and Mpigi districts, but is not profitable in Luweero districts.

Although many of the introduced technologies are profitable at farmers' level, constraints still exist that need to be addressed if more profitable sweetpotato production and processing are to be enhanced both on the local and international market as mentioned in the following recommendations to further increase the profitability of sweetpotato production:

i. Farmers need to be organized into marketing groups and / or associations through which they can be helped to establish sustainable and reliable market linkages especially with exporters, local traders, and other consumer institutions. A mechanism to ensure steady supply and product quality assurance should be part of the overall supply chain management strategy. In addition, if farmers are organized, this will enhance their capacity to access loans and be able to purchase equipment such as packing materials and machinery required for processing.
ii. The farmers should be availed market information for all sweetpotato products including vines so that business networks can be established.
iii. More research is still needed to determine the most suitable combination of the different technologies at the farm level so as to enhance both farm profitability and productivity. It is, for example, not known what ratio of the farm produce should be sold fresh and what proportion should be processed for the different technologies to give a viable combination. Such studies will enable the project to effectively provide technical support to the farmers.
iv. There is still low awareness of the sweetpotato products mainly the juice. There is need to invest in creating public awareness which will greatly increase both the consumption and usage of the sweetpotato derived products.

ANNEX I: LIST OF STUDY RESWEETPOTATOONDENTS AND KEY INFORMANTS

Name		Occupation/ District
1.	kalonda	Kasawo Grain Millers
2.	Iga Abubakar	Farmer Mpigi
3.	Kayondo Dick	Farmer Luweero
4.	Kigula Eria	Farmer Mpigi
5.	Kiyaga Nasula	Framer Luweero
6.	Kyeba Benard	Farmer Mpigi
7.	Lutaaya Daudi	Framer Luweero
8.	Nabawesa Mariam	Farmer Luweero
9.	Nakagire Lovence	Farmer Luweero
10.	Nakitibwa Safina	Farmer Luweero
11.	Namutebi Maria	Farmer Mpigi
12.	Namutebi Sofia	Farmer Luweero
13.	Nankabirwa Hadija	Framer Luweero
14.	Nantabirwa Hedwig	FOSRI
15.	Nantume Sweetpotatoecioza	Farmer Luweero
16.	Owori Constance	KARI
17.	Sekiyanja Joeria	Farmer Luweero
18.	Sempa John	Farmer Luweero
19.	Setyabula Rajab	Farmer Luweero
20.	Sezaliyo Ochenyi	Farmer Luweero
21.	Yiga Beatrice	Farmer Mukono
22.	Immaculate Sekitto	Project Officer/Coalition
23.	James Nsumba	PRAPACE

ANNEX II: DATA USED TO CONDUCT THE BCA

Table 1: Financial Data on production of Fresh Roots for the Local Market in Selected Districts

Item	**Luwero District**			**Mukono**		
Start up Capital						
Vines	25,000					
Land preparation	40,000			55,000		
First ploughing	110,000			60,000		
Total	**175,000**			**115,000**		
Working Capital	**Year 1**	**Year 2**	**Year 3**	**Year 1**	**Year 2**	**Year 3**
Weeding	80,000	80,000	80,000	168,000	168,000	168,000
Harvesting roots	80,000	80,000	80,000	40,000	40,000	40,000
Hiring land	50,000	50,000	50,000	50,000	50,000	50,000
Ploughing	100,000	100,000	100,000	60,000	60,000	60,000
Planting	40,000	40,000	40,000	30,000	30,000	30,000
Sisal bags				36,000	36,000	36,000
Transport				60,000	60,000	60,000
Cash out flow	**350,000**	**350,000**	**350,000**	**444,000**	**444,000**	**444,000**
Fresh roots	800,000	800,000	800,000	1,050,000	1,050,000	1,050,000
Cash Inflow	**800,000**	**800,000**	**800,000**	**1,050,000**	**1,050,000**	**1,050,000**
Net Cash inflow				**606,000**	**606,000**	**606,000**
Net Income	**450,000**	**450,000**	**450,000**	**606,000**	**606,000**	**606,000**

Table 2: Data on potential Export of Oriented Sweetpotato Production in Mpigi District

