Vol. 13(1), pp. 34-44, January-March 2021
DOI: 10.5897/JDAE2020.1211
Article Number: 7EB1E5565942
ISSN 2006-9774

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Journal of Development and Agricultural Economics

Full Length Research Paper

Can orange fleshed sweet potatoes processing trigger farmers to use quality improved planting materials? Empirical evidence from selected regions in Tanzania

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Received 3 September, 2020; Accepted 8 December, 2020

Production of orange-fleshed sweet potato (OFSP) in Tanzania is constrained by the underutilization of virus-free improved certified planting materials. The sustainable use of these planting materials leads to the constant demand of the planting materials by farmers which can be triggered from viable processing. We determine the viability of processing in the OFSP value chain and its contribution to the uptake of high-quality improved planting materials. Data for this study were collected by field survey method from 15 processors and 150 farmers. Purposive and three-stage random sampling methods were used in sampling. We adopted a mixed method of analysis using descriptive statistics, gross margin analysis, and econometric estimation of the multivariate probit model by means of a Simulated Maximum Likelihood (SML). We found no direct effect of processing to trigger the use of improved OFSP planting materials unless formalization of the supply arrangements between processors and farmers is institutionalized. However, it was economically viable to engage in the processing of OFSP. Processors were found to be generating a benefit of US$ 76/ton of OFSP processed with a margin to a total cost ratio of 19% implying a relatively low margin with significant processing costs. Seed renewal was low as 63.1% of the farmers used retained planting materials. Nevertheless, contractual arrangements with the processors increased the desire to use high-quality improved planting materials and the likelihood to source them from research institutes (p<0.05). Additionally, access to credit and a high level of specialization influenced farmers to source planting materials from local vine multipliers. Creation of market linkage and formalization of supply arrangements between processors and farmers and awareness creation on the economic benefits of seed renewal will increase the benefits generated by processors. This may contribute to the uptake of high-quality improved OFSP planting materials in Tanzania.

Key words: Economic viability, orange fleshed sweet potato, processing, value chain, market linkage.

INTRODUCTION

Sweet potato (*Ipomoea batatas* Lam) is one of the most important food crops worldwide. In Africa, the crop is used for food and income though its marketing is limited by its short shelf life (Rees et al., 2001; Oladoye et al., 2016; Flores, 2018). In Tanzania, sweet potato is an important food security root crop after cassava being grown by 1.08 million smallholder farmers (NBS, 2017). With its annual production of 4.2 million tons per annum, Tanzania is the leading producer in Africa, and accounts for 3.8% of the world's sweet potato production (FAO, 2020).

The crop has consistent reliable yields, due to the reason that it can be grown on marginal land, and thus suitable for areas with long dry seasons. The crop is useful disaster recovery crop when other crops fail. Sweet potatoes are also important source of food in the homes of the rural and urban poor and important income source for households in Tanzania. Sweet potato lies within its adaptability to marginal conditions such as drought, low soil fertility, and thus make it ranked highly as food security crop when local staple crops such as maize and rice fail (HKI, 2012; Waziri, 2013).

Tanzania ranks fifth in the world in terms of sweet potato production (HKI, 2012). Tanzania's production data for sweet potato show that there had been increasing trends in the production and area under sweet potato production in the country from year 2008 to 2018 (NBS, 2020). However, there is no disaggregated data that would indicate the level of Orange Fleshed Sweet Potatoes (OFSP) and the White Fleshed Sweet Potatoes (WFSP) production. OFSP are rich in beta carotene, a vitamin A precursor for improving the nutrition of people especially children under five years of age. They have high content of carotenoids and pleasant sensory characteristics with color (Neela and Fanta, 2019).

In 2010, sweet potatoes ranked 13th of all crops cultivated in Tanzania in terms of gross production value; the top five crops included bananas, maize, beans (dry), cassava, and rice. According to HKI (2012), major sweet potatoes producing areas are the Lake Zone regions especially Mwanza, Geita, Simiyu and Shinyanga. The key regions for OFSP value addition include Dar es Salaam, Kilimanjaro and Arusha (Mmasa, 2014). Although production trend has been increasing, the average sweet potato yields have been stagnant over the past 10 years, and are far below potential yields due to low use of high yielding planting materials, the seasonal nature of production and insect pests and diseases.

While inputs are important for producing any crop, sweet potatoes have been facing a lot of problems in input use and supply as most sweet potato farmers plant the locally-supplied vine cuttings. Apart from the aforementioned constraints, sweet potato production faces long dry season which causes shortage of good planting materials at the start of the harvesting season, and thus makes it difficult for farmers to plant on time and in sufficient amounts. Some farmers maintain planting materials in the dry season on swampy land or through other alternate methods, but most of them must buy it from other farmers or merchants, often over great distances at significant cost. According to Mirembe (2018), limited access to quality input materials, quality markets, inadequate extension services and limited access to financial services, prevalence of weak production records management, lack of access to quality information as well as poor management of insect pest and disease out breaks, had been hampering sweet potatoes production in Africa. This calls for the need to intervene along the sweet potato value chain to address the prevailing challenges especially the use of high yielding clean cuttings.

