ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR1401

Analysis of Economic Efficiency: Case of Sweet Potato Seed Vine Production in Homabay County, Kenya

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Abstract:- Sweet potatoes are not only a nutritious, high value food for the daily diet, but also an important source of income. In the selected survey areas in the Lake Region of Kenya, sweet potato is amongst the major commercially grown crops. Therefore, in order to understand the profitability and performance of sweet potato producers in the study area, this study was implemented. Sweet potato is one of the main commercially produced crops in the selected survey areas in the lake region of Kenya. Therefore, this study was conducted to understand the profitability and performance of sweet potato producers in the study areas.

The study employed Cost Function in the analyses of Economic Efficiency of Sweet Potato Seed Vine Production system in Kenya. A multi-stage random sampling technique was used to select sample size of 150 sweet potato vine producers for this study. By use of a structured questionnaire, data was collected on production input, output, input and output prices, characteristics of sampled farmer and plot. Using the maximum likelihood method, the variables of the cost function were estimated. Result revealed that the farm level cost- efficiency was about 56 percent. The research has shown that age and farm size were negative but significantly related to cost-efficiency at ten and one percent respectively. Gender, farming experience, Education, access extension to and credit were positive but significantly associated with cost-efficiency at one percent.

The study advocates for policy decision that youthful farmers be inspired to venture into SP vine production and the government to enhance access to education, credit and extension services the ongoing farming.

Keywords:- *Efficiency, Sweet Potato, Seed Vine, Kenya.*

I. INTRODUCTION

Sweet potato has a high proficiency to endure the antagonized inhabitants of the developing world and reduce malnutrition and hu2nger due to its' remarkable nutritive benefits and product potential in a specific period [4]. In majority of farm families in sub-Saharan Africa, the crop plays crucial function in addressing nutrition insecurity [8]. Some cultivars have high βeta-carotene content and have highly been adopted in food and nutrition programs that focus in addressing deficiency in vitamin A which is a challenge in Sub-Saharan Africa [11].

Unavailability of improved seed for planting at the on-set of the rains is a major constraint to sweet potato production in the developing countries of Africa [11]. According to [12] Availability of improved planting materials of adapted varieties is among the constraints that require to be addressed for wider uptake of improved sweet potato varieties in SSA. Full production potential of sweet potato in Kenya is hindered by various constraints which include: inadequate clean and improved planting material at the onset of planting season [18].

Sweet potatoes can be grown in a wide range of agro-ecological zones including low precipitation, areas and has low input demand. African growers produce only about 14.39 million tones of sweet potatoes annually but the bulk of the crop is cultivated for human consumption [14].

In Kenya the crop is produced in Rift Valley, lake region, and Central and Coastal Counties of Kenya with Lake Region prominent in production. Climate change has led to scarce and uncertain rains leading to rains either coming before or late in the season. Sweet potato crop is sensitive to drought at the tuber initiation stage 50–60 days after planting. If drought occurs during tuber initiation and bulking, it could considerably reduce yield [14].

Unavailability of improved varieties adapted to the diverse local environments and that meet consumer preferences is another challenge facing sweet potato production. Farmers use farmer to farmer vine exchange to propagate the crop which are mainly landrace varieties; therefore, there is minimal access to improved varieties. Research on sweet potato has resulted in varieties that have good consumer preferred attributes that are adaptable to the local conditions. Some of the varieties released by KALRO-Njoro possess outstanding attributes that include; early maturity period, high dry matter content, high yielding, drought resistant, have improved nutritional content and are tolerant to various diseases [17]. Incidentally, these being new varieties, their performance under varied soil moisture regimes have not been published.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR1401

Although the production trend of the crop is increasing over years, however, there are a number of constraints limiting the production and productivity of sweetpotato in Kenya [10]. One of the major limitations in sweetpotato production is the constant shortage of planting materials to be utilized for the subsequent planting seasons [9]. Quality planting materials are exceptionally basic to boost productivity of sweet potato [10]. In Kenya, however, most farmers used to preserve the planting materials in their farms until the rainy seasons for planting. These days, due to periodic dry spell the farmers are losing their planting materials and are forced to stop sweetpotato production. It is not as it were when seed vines were available and accessible; moreover, the quality of seeds is of paramount importance due to prevalence of sweetpotato virus diseases.

