Yield Estimation and Factors Influencing Acceptance of Sweet potato Vines of Virus Free Varieties in Selected Agro-ecological Zones in Tanzania

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4 authors, including:

Castory Kibiki
Sokoine University of Agriculture (SUA)

Paul Saidia
Tanzania Agriculture Research Institute (TARI)

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Yield Estimation and Factors Influencing Acceptance of Sweet potato Vines of Virus Free Varieties in Selected Agro-ecological Zones in Tanzania

Castory Kibiki
Beyond Cotton Project, World Food Program, Mwanza, Tanzania

Paul Saidia
Tanzania Agricultural Research Institute, Ukiriguru, Mwanza, Tanzania

Mohammed Shemahonge
Tanzania Agricultural Research Institute, Ukiriguru, Mwanza, Tanzania

Fabian Mihafu
Mbeya University of Science and Technology, Mbeya, Tanzania

ABSTRACT
The effort of initiating the production and vine multiplication of sweetpotato using certified virus free vines focuses on promoting high yields towards enhancing food security and income generation among smallholder farmers. This study examines yield of sweetpotato tubers and vine multiplication per hectare using certified virus free vines in the Lake Victoria and Coastal Zones in Tanzania. Primary data were collected using questionnaire tool from 362 farmers who are sweetpotato tubers producers and 133 farmers who are producers of virus free vines. The sample was chosen from each selected agro-ecological zone by simple random sampling technique. The yield estimation was calculated using Microsoft Excel 2007 and the factors influencing uptake of variety was analyzed using Statistical Package for Social Science (SPSS ver. 20, IBM, USA). The study findings showed that, mean production of virus free sweetpotato tubers was relatively higher in the Lake Zone (1309.44kg) compare to Coastal Zone (1249.75kg). On the other hand, mean of vine multiplication was relatively higher in Coastal Zone (276.65kg) compared to Lake Zones (133.34kg). These results highlight that, the level of sweet potato yield depends on the amount of land used in production, as the farmers expand the cultivated area the amount of yield increases significantly. Gender, occupation, training and distance were some of the factors that influenced the acceptance of sweetpotato tubers and vine multiplication significantly at 10%. Therefore, investing in the production of sweetpotato tubers and vine multiplication using quality variety which is free from virus is highly worth undertaking as the variety generates high quantity of yields per hectare.

Keywords: Farmers, Food security, Income, Planting materials, Viral disease

INTRODUCTION
Sweet potato (*Ipomea batatas*) is a tuber crop of great potential as it enhances food security of poor households in developing and underdeveloped countries [5]. It is an important food crop

in Sub-Saharan Africa and it is adaptable to a wide range of agro-ecologies in East Africa. In Tanzania, Sweet potato (SP) is among of the staple food and source of income in various administrative regions and is ranked to be twelfth by value and sixth by quantity [11]. The SP production promotes employment and food security for the poor rural [1]. SP acts as a major source of subsistence and is considered to be a famine relief crop [5]. The crop is mainly grown for both home consumption and cash crop [12] [7].

SP have a potential impact towards nutrition improvement, household income and poverty reduction to smallholder farmers [2] [3] [4] [9] but in rural areas it is hampered by low productivity caused mainly by pests and diseases of viral origin among others. Virus diseases alone can cause yield reductions of 56 % to 98 % whereby SPMFV is the most prevalent virus [10]. [13] pointed out that there is a need of continuing to enhance more mechanism to engineer

SPCSV-resistant cultivars where by controlling this single virus alone is expected to improve the yields of sweetpotato significantly. Due to such situation, efforts have been put in place by introducing new variety of high quality which is virus free sweetpotato (VFSP) vines, and farmers appreciate the importance of VFSP vines as they are of genetic purity, good physiological state and free from insect pests and diseases [6].

The introduction of VFSP vines has been advocated by Tanzania Agricultural Research Institute (TARI) since 2012, by promoting commercial production of quality SP planting materials in East Africa through Bioinnovate Africa Program Phase II. The approach adopted in the implementation of this project has carried along with multiplication and distribution of VFSP vines through integrating ICT in commercial production of quality sweet potato planting materials in East Africa (ICOPSEA) project to the growing zones that are supervised by TARI. The focus of ICOPSEA project has been to ensure increased production of SP tubers while controlling the problem of viral diseases that tends to affect SP productivity and hereby improving nutrition and food security among smallholder farmers. The implementation of ICOPSEA project by TARI is in line with the current move of promoting the adoption of new agricultural practices with the view of improving agricultural productivity and food security in the country more specifically VFSP vine multiplication as perceived to increase production and improve livelihood. This study is therefore aimed at examining the yield of SP tubers and vine multiplication per hectare using certified virus free vines in the Lake Victoria and Coastal Zones in Tanzania.