Value addition in terms of processing of sweet potatoes is done in various forms. There are specialized actors who do processing and also farmers do the home-based processing activities. The home-based processing always leads into dried sweet potato chips commonly known as *michembe* and *matobolwa.* There are various reasons driving households to participate in value addition along the sweet potato value chain in Tanzania. The study by Mmasa (2014) in Coast, Shinyanga and Mwanza regions asserted that the primary motives for processing sweet potato at farm level were household food security, emergency income security, and the desire to keep away from the limited fresh sweet potato market. The specialized processing is the one that is done commercially (Mirembe, 2018).

Sweet potato unlike cereal crops for many years suffered from lack of an official formal seed system for production and delivery of certified planting materials (Bull et al., 2011; HKI, 2012; Mirembe, 2018). Several initiatives each at some point contributed specific interventions in developing and institutionalizing a sustainable seed delivery system in Tanzania, by strengthening and modernizing the existing traditional seed system. However, the delivery of improved planting materials has remained low, inconsistent and unsustainable.

The average productivity is still far below the estimated sweet potato potential yield of 15-23t ha^{-1}. The current yield of sweet potatoes stands at 7.45t/ha about 50% below the existing potential (NBS, 2019). This is due to low utilization of improved high-quality planting materials. The low productivity is contributed by numerous constraints both abiotic and biotic. The main biotic constraint is the limited access to certified high quality improved planting materials which is partly exacerbated with prevalence of viral diseases and weevils infestations (Bull et al., 2011; Ngailo et al., 2016). Over reliance on traditional seed delivery system from farmer to farmer and/or recycling of owns seed from previous crop not only contributes to further spread and persistent of sweet potato virus disease, but also dissemination of inferior

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cultivars.

There are continuous efforts by sweet potato seed actors focusing on multiplication and delivery of improved varieties with emphasis on improved certified planting materials. The government of Tanzania and other development partners recognize the importance of raising crops productivity. The Agricultural Sector Development Plan (ASDP II) details the government's agricultural transformation agenda that is based on increasing productivity and moving farmers and other value chain actors towards commercialization. Partners such as the Swedish International Development Cooperation Agency (SIDA) through the Bioinnovate programme has been supplementing government efforts through providing direct support to the institutionalization of the sweet potato seed system and supporting key stakeholders in the seed system aimed at increasing sweet potato productivity. The Bioinnovate programme is working on the project of integrating Information Communication Technology (ICT) in commercial production of tissue culture-based quality sweet potato planting materials in East Africa.

The institutionalization of the sustainable formal seed system is further enhanced by the enforcement of the existing legal frameworks such as the Seeds Act (2003) as amended which guides on the multiplication and certification procedures for all grades of sweet potato seeds prior to selling. Nevertheless, the problem of demand and supply mismatch and existence of ineffective demand of seeds within the sweet potato seed value chain affects these efforts.

An assured market for products of innovation is known to drive adoption. Studies have confirmed in other crops especially cereals that access to product markets creates a pull to the production system triggering farmers to use productivity enhancing inputs especially improved seeds (Kangile et al., 2020). Therefore, for quality seed system to be sustainable and profitable, there must be high and constant demand of the vines which is triggered from the product market side. Therefore, the challenge of availability and utilization of improved sweet potatoes planting materials can be addressed backwards by intervening from the product market side.

It is in this respect that this study was conducted to determine the viability of processing in the orange fleshed sweet potato value chain in Tanzania and whether it can contribute to the uptake of high-quality improved orange fleshed sweet potato planting materials.

METHODOLOGY

Description of the study areas

This study was conducted in three zones of Tanzania mainland namely the Lake Zone, Eastern Zone and Northern Zone. In the lake zone the study focused in Shinyanga region. Pwani and Dar Es Salaam regions represented the Eastern Zone. The Northern Zone covered Arusha and Kilimanjaro regions. Shinyanga Region included Shinyanga Municipal and Shinyanga rural district while in Pwani region Kibaha town council and Kibaha district councils were the areas surveyed. In Dar Es Salaam Region, the study covered Ubungo, Temeke and Kigamboni districts. Other districts included Moshi district council, Hai, Rombo, Same and Moshi Municipal in Kilimanjaro region whereas Arumeru, Arusha city and Arusha district council were the areas in which the study was conducted in Arusha Region (Figure 1).

Regions falling under the same zone have similarities in ecological climate, level of production of commodities characteristic to the given zone, processing capacity and potential of priority commodities for the zone as well as planned and existing infrastructure connecting different regions (URT, 2016). Lake Zone is suitable for agricultural production with some of its areas receiving bimodal rainfall. However, some of these lake zone regions such as Shinyanga receive unimodal rainfall. People in these areas are engaged in farming crops such as rice, maize, sweet potatoes, sorghum, millet, cassava, nut oil seeds and cotton, while others are engaged in livestock keeping, fisheries, mining and businesses. The zone is also known to have used improved OFSP planting materials for a long time. The zone has the high population of about 13.4 million people implying high number of consumers as well as farming household (NBS, 2020).