Sweetpotato virus disease (SPVD) causes decline of about 85% yield reductions in East Africa, [16] SPVD is the most catastrophic disease of sweet potato in Kenya [15]. Since SPVD is mainly transmitted through use of infected planting vines, use of clean improved sweetpotato seed vines is key to reducing yield losses associated with SPVD. Therefore, Availability and access to clean planting seed vines in a timely manner by cleaning the planting materials in tissue culture, acclimatizing, multiplication in insect proof greenhouse and isolated open fields is very important.

Access to sufficient amounts and standard SP seed vines cuttings has been documented as one of the main impediment to the actualization of the entire potentiality in the production of sweet potato in the low developed countries [23] this grave Circumstances are aggravated by the collapse of the conventional seed distribution channels and the decomposable, enormous complexity of the SP seed cuttings. The formal seed sector function of distributing standard and timely SP vines to producers has brought about a thriving unofficial local vine propagation system [22]. Hence, it is crucial to build up and support on the un-official vine propagation aimed for appropriate Distribution of improved and standard vines to producers.

The efficiency of farm level has triggered a massive body of literature worldwide and is important in micro and macro-economic perspective. is very crucial to Improve the competence with which producers use the accessible resources to increasing output, food, poverty minimization, house-hold emoluments and overall economic enhancement. Documented studies on SP, for example, [12]; [3]; [1]; failed to focus on cost reduction in production of SP vines. This study attempted to focus on this.

The purpose of the research consequently estimated the level of remunerative production and its causality in sweet-potato vine production in Homa bay County, Kenya using the stochastic frontier translog cost approach. This integrates the hypothesis of technological and distributive efficiency in cost relation. Technological and distributive efficiencies are essential. This implies that a production unit produces a given level of output with very few inputs [4].

II. MATERIAL AND METHODS

A. Study Area

➢ *Climatic Conditions*

Homa Bay County has an inland equatorial type of climate. The climate is however modified by the effects of altitude and nearness to the lake which makes temperatures lower than in equatorial climate. There are two rainy seasons namely the long rainy season from March to June and the short rainy season from August to November. The rainfall received in the long rainy season is 60 per cent reliable and ranges from 250 – 1000 mm while 500 –700 mm is received in the short rainy season. The county receives an annual rainfall ranging from 700 to 800 mm.

The study was conducted in the Homa bay county of Kenya. This County was chosen based on the intensity of sweet potato vine production. The County has an inland equatorial type of climate. The climate is however modified by the effects of altitude and nearness to the lake which makes temperatures lower than in equatorial climate. There are two rainy seasons namely the long rainy season from March to June and the short rainy season from August to November. The rainfall received in the long rainy season is 60 per cent reliable and ranges from 250 – 1000 mm while 500 –700 mm is received in the short rainy season. The county receives an annual rainfall ranging from 700 to 800 mm [24].

Sweet potato is an important crop in Homa Bay County, that occupies close to 6,131 ha which is about three percent of the productive land. Ndhiwa, Kasipul, Kabondo-Kasipul Homa Bay and Rangwe are the main SP producing sub-counties [2].

The MoA report SP yields of close to ten to twenty tonnes per hectare and a total county production of 99,633 t 2020/21. Among the most grown varieties of the SP is orange flesh sweat potato (OFSP), being promoted by Caritas and KALRO. Compared to maize, much income is obtained from SP production if grown in two seasons per year, [2]. In some cases, rains are realised throughout the year which makes it possible to continual, planting of SP.

Multistage sampling was used in selecting the interviewees in this survey. The first stage involved purposively selection of three sub-counties of Homa Bay County based on their distinct SP production [24]. The three selected Sub-counties were Suna East, Suna West, Kuria West and Kuria East.