MATERIAL AND METHODS

Sampling Techniques and Sample Size

The target populations were vine multiplier, small holder farmers and virus free sweet potato producers, the survey included other actors along the virus free sweet potato production. Multi-stage sampling and simple random sampling techniques were employed. The sample size involved 495 farmers from the Coastal and Lake Victoria Zones. The sample size was calculated based on the formula described by [14].

Data Collection

Data were collected from key actors in the virus sweet potato value chain: mainly Farmers, Decentralized Vine Multipliers (DVM), District Agricultural Irrigation and Cooperative Officer (DAICO) and Extension Officers using structured questionnaires.

Data Processing and Analysis

Both descriptive and quantitative analyses were employed. Statistical Package for Social Science (SPSS ver. 20, IBM, USA) was used to analyze descriptive statistics. Yield estimation ha^{-1} was calculated using Microsoft Excel 2007.

Descriptive Analysis

Descriptive statistics were used to describe the responses, characteristics and some information trends about yield of VFSP tubers and vine multiplication. Descriptive analyses included means, frequency and percentages which are statistical measures of central tendency.

Analysis of Yields of Sweetpotato and Vines Production

In this section yields were obtained by considering land and production. Thus, land included the area cultivated in acre while production included amount of produce per unit area which was measured using kilogram (Kg) of SP tubers and vine cuttings using common sacks.

Mathematically yield was obtained as;

Yield = Amount Produced divided by area cultivated which was simplified as

Yield = Production / Area cultivated ………………………...…………..………... (1)

Binary Logistic Regression Analysis

Binary logistic regression model was used to address factors influencing uptake of certified VFSP planting materials. The model specification is described below;

The logistic regression model is based on the logistic probability function given as:

$$P_i = f(Z_i) = \frac{1}{1+e^{-Z}} \quad \ldots (2)$$

Where P_i is the probability of success i.e. the probability that a farmer adopted the new variety, which is VFSP vines, and Z_i represents exposure to factors that may influence uptake of VFSP vines i.e. $Z_i = \alpha + \beta X_i$ and its probability is expressed as:

$$Z_i = \ln(\frac{P_i}{1-P_i}) \quad \ldots (3)$$

Thus;

$$Z_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + \varepsilon_i \quad \ldots (4)$$

$$Yi = \beta 0 + \beta 1X1 + \beta 2X2 + \ldots \beta 14X14 + \mathcal{E}i \quad \ldots (5)$$

Whereby:
Yi = Uptake of certified VFSP planting materials
X1 = Area X7 = Maturity X13 = Gender
X2 = Education X8 = Technology X14 = Age
X3 = Occupation X9 = Fertilizer
X4 = Variety X10 = Training
X5 = Distance X11 = Advice
X6 = Recycling, X12 = Zone
β1, β2, β3, β4, β5 … and β14 = coefficients of variables (βs indicate the degree to which different factors affect uptake of certified VFSP planting materials).
α = constant term
μ = error term

Where ε_i is the error term, P_i is the probability of adopting VFSP vine, and $1 - P_i$ is the probability of the farmer not to uptake VFSP vines.

RESULTS AND DISCUSSION

Age of the Respondents

The mean age of SP producers using certified virus free planting materials was 41years (Table 1). The study revealed that middle age groups are mostly involved in SP production in the study area. For the case of SP vine multipliers, the mean age was 43 years. This implies that many of the respondents in the study area were matured enough to actively participate in SP production and vine multiplication business and being able to generate sufficient income for their families and community at large.

The present findings prove that age is among of the factors which influence individual income generating capacity. Also stated that the accumulation of wealthy is mostly depends on age of an individual, since age determines individual maturity and ability to make economic decisions.

Education Level of the Respondents

Education level of the respondents amplifies the working efficiency which results into family income generation. Education is a key to improving SP production using virus free certified vines. The study findings (Table 1) pointed out that there is low level of literacy in all categories of respondents. For the case of vine multipliers, it was observed that most of them had secondary, certificate, diploma and/or university level this is because operation in the vine production requires competence in terms of language especially English since training manual and directives mostly uses technical language.