In the Eastern Zone, Dar es Salaam is the main trading city in Tanzania with many consumers of OFSP products and other commodities. Additionally, Eastern Zone has the high population of consumers in Tanzania. Eastern Zone has the population of 11.34 million people. The Northern Zone is the tourist hub with proximity to bordering Kenya. These features make the Zone to be a hub of OFSP processors which serve both the domestic market and export market in Kenya. It is the zone with a high level of potentials for OFSP commercialization.

Data, sampling procedures and sample size

Data for the study were collected by field survey method in July 2020 from 15 processors and 150 farmers in five selected regions of Tanzania. Data were collected using a semi-structured questionnaire implemented using Computer Aided Personal Interviews (CAPI). The study is based on Sudman (1976) to establish the sample size required for the study. Sudman (1976) asserts that a minimum of 100 elements is needed for each major group. For the purpose of this study, the major group are farmers. Therefore, the sample size for farmers is 150.

The mix of purposive and random sampling methods aimed to capture both probabilistic and non-probabilistic sampling effects. The study involved five regions of Tanzania which are Shinyanga, Pwani, Dar es Salaam, Kilimanjaro and Arusha. Shinyanga, Pwani and Dar es Salaam have both high number of farmers engaged in orange fleshed sweet potato production and high number of processors. Therefore, farmers were sampled from the districts within these three regions. Kilimanjaro and Arusha have only high number of processors but few farmers engaged in orange fleshed sweet potato production.

Random sampling was used in sampling farmers. Processors were purposively sampled based on the processing technology used, the scale of production, and the number of product variants produced. Three processors were purposively selected from each region making a total of 15 processors.

The three-stage sampling/multi-stage random sampling method was used in sampling farmers. The first stage involved a purposive selection of three districts; Shinyanga district in Shinyanga region, Kigamboni district in Dar es Salaam region and Kibaha district in Pwani region. The second stage involved selection of 5 enumeration areas (EAs)/villages using Systematic Random Sampling (SRS) from the list of villages engaged in orange fleshed sweet potato production within each district. The third and last stage involved