Item	**Local Market**			**Export Market**		
Start up Capital						
Vines	42,000			42,000	42,000	42,000
Land preparation	50,000			50,000	50,000	50,000
First ploughing	50,000			50,000	50,000	50,000
Total	**142,000**			**142,000**	**142,000**	**142,000**
Working Capital	**Year1**	**Year 2**	**Year3**	**Year 1**	**Year 2**	**Year 3**
Weeding	40,000	40,000	40,000	40,000	40,000	40,000
Harvesting roots	46,000	46,000	46,000	46,000	46,000	46,000
Hiring land	50,000	50,000	50,000	50,000	50,000	50,000
Ploughing	110,000	110,000	110,000	1100,000	1100,000	1100,000
Planting	20,000	20,000	20,000	20,000	20,000	20,000
Washing roots				48,000	48,000	48,000
Harvesting vines	50,000	50,000	50,000	50,000	50,000	50,000
Transport	20,000	20,000	20,000	40,000	40,000	40,000
Cash out flow	**336,000**	**336,000**	**336,000**	**394.000**	**394.000**	**394.000**
Income						
Sale of Fresh roots	800,000	800,000	800,000	1,600,000	1,600,000	1,600,000
Sale of vines	250,000	250,000	250,000	250,000	250,000	250,000
Cash Inflow	**1,050,000**	**1,050,000**	**1,050,000**	**1,600,000**	**1,600,000**	**1,600,000**
Net Cash flow	**714,000**	**714,000**	**714,000**	**1,206,000**	**1,206,000**	**1,206,000**
Net Income	**714,000**	**714,000**	**714,000**	**1,206,000**	**1,206,000**	**1,206,000**

Table 3: Production of Fresh Roots and Selling Vines in Luweero District

Item	**Fresh roots and Vines**			**Fresh roots only**		
Start up Capital						
Vines	25,000	25,000	25,000	25,000		
Land preparation	40,000	40,000	40,000	40,000		
First ploughing	110,000	110,000	110,000	110,000		
Total	**175,000**	**175,000**	**175,000**	**175,000**		
Working Capital	**Year 1**	**Year 2**	**Year 3**	**Year 1**	**Year 2**	**Year 3**
Weeding	40,000	40,000	40,000	40,000	40,000	40,000
Harvesting roots	40,000	40,000	40,000	40,000	40,000	40,000
Hiring land	50,000	50,000	50,000	50,000	50,000	50,000
Ploughing	100,000	100,000	100,000	100,000	100,000	100,000
Planting	40,000	40,000	40,000	40,000	40,000	40,000
Harvesting vines	15,000	15,000	15,000			
Cash out flow	**285,000**	**285,000**	**285,000**	**270,000**	**270,000**	**270,000**
Fresh roots	900,000	900,000	900,000	900,000	900,000	900,000
Sale of vines	150,000	150,000	150,000			
Cash Inflow	**1,050,000**	**1,050,000**	**1,050,000**	**900,000**	**900,000**	**900,000**
Net Cash inflow	**765,000**	**765,000**	**765,000**	**630,000**	**630,000**	**630,000**
Net Income	**765,000**	**765,000**	**765,000**	**630,000**	**630,000**	**630,000**
Profit Margin	**73**	**73**	**73**	**70**	**70**	**70**

Table 4: Financial Analysis of Sale of Juice

Start up capital	**Juice only**			**Roots, Juice, Vines**		
Vines				74,000		
Land preparation				50,000		
Ploughing				100,000		
Saucepans	90,000			90,000		
Stove	50,000			50,000		
Weighing scale	200,000			200,000		
Knife	1,000			1,000		
Buckets	9,000			9,000		
Mingling stick	500			500		
Sieves	3,000			3,000		
Fresh roots	1000					
Total	**354,500**			**577, 500**		
Working Capital	**Year 1**	**Year 2**	**Year 3**	**Year 1**	**Year 2**	**Year 3**
Weeding				80,000	80,000	80,000
Harvesting				30,000	30,000	30,000
Making ridges				60,000	60,000	60,000
Planting				40,000	40,000	40,000
Hiring land				50,000	50,000	50,000
Labour	36,000	36,000	36,000	36,000	36,000	36,000
Packaging materials	90,000	90,000	90,000	90,000	90,000	90,000
Labels	40,000	40,000	40,000	40,000	40,000	40,000
Fresh roots	50,000	50,000	50,000	50,000	50,000	50,000
Charcoal	96,000	96,000	96,000	96,000	96,000	96,000
Water	28,800	28,800	28,800	28,800	28,800	28,800
Sugar	70,500	70,500	70,500	70,500	70,500	70,500
Depreciation of scale				66,667	66,667	66,667
Cash outflow	**411,700**	**411,700**	**411,700**	**738,367**	**738,367**	**738,367**
Income						
Sale of roots				800,000	800,000	800,000
Sale of Juice	360,000	360,000	360,000	360,000	360,000	360,000
Weighing scale			100,000			
Sale of vines				150,000	150,000	150,000
Cash outflow	**411,700**	**411,700**	**411,700**	**1,310,000**	**1,310,000**	**1,310,000**
Net Cash inflow	**-51,700**	**-51,700**	**-51,700**	**571,633**	**571,633**	**571,633**
Net Income	**-51,700**	**-51,700**	**-51,700**	**571,633**	**571,633**	**571,633**
Profit Margin	**-14**	**-14**	**-33**	**44**	**44**	**44**