Sex of the Respondents

Sex is among of the factors which influence income generating capacity of the household also has implication on the roles and responsibility in the society. In this study sex had an economic implication in the use of certified virus free SP production system. The study results indicated that there is difference in the production of SP using virus free based on sex, majority of the SP producers were women (68.3%) while men were 31.7% (Table 1). This implies that women contributed greatly to the income generation through production of SP compared to men in the study area. On certified virus free vine production, men accounted to 52.3% and women 47.7% of the production, the difference may be due to the fact that there is much profit in vine production than potato production thus men being involved in that business.

Table 1: **Socio characteristics of the respondents from the survey**

Category	SP producers n=362	Vines producers n=133
Age in years		
Mean	41.00	43.00
Minimum	23.00	27.00
Maximum	65.00	73.00
Sex (%)		
+Male	31.70	51.30

Female	68.30	48.70
Education (%)		
None	3.30	-
Primary	71.30	9.30
Secondary	12.70	13.10
Certificate	1.70	31.00
Diploma	4.40	30.90
University	6.60	15.70

Source of Planting Materials

Majority of the respondents obtained their planting materials from vine multipliers and research institutes, a few respondents highlighted other sources of planting materials as fellow farmers, and own source (Figure 1). The present findings indicated that (34.5%) of the interviewed smallholder farmers buy their planting materials from certified vine multipliers and about (28.7%) farmers buy planting material from research institutes (Figure 1). This shows SP growers are using certified planting materials.

These findings are in line with the study by [8] on "Sweetpotato Seed Systems and Crop Management Community of Practice" which revealed that vine multipliers play an important role, often trading the vines they produce to the farmers around the production area. The findings also showed the important role of Seed delivery system which is dissemination of improved technology since vine multipliers obtained their initial materials (pre-basic/basic grades) from research institutes.

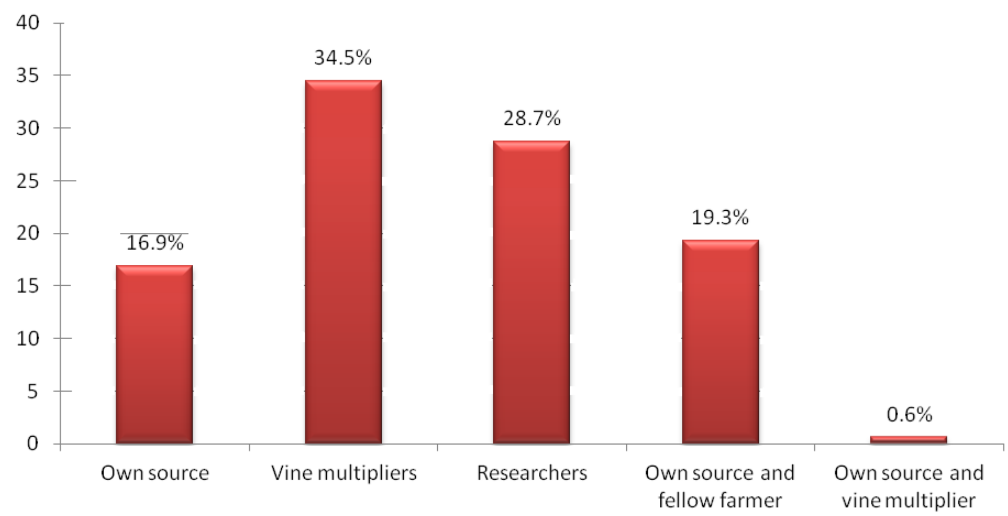

Figure 1: Source of sweet potato planting materials

Mean Yields of Production of Sweet Potato Tubers ha^{-1} using VFSP

Table 2 presents productivity of SP using certified virus free per ha across the zones. Although the sample size was very small to represent the respective zones, the overall average yield of SP production across zones was 1702.79 Kg/ha, which is well far below the potential yield of SP of 15 Ton/ha. Across zones, average SP tubers production was higher in the Lake Zone and slightly lower in Coastal Zone (Table 2). The difference in production between the two agro-ecological zones could be attributed to number of reasons including differences in the size of cultivated area and cultural practices, for example in Lake Victoria Zone sweetpotato is used as staple food for household consumption.