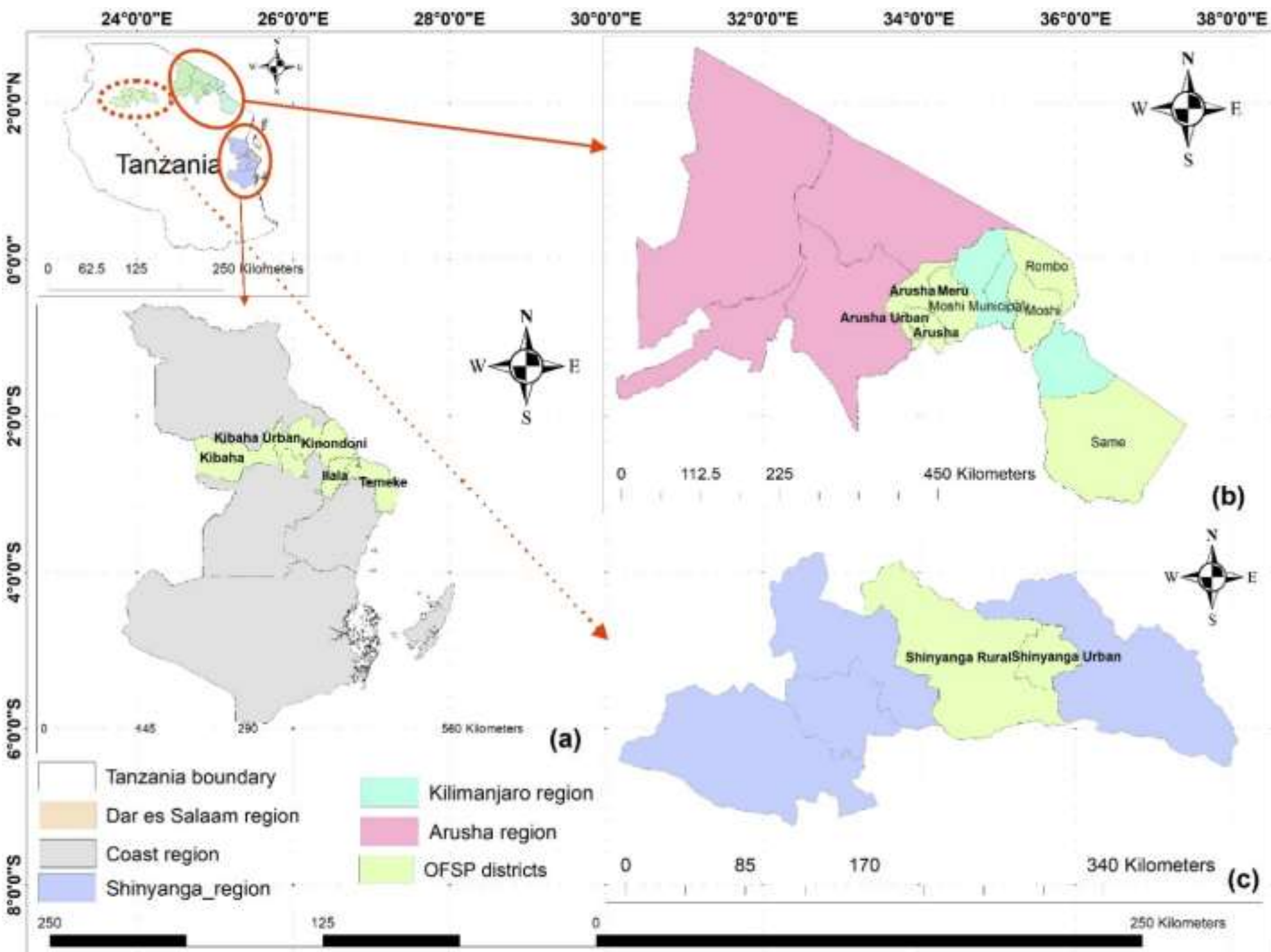

Figure 1. Map showing the study areas.

random selection of 10 farmers from each village using SRS. SRS was implemented by selecting each 5th farmer in the list of orange fleshed sweet potato farmers after reshuffling it.

Analytical framework

This study uses a combination of approaches in its analytical framework. This includes descriptive statistics, gross margin analysis and econometric methods. Descriptive analysis was used to depict the levels of the variables under study and the association among the variables. In showing the association among the variables of interest, the chi-square statistic was used. The descriptive statistics analysis includes proportions, frequencies, percentages, tabulations and cross tabulations of key survey variables and their correlates.

Gross margin analysis (GM) method was used in the determination of the benefits accrued or value added (VAD) by the orange fleshed sweet potato (OFSP) processors and farmers along the value chain. The GM method was applied using the formula shown in Equation 1.

$$VAD = \sum_{i=1}^{n} VG - \sum_{i=1}^{n} VC \qquad (1)$$

Where, VAD is the value added by the OFSP value chain actor; $\sum_{i=1}^{n} VG$ is the total value generated by the value chain or by the stages of the value chain that is $\text{Price} * \textit{Quantity sold}$; and $\sum_{i=1}^{n} VC$ is the total variable cost. Benefits generated using the GM method was subjected to sensitivity analysis.

The econometric method was applied in determining whether contractual arrangements with processors and other factors influence choice of source of improved OFSP planting materials (Table 1). The estimation involved the use of Multivariate probit regression model. The model was estimated using Simulated Maximum Likelihood (SML) method as suggested by Cappellari and Jenkins (2003). Four equations were estimated from the general multivariate probit regression model (Equation 2).

Table 1. Description of variables used in estimation of multivariate probit model.

Factor	Variable	Definition
Socio-economic characteristics	Sex	x_1 =Sex of the farmer coded as 1 if female and 0 if male
	Education	x_2 = Highest level of education reached by the farmer in number of years spent in formal training
Institutional factors	Access to credit	x_3 = Accessed to credit by the farmer coded as 1 if accessed credit in the past 12 months and 0 if did not access
	Contractual arrangement with the processor	x_4 = contractual agreement coded as 1 if the farmer had the contractual agreement with the buyer and 0 if no contract.
Economies of scale	Level of specialization	x_5 = Level of specialization in OFSP production estimated as the ratio of OFSP farm size to the total farms used in production of all crops

$$y^{*}_{im} = \beta^{'}_{m} X_{im} + \varepsilon_{im} \quad (2)$$

Where, $m = 1.........4$; X are the explanatory variables (Table 1) and ε_{im} is the error term distributed as multivariate normal; $y_{im} = 1$ if $y*_{im} > 0$ and 0 otherwise. This means that, $y_1 = 1$ if $y*_{im} > 0$ the farmer uses own saved planting materials; $y_2 = 1$ if $y*_{im} > 0$ the farmer obtains from neigbouring farmers/friends and relatives; $y_3 = 1$ if $y*_{im} > 0$ the farmer obtains from local vine multipliers/Quality Declared Seeds multipliers and $y_4 = 1$ if $y*_{im} > 0$ the farmer obtains from research institutes

The farmer is assured of getting clean improved OFSP planting materials if obtained from local vine multipliers/Quality Declared Seeds (QDS) or from research institutes and seed companies. The Simulated Maximum Likelihood (SML) method shown in equation 3 was used in the estimation of the multivariate probit model.

$$L = \sum_{i=1}^{N} w_i \log \Phi_4(\mu i; \Omega) \quad (3)$$

Where, w_i are weights of the observation i…………………. N; and $\Phi_4(.)$ is the density function of the multivariate probit.

RESULTS AND DISCUSSION

Socio-economic characteristics of farmers and processors

Farmers involved in the study were orange fleshed sweet potatoes farm managers. These are heads of households who make most of the OFSP farm decisions. In this context, in a male and female adult household type, if the female spouse was found to be making most of the farm decisions, then this was the key respondent interviewed. Results indicate variations in sex of the farmers, age and level of specialization across the three districts involved in the study (p<0.05). Marital status, level of education and primary occupation do not vary across the three districts involved in the study (Table 2). Many (77.3%) of the farmers were found to be married indicating that they have collective actions in decision-making at their households.