Table 5: Production of Chips in Ten Years

Start up Capital	10 Year period		Chips with Fresh Roots		
Motorised chipper	1,700,000		1,700,000		
Drying rack	110,000		110,000		
Land preparation			75,000		
Vines			150,000		
Total	**1,810,000**		**2,035,000**		
Working Capital	**Year 1**	**Year 2-10**			
Cost of fresh roots	665,000	665,000			
Labour –chipping	12,000	12,000			
Washing	30,000	30,000			
Fuel	16,800	16,800			
Carrying home	12,000	12,000			
Transport to Kampala	25,000	25,000			
Depreciation-chipper	170,000	170,000			
Cash outflow	**930,800**	**930,800**	**1333800**	**1333800**	**1333800**
Income					
Sale of chips	1,000,000	1,000,000	1,000,000 ,	1,000,000	1,000,000
Sale of motorized chipper					
Sale of ROOTS			**600,000**	**6,000,000**	**6,000,000**
Cash inflow	**1,000,000**	**1,000,000**	**1,600,000**	**1,600,000**	**1,600,000**
Net cash inflow	**69,200**	**69,200**	**266200**	**266200**	**266200**
Net Income	**69,200**	**69,200**	**266,200**	**266,200**	**266200**
NPV	**(1,133,291)**		**476642**		
Profit Margin	**6.92**	**6.92**	**16.6**	**16.6**	**16.6**

Table 6: Production of Flour in Ten Years

Start up Capital	Roots Bought			Own Land		
Fresh roots	1,600,000					
Motorised chipper	1,800,000			1,800,000		
Land preparation				50,000		
Ploughing				80,000		
Vines				80,000		
Motorised Chipper				1,800,000		
Total	**3,400,000**			**3,810,000**		
Working Capital	**Year 1**	**Year 2**	**Year 3**	**Year 1**	**Year 2**	**Year 3**
Labour	160,000	160,000	160,000	160,000	160,000	160,000
Milling	100,000	100,000	100,000	100,000	100,000	100,000
Drying racks	100,000	100,000	100,000	100,000	100,000	100,000
Polythene	10,000	10,000	10,000	10,000	10,000	10,000
Packing bags	6,000	6,000	6,000	6,000	6,000	6,000
Depreciation of chipper	170,000	170,000	170,000	170,000	170,000	170,000
Hiring Land				50,000	50,000	50,000
Making Ridges				240,000	240,000	240,000
Planting				25,000	25,000	25,000
Hiring Land				50,000	50,000	50,000
Cash outflow	**546,000**	**546,000**	**546,000**	**911,000**	**911,000**	**911,000**
Income						
Sale of flour	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Cash inflow	**2,000,000**	**2,000,000**	**2,000,000**	**2,000,000**	**2,000,000**	**2,000,000**
Net Cash inflow	**1,454,000**	**1,454,000**	**1,454,000**	**1089000**	**1089000**	**1089000**
Net Income	**1,454,000**	**1,454,000**	**1,454,000**	**1089000**	**1089000**	**1089000**
Profit Margin	**73**	**73**	**73**	**54.5**	**54.5**	**54.5**
NPV	**8,810,935**			**6,898,000**		
Profitability Index	**3.66**					
Decision	Viable			Viable		

Table 7: Financial Analysis of the Production of sweetpotato Snacks

Start up Capital	**Single use**			
Wheat flour		2000		
SP flour		1000		
Saucepans		15,000		
Stove		3,000		
Rolling stick		3,000		
Total		**24,000**		
Working Capital		**Year 1**	**Year 2**	**Year 3**
Cooking Oil	1,200	312,000	312,000	312,000
Salt	50	13,000	13,000	13,000
Wheat flour	1,800	468,000	468,000	468,000
SP flour	1,000	260,000	260,000	260,000
Labour	800	2080,000	2080,000	2080,000
Packing bags	**200**	52,000	52,000	52,000
Cash outflow	**5050**	**1,313,000**	**1,313,000**	**1,313,000**
Income				
Annual Sales		**1,430,000**	**1,430,000**	**1,430,000**
Cash Inflow		**1,430,000**	**1,430,000**	**1,430,000**
Net Cash Inflow		**117,000**	**117,000**	**117,000**
Net Income		**117,000**	**117,000**	**117,000**
NPV		**298,916**	**298,916**	**298,916**
Profit Margin		**8.18**	**8.18**	**8.18**
Profitability Index		**13.89**	**13.89**	**13.89**

ANNEX III: DATA COLLECTION TOOLS

COST BENETIT ANALYSIS OF SWEET POTATO ON-FARM ENTERPRISES IN CENTRAL UGANDA

General Information

Group / Processor Information			
ID No.	……	Group name	……
District	……	Age of group	……
County	……	Male group members	……
Sub county	……	Female group members	……
Village	……	Technology	……
Date	……	Interviewer	……
Sex of respondent	……	Respondents name	……
Age of respondent	……		