The study results reflect previous report by the Tanzania agriculture survey report 2016/2017 which showed that difference in yield between regions in the lake zone and other zone was accounted by area cultivated. Regardless of similar agronomic practices and the use of improved varieties, in this study, high yields were obtained in Lake Zone compared to Coastal Zone due to the area cultivated.

Table 2: Mean yields of VFSP production (Yield in Kg/ha)

Category	Lake Zone	Coastal Zone	Overall
Mean	1309.44	1249.75	1702.79
Minimum	300.00	300.00	300.00
Maximum	3333.33	2222.22	3703.70
Std	461.42	497.69	493.10

Regression Analysis Testing the Significance Level of Yield per ha

The aim of this part was to test the significance relationship between yield of SP production and the acre of land used in production. The results displayed that, there is significance difference between SP production and hectare of land used in production (F=0.0033) (Table 3). This indicates that the level of SP yield depends on the amount of land used in production, as the farmers expand the cultivated area the amount of yield increases significantly.

Table 3: Significance level of yield/ha

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.257596	4.257596	8.770503	0.003265
Residual	360	174.7602	0.485445		
Total	361	179.0178			

Category	Mean	Standard deviation	Standard Error Mean	t	df.	Sig.
Yield of SP production	1284.710	483.899	25.433	2.9615	1	0.0033

Mean Yield VFSP Vine Multiplication ha^{-1}

The yields of virus free vines multiplication across the two zones were described in table 4. In both zones the common method of selling planting materials is bundles, which contain about 50-60 vine cuttings of 15-20 cm. The result showed that, the average multiplication of virus free vines in the Lake Zone was 133.34 bundles whereas in the Coastal zone was 276.65 bundles**.** This indicates that, vine multiplication was higher in Coastal Zone compared to Lake Zones.

Table 4: Average production of virus free SP vine ha^{-1} (Kg/ha)

Category	Lake Zone	Coastal Zone
Yield of vine multiplication ha^{-1}		
Mean	133.34	276.65

Minimum	10.68	15.91
Maximum	512.82	2447.98

Factor Influencing uptake of Certified VFSP Planting Materials

The results of the study indicate that the coefficients of gender, occupation, training and distance, were positive and significant at 10% (Table 5), and thus implies an increased demand of VFSP planting materials, because when training is provided, the farmers generate knowledge and skills about new variety which influence demand of it, also women have high concern about VFSP vines as they are big SP producers. For the case of variety, it was observed that farmers that already grew local variety were less likely to adopt improved VFSP. Furthermore, farmers using industrial fertilizer were less likely to adopt improved VFSP this is because majority of farmers do not use fertilizer in sweetpotato production.

Table 5: Binary regression results: demand for planting materials

	B	S.E.	Wald	Sig.	Exp (B)
Area	-.052	.135	.147	.701	.949
Education	.127	.111	1.317	.251	1.135
Occupation	.677	.306	4.885	.027	1.968
Variety	-1.138	.533	4.569	.033	.320
Distance	.581	.294	3.912	.048	1.787
Recycling	.166	.245	.459	.498	1.181
Maturity	-.546	.984	.307	.579	.579
Technology	-.864	.384	5.063	.024	.421
Fertilizer	-1.118	.391	8.167	.004	.327
Training	1.137	.425	7.154	.007	3.118
Advice	-.449	.399	1.271	.260	.638
Zone	.318	.323	.966	.326	1.374
Gender	2.663	.966	7.603	.006	14.336
Age	-.274	.214	1.652	.199	.760
Constant	-1.297	.948	1.872	.171	.273

B-Slope, SE- Standard error, Wald-, Sig- Significance, Exp- Expected

CONCLUSION

The SP tubers production and vine multiplication using certified virus free vines performed differently in terms of yield ha^{-1} in each Zone. Generally, production of both sweetpotato tubers and vine multiplication using virus free variety was found to have high yield ha^{-1} in the study areas. However, the variation in yield ha^{-1} among actors in production of sweetpotato tubers and vines multiplication using certified varieties which are free from virus was mainly attributed by differences in cultural aspects and the size of land cultivated. Therefore, the findings of this study highlight that yield estimated ha^{-1} was significantly related to the area cultivated.

It was also observed that farmers that already grew local variety and those who use industrial fertilizer were less likely to adopt improved varieties. Not only that but also this study showed that an increased demand of VFSP planting materials was contributed by factors like gender, occupation, training and distance.

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Conflict of Interest: The authors declare that they have no competing interests.

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