Majority of the farmers (80.9%) have completed the formal training especially the primary education level. This implies that OFSP farmers can easily absorb the good agricultural practices disseminated through the agricultural extension system. Other studies have found that education is key in influencing the absorption of agricultural technologies disseminated by the extension system (Wambura et al., 2015; Mtega et al., 2016; Ragasa et al., 2016). This implies that there is a high likelihood of farmers to adopt new technologies including improved planting materials if extensive dissemination is conducted. Additionally, this would be spurred by the fact that many sweet potatoes farmers (91.9%) are involved in crop farming as their primary occupation. Few farmers (3.4%) are in wage employment. This implies that there are people in the formal sector who have seen emerging opportunities in the OFSP value chain.

Sex varied across the districts with Shinyanga and Kibaha having more female than Kigamboni. Results indicate that the proportion of female farmers is 84 and 60% in Shinyanga and Kibaha respectively. The highest proportion of male farmers (72%) was found in Kigamboni district. This implies that as the level of commercialization of the crop increases, more men tend to engage in production of that crop. The level of commercialization of sweet potatoes is more in Kigamboni than in other districts. This is validated by the growing number of youths (31%) who have been engaged in production of the crop. Kigamboni district has the highest number of youth (38%) who are engaged in

Table 2. Socio-economic characteristics of OFSP farmers.

Socio-economic variable (%)		District			Total (n=150)	χ^2 statistics
		Shinyanga (n=50)	Kibaha (n=50)	Kigamboni (n=50)		
Sex	Male	16	40	72	42.7	32.32(0.00) * †
	Female	84	60	28	57.3	
Age	Youth (≤ 35 years)	36	18	38	30.7	16.44(0.002) *
	Adult (36 to 59 years)	50	50	58	52.7	
	Old (≥60 years)	14	32	4	16.6	
Marital status	Single	6	16	10	10.7	9.35(0.155)
	Married	74	72	86	77.3	
	Separated/windowed/Divorced	20	12	4	12	
Education level	Not completed formal education	0	0	2.2	0.8	5.39 (0.495)
	Primary education	81.4	79.1	82.2	80.9	
	Secondary education	16.3	14	6.7	12.2	
	College and university education	2.3	7	8.9	6.1	
Primary occupation	Crop farming	84	96	96	91.9	17.414(0.066)
	Business-trade/services	12	2	0	4.7	
	Wage employment	4	2	4	3.4	
Level of specialization	Less than 25%	40	42	0	27.3	34.325 (0.00) *
	25-50%	42	46	54	47.3	
	More than 50%	18	12	46	25.4	

*Significant at the 5% probability level; †Values in brackets are p-values.

sweet potatoes production activities.

Level of specialization varied across the districts surveyed. Kibaha and Kigamboni districts have the highest level of specialization in sweet potatoes production. Results show that about 46% of the farmers in Kigamboni district use more than 50% of their crop land to produce sweet potatoes. Additionally, the production of sweet potatoes is done in own land. Results reveal 52 and 56% of the farmers use their own farm in Shinyanga and Kibaha respectively. However, due to the high level of specialization in Kigamboni, only 20% of the farmers use their own land in the production of sweet potatoes. Many farmers (80%) use other means such as renting to obtain the land for sweet potatoes production activities. Nevertheless, these farmers are small scale sweet potato producers who have allocated an average land size of 0.57 hectare to sweet potato production (S.E 0.046).

OFSP processing is a new business venture with few actors just starting to step in the business. Many (80%) of the OFSP processing facilities are owned by individuals (sole proprietorship). The remaining (20%) are owned as partnerships and limited companies. These processing businesses have been established between 2007 and 2019. Many of these processing businesses have an average of less than 10 employees. Females are more active in this OFSP processing business than the males. Among the processing enterprises surveyed, 60% are owned by female. Owners of these processing enterprises are 30-56 years old.

Typology of OFSP products

OFSP products exist in two forms; primary and secondary products. Primary products are those products that are utilized directly without significant value addition or processing. The processed products are known as secondary products. These are value added products such as flour, chips, crisps, juice and purée. Depending on the stage of processing, these products can further be processed into tertiary products. Example purée can be used as an ingredient into bread making. The study found processing OFSP into floor being the main value-added product that is processed from OFSP. All other baked products such as bread and biscuits are found to be made from OFSP flour. Additionally, this study identified a huge growing market of composite nutritious flour. This is the flour made from various grains and mixed with a certain proportion of OFSP flour (Figure 2).