B. Household Details: Employment and Education

1. Give the details of persons in your household in the last 12 months

No	Name	Sex	Age	Marital status code	Literacy	Education code	Occupation code	Position code
1								
2								
3								
4								
5								
6								

Marital status code

Single	1
Married	2
Separated	3
Polygamous	4
Cohabitation	5
Widowed/ divorced	6

Educational level code

None	1
P.1-P.4	2
P.5-P.7	3
S.1-S.4	4
S.5-S.6	5
Post -secondary	6

Occupation code

Non/ not working	1
Agriculture	2
Processing	3

Position code

Employer	1
Regular employee	2
Self employed	3

Trading	4		Unpaid family labour	4
Export	5		Unemployed	5
Professional	6			
Others	7			

C. Group Details:

2. Give details of the sweet potato group you belong to.

Name……..

Formation date	No of members	Products sold	Source of income	Income per yr	Achievements	Challenges

[i] Achievements:

……
……
……
……
……
……

[ii] Challenges:

……
……
……
……
……

D. Sweet Potato Production:

3. State number of acres grown and managed in the last 12 months Acres [ ]

4. For each variety grown provide the following information

	Variety code	High yield/ acre	Low yield/acre	Market acceptability	Product form code	Product contract
1						
2						
3						

4						
5						
6						

Market acceptability code		**Variety code**		**Product code**		**Contract code**	
Highly acceptable	1	Improved	1	Fresh roots	1	Contract farming	1
Acceptable	2	Local	2	Dried chips	2	No contract	2
Not acceptable	3	Teso	3	Vines	3	Others	3
Highly unacceptable	4	Others	4	Flour			
				Juice	4		
				Others	5		

5. Have you received any specialized training in production and marketing of sweet potato? State the training received.

Training received	
Production training	Marketing training

Production training code

1	Variety availability	1
2	Crop husbandry	2
3	Post harvest handling	3
4	Processing	4
5	Others	5

Marketing training code

Quality standards	1
Market requirements	2
Pricing	3
Market information	4
Others	5

E. Process Technology

6. For the technology implemented give details about the equipment used.

	Equipment	Importance code	Life span code	Ease to use	Efficiency code	Maintenance code
1						
2						

3						
4						
5						
6						

Importance code			**Life span code**			**Usage code**	
Core	1		> 5 years	1		Very easy	1
Support	2		3-4 yrs	2		Easy to use	2
Peripheral	3		2-3 yrs	3		Complicated to use	3
Frill	4		1 yr	4		Very complicated	4
			< 1yr	5			

Maintenance code			**Efficiency code**	
Very easy	1		Highly efficient	1
Easy	2		Efficient	2
Difficult	3		Wasteful	3
Very difficult	4		Highly wasteful	4

7. For the core equipment mentioned state the quantity produced per hour

Equipment	**Product**	**Unit of measure**	**Quantity produced**

F. Marketing Aspects

8. For each product sold specify the following

	Product code	Distance to market	Selling unit	Selling price	Major customer
1					
2					
3					
4					
5					
6					

Product code			**Distance code**			**Customer code**	
Fresh roots	1		<1 Km	1		Exporters	1
Vines	2		2-5 Km	2		Processors	2
Chips	3		6-10 Km	3		Farmers	3
Flour	4		11-49 Km	4		Traders	4
Juice	5		Over 50 Km	5		Consumers	5
Others	6					Others	6

G. Financial Issues

9. For the technology used indicate the expenses involved

Project stage	Item	Unit cost	Quantity	Total
Start up stage				
Working Capital expenses				
	Item	**Year 1**	**Year 2**	**Year 3**
Production				
Processing				
Marketing				
Closure expenses				

10. State your estimated income for the first 3 years

Year	Source of Income	Quantity sold per year	Unit price	Sub Total	Total
Year 1					
Year 2					
Year 3					

Additional question for Storage Structure

11. For the storage structure you have put in place, state the following:

[i] What are the key features?

……
……
……
……
……

[ii] Give details of the storage structure

	Unit of measure	Quantity/Amount
Year of construction	-	
Size	Sq m	
Holding capacity		
Times of holding in a year	-	
Average duration		
Anticipated price change	Ug sh	

QUALITATIVE DATA COLLECTION TOOL

Farmers or Processors

1. Explain the production process indicating all the major activities?
2. What are the advantages of this technology compared to other sweet potato processing technologies?
3. What constraints do you find in using this technology [in production, processing and marketing]
4. What are the social-economic benefits associated with the technology?

Researchers

1. What are the advantages of this technology compared to other sweet potato processing technologies?
2. What are the associated social –economic benefits of this technology?
3. What are the industry key success factors?
4. What are the major challenges, constraints in using this technology?