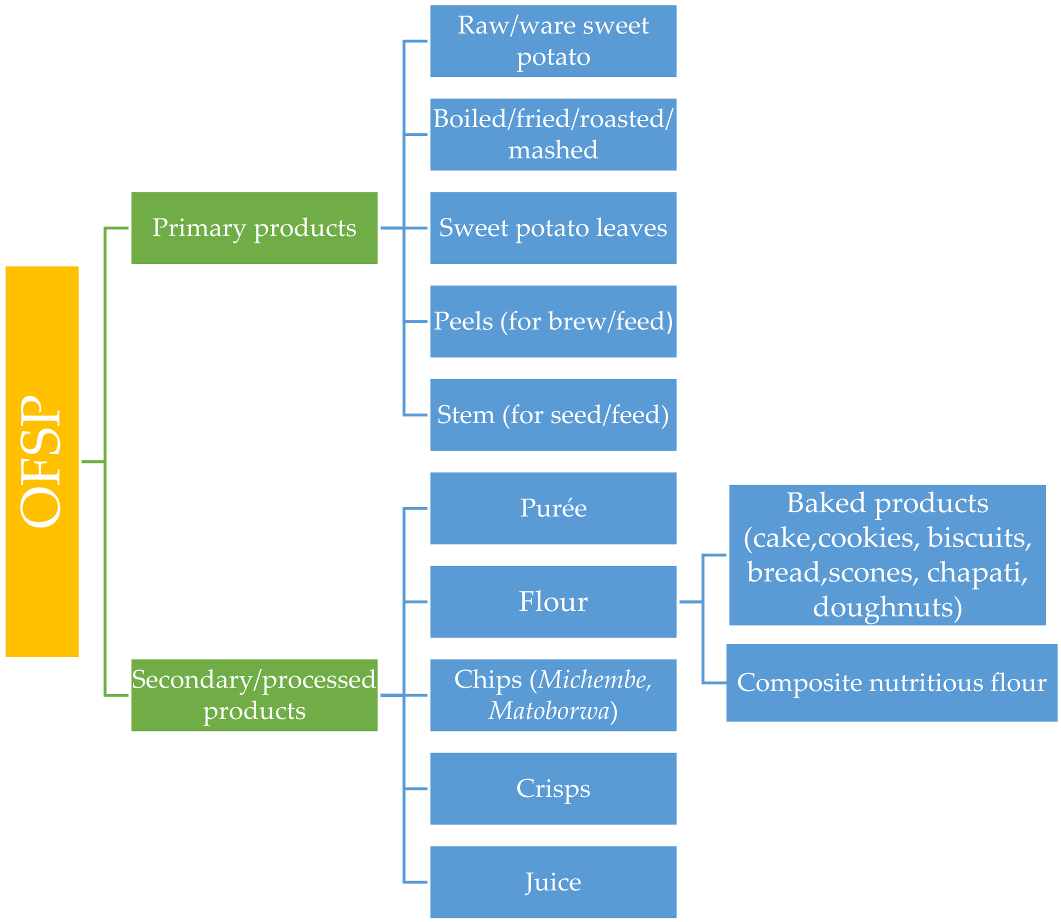

Figure 2. Primary and secondary OFSP products in Tanzania.

The influence of contractual arrangements with processors and other factors on the choice of source of improved OFSP planting materials

In determination of the influence of contractual arrangements with processors and other factors on the choice of source of improved OFSP planting materials, the Wald test result was found to be significant (p<0.01) indicating that the multivariate probit model fitted well the data used in the analysis. The likelihood ratio test was significant indicating that the dependent variables had joint correlations such that it would not have been plausible to use separate equations for estimation. This asserts that it was necessary and sufficient to use the multivariate probit model. Choice of source of improved sweet potato planting materials was found to be influenced by the level of education of the farmer, sex, access to credit, contractual arrangement, and the level of specialization.

The levels of education and sex were the only significant factors that influenced farmers to use own saved planting materials. The farmers, being females, reduce the likelihood of using own saved planting materials. This means that the female farmers are less likely to recycle the planting materials than male farmers. This implies that the decision to use a particular source of improved OFSP planting materials is conditioned on a gender lens such that female farmers can easily take up in the commercialization of the OFSP seed system by stopping the recycle of the planting materials. This is linked to the participation of women in demonstration plots. This study revealed that the participation of women in demonstration plots is higher than that of men within the OFSP value chain. This refutes the earlier findings of studies such as Iradukunda et al. (2019) who indicated that the participation of women in the uptake of innovations is lower than that of men. This implies that activeness of women to take-up innovations depends on the crop. The increase in the level of education of the farmers also reduced the likelihood of the farmers to get OFSP planting materials using own planting materials. This implies that training farmers on the importance of using planting materials from reliable sources of quality planting materials can bring about increased use of the quality OFSP vines and thus improving market for the same planting materials in Tanzania.

Table 3. Factors influencing choice of source of improved OFSP planting materials.

y^*_{im}	Variable	Coef.	Robust Std. Err.	Z	P>$\lvert z \rvert$
Using own saved planting materials	Sex	-0.774**	0.255	-3.040	0.002
	Education	-0.048*	0.026	-1.850	0.064
	Access to credit	0.068	0.298	-0.230	0.819
	Contractual arrangement	0.163	0.464	0.350	0.725
	Level of specialization	-0.210	0.429	-0.490	0.625
	Constant	1.645	0.393	4.190	0.000
Neigbouring farmers/friends and relatives	Sex	-0.322	0.223	-1.440	0.149
	Education	-0.057**	0.027	2.150	0.032
	Access to credit	-0.069	0.303	-0.230	0.820
	Contractual arrangement	0.536	0.409	1.310	0.190
	Level of specialization	-0.200	0.452	-0.440	0.657
	Constant	-0.286	0.317	-0.900	0.366
Local vine multipliers/Quality Declared Seeds multipliers	Sex	0.118	0.258	0.460	0.648
	Education	0.019	0.025	0.750	0.452
	Access to credit	0.557*	0.321	1.740	0.083
	Contractual arrangement	0.048	0.585	0.080	0.935
	Level of specialization	0.845**	0.403	2.100	0.036
	Constant	-1.460	0.371	-3.940	0.000
Research institutes	Sex	-0.070	0.383	-0.180	0.855
	Education	0.121***	0.041	2.990	0.003
	Access to credit	-3.268**	1.047	-3.120	0.002
	Contractual arrangement	1.400**	0.581	2.410	0.016
	Level of specialization	-0.414	0.688	-0.600	0.547
	Constant	-3.035	0.605	-5.010	0.000

Number of observations=150; Likelihood ratio test chi2(6) = 16.7133 Prob > chi2 = 0.0104; Log pseudolikelihood = -250.22312; Wald $chi^2(20)$ = 75.15; prob> chi^2 =0.0000; *** p<0.01, ** p<0.05, *p<0.1.

Additionally, the level of education also reduced the likelihood of the farmer to get OFSP planting materials from neigbouring farmers/friends and relatives. On the other hand, the level of education increases the likelihood of farmers to source clean vines from research institutes. The contracted farmers also are sensitive to clean or virus free planting materials hence their likelihood to source from research institutes increases with the situation of having contractual arrangements with the processors.

Access to credit and level of specialization influenced farmers to source planting materials from local vine multipliers. Access to credit by the farmers enhances their purchasing power of agricultural inputs hence are positively likely to buy OFSP planting materials from vine multipliers. However, access to credit reduces the likelihood of farmers to source OFSP seed from research institutes. This implies that in order to ensure that the vine multipliers can easily sell their seeds, the farmers need to have access to credit.

The level of specialization as measured by the proportion of land allocated to OFSP production also influences farmers to source from local vine multipliers. The higher the level of specialization which depicts economies of scale the higher will be the likelihood of farmers to choose to source OFSP planting materials from vine multipliers. This is validated by the fact that specialization allows farmers to enter into lucrative markets (Kangile and Mpenda, 2016). This implies that the market of OFSP vines produced by local vine multipliers lies with the more specialized producers in sweet potato production (Table 3).

The economic feasibility of OFSP processing to trigger use of improved planting materials

Findings indicate that it is economically viable to engage in OFSP processing. Processors are currently generating a benefit of TZS 175,000/ton, equivalent to US$ 76/ton of

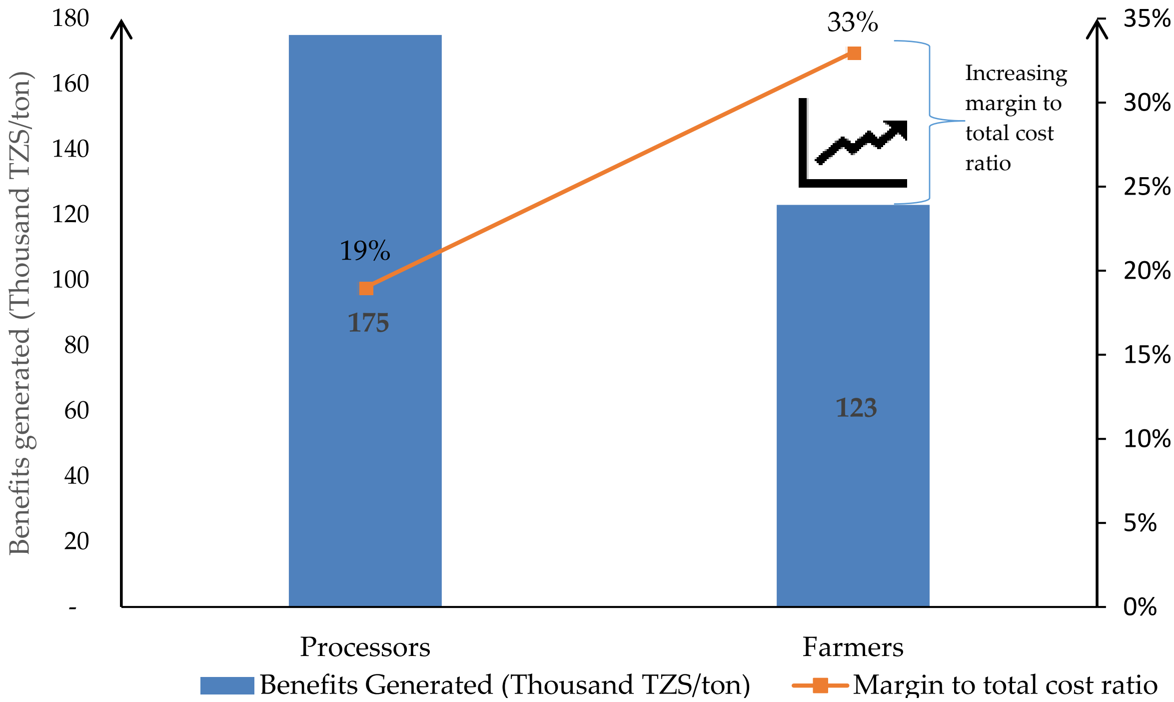

Figure 3. Benefits generated by processors and farmers.

OFSP processed (Figure 3). Farmers generate a benefit of TZS.123,000 per ton, equivalent to US$ 53/ton of OFSP sold. It is evident that the benefits generated by processors are higher than that generated by farmers. However, farmers have lower operating costs leading to the higher margin to total cost ratio of 33% than 19% obtained by processors.

The benefits generated by processors can be increased further from the creation of supply agreements with legal bindings to reduce the current competition of processors and wholesalers over ware OFSP purchased from farmers. Having legal agreements (contracts) will have a positive effect on farmers given the fact that there is an increasing trend of margin to total cost ratio implying increasing margins with relatively reduction in costs. These findings concur with the findings by Nabay et al. (2020), Oladimeji et al. (2019) and the study by Prakash et al. (2016) who found increasing margins for farmers in the sweet potatoes value chain. According to Nabay et al. (2020) in their study using the benefit-cost ratio (BCR) sweet potato trading investment had a net positive return. On the other hand, the profitability analysis of sweet potato production by Prakash et al. (2016) conducted in Odisha India revealed that sweet potato farmers got the positive profit.

Competition of processors with household consumers reduces supply and increases the cost of raw materials making processing less attractive. However, the direct effect of processing to trigger the use of improved OFSP planting materials requires further interventions of reconfiguration of the entire OFSP value chain. This should include market linkage and formalization of supply arrangements among processors and farmers of ware OFSP. It is only formalization of the supply arrangements between processors and farmers; or vertical integration of the processors that will trigger the use of improved OFSP planting materials.

Currently there exists lack of markets for processed products, lack of storage facilities and effective postharvest handling technologies for storing and processing the OFSP which make it difficult to realize lucrative benefits from the OFSP product marketing. From this study it is learnt that farmers have less information regarding vines multipliers, nutritional importance, value added products from OFSP, and processors. Similarly, processors lack information on the reliable suppliers of quality OFSP in addition to lack of relevant technology and equipment for processing OFSP. Thus, creating market linkages could bring about market pull for them to benefit with efficient marketing.

The challenges around OFSP processing are not only in Tanzania. Other countries also experience similar trends in processing of OFSP. Degu et al. (2015) in the study in Ethiopia asserted that there were small scale processors who made boiled sweet potatoes by buying potato from retailers or the farmers, process it and sell it and that large-scale processing of sweet potato was not existing. Given the fact that the processors in Tanzania are generating significant benefits of an average of TZS 175,000/ton of OFSP processed, easing access to raw materials, access to credit and making a policy shift towards charging of Value Added Tax (VAT) would increase the volume processed and the number of processors in Tanzania. The processors who use raw materials from farm-based products produced within the country should be given their dues by the Tanzania Revenue Authority (TRA) as it is for other traders who are collecting the VAT.

It is thus important to adopt the creation of awareness as one of the interventions. The economic performance of OFSP processing can lead to increased use of planting materials when the community at hand is aware of the health benefits which could increase consumption rates and trigger down to increased production by ware OFSP farmers.

Conclusion

It is economically viable to engage in OFSP processing. Processors are currently generating a benefit of TZS 175,000/ton of OFSP processed. Farmers as well generate a significant benefit with an increasing margin to total cost ratio. Seed renewal is low as 63.1% of the farmers use retained/own saved OFSP planting materials indicating that they obtained the improved planting materials and kept on recycling them. This is spurred by the low level of awareness among farmers on the benefits about good and virus free vines for planting. Access to credit and high level of specialization influenced farmers to source planting materials from local vine multipliers. The implication of this is that the market of OFSP vines produced by local vine multipliers lies with the more specialized farmers in OFSP production.

This study recommends creation of awareness among farmers on the benefits generated from seed renewal. The costs associated with seed recycling should also be made clear to the farmers. The anticipated economic benefits are important in driving adoption of improved seed varieties. It is thus important to create awareness on the use of virus free vines and other paybacks such as income and nutritional benefits. Given the fact that the processors in Tanzania are generating a significant benefit, easing access to raw materials, access to credit and making a policy shift towards charging of Value Added Tax (VAT) would increase the volume processed and the number of processors in Tanzania triggering the use of improved virus free sweet potatoes planting materials by farmers.

Additionally, the direct effect of processing to trigger the use of improved OFSP planting materials requires further interventions of reconfiguration of the entire OFSP value chain. This should include market linkage and formalization of supply arrangements among processors and farmers of ware OFSP. It is only formalization of the supply arrangements between processors and farmers; or vertical integration of the processors that will trigger the use of improved OFSP planting materials.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

This work was supported by the Tanzania Agricultural Research Institute-Mikocheni (TARI-Mikocheni) through funds obtained from the Bio innovate Africa Programme Phase II under the ICOPSEA Project Grant no: BA/C1/2017-03. We are also grateful to all OFSP farmers and processors for their acceptance to participate in the study and for their provision of information.

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