The second stage convoluted a random selection consisted of 150 vine farmers from Suna East (30), from Suna West (30), Kuria West (30) and Kuria East (30) sweet potato producers from the sampled study areas from sampling frame obtained from sub-county agricultural offices.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR1401

B. Theoretical Model

The cost function of the i[th] firm is defined by:

$$C_{i=f(y_i,p_i,\alpha)} + \varepsilon_i \qquad (1)$$

Where
c_i=represent the i[th] farms total input cost
f= suitable functional form (the translog)
y_i= yield of vine in kg
P_i= i[th] farm Vector of input prices employed
α= parameters for estimation
ε_i =Composed random error terms ($v_i + u_i$)

The cost minimizing input vector,X_i^E , which is derived by use of Sheppard's Lemma also substituting the farm's input prices and estimated quantity of output into the demand equations system [5]

$$\frac{\delta c}{\delta_{p_i}} = X_i^E(W_i, Y_i, \alpha) \qquad (2)$$

For a specified output level , the correlating, economic, efficient and real production cost are equivalent to $W_i X_i^E$ and $W_i Y_i$ separately. The two cost estimates act as a basis for calculation of the remunerative efficacy indices for the i[th] firm:

$$EE_{i=\frac{W_i X_i^E}{W_i X_i}} \qquad (3)$$

C. Empirical Model

This study, the cost function was estimated for sweet potato vine producers using the likelihood method and the model is specified as:

$$\ln C_i = \beta_0 + \beta_1 \ln p_1 + \beta_2 \ln p_2 + \beta_3 \ln p_3 + \beta_4 \ln p_4 + \beta_5 \ln p_5 + \beta_6 \ln p_6 + \beta_7 \ln Y^*_7 + 0.5\beta_8 \ln p_1^2 + 0.5\beta_9 \ln p_2^2 + 0.5\beta_{10} \ln p_3^2$$

Where
C_i = total cost of input of i[th] farm,
P_1= cost of hiring land in KES per hectare,
P_2 =cost of seed vines in KES per bundle,
P_3 = fertilizer cost in KES per kg,
P_4 = transport cost in KES,
Y = yields of SP seed vine in KES,
P_5 = mean daily wage per person per day,
$B_0, B_1, B_2, \ldots, B_{10}$ are parameters to be estimated.

To estimate the economic efficiency of sweet potato vine growers, the transcendent logarithmic functional form using the cost function model was estimated. STATA version 10.0 was used to implement the economic efficiency model. The cost efficiency estimate takes a value between 0 and 1.0, with the value of 1.0 indicates very efficient. Ordinary least squares regression technique was used to estimate the determinant of economic efficiency

D. Determinants of Economic Efficiency

Farm specific factors and socio-economic variables were used to model the economic efficiency of SP vine growers [7], the determining factor of cost efficiency model was concurrently evaluated with Exp (-µi) defined by:

$$\text{Exp}(-\mu i) = \beta_0 + \beta_1 B_1 + \beta_2 B_2 + \beta_3 B_3 + \beta_4 B_4 + \beta_5 B_5 + \beta_6 B_6 + \beta_7 B_7 + \beta_8 B_8 + \beta_9 B_9 + \beta_{10}\beta_{10} \qquad (5)$$

Where:
Exp ($-\mu_i$) is the cost efficiency of the [i]th vine farmer,
B_1 is the no of years the vine in years,
B_2 is sex, a dummy variable, 1 for male and 0 for female,
B_3 is the farmer's level of education in years,
B_4 is size of household in number, has been developed
B_5 is farmers farming experience in years,
B_6 is access to credit, a dummy variable, 1 for access and 0 for no access,
B_7 is number of times visited by an extension agent per farming year,
B_8 is membership of farmer group, a dummy variable, 1 for member and 0 for non member,
B_9 is production system, a dummy variable, 1 for sole cropping and 0 for mixed cropping,
B_{10} is farm size in hectares, while
$\beta_0, \ldots, \beta_{10}$are parameters to be estimated.

III. RESULTS AND DISCUSSION

Agro Enterprise Development Groups (AEDGs) have been formed as an entry point for SP producing farmers to manage their own production systems in a more sustainable manner. This process includes substantial seed multiplication and dissemination, capacity building for good agronomic, harvesting, postharvest handling, value addition and collective marketing for nutrition and income diversification.

Table 1: AEDGs and Membership Under Sweat Potato Production – Homabay County

Name of Sub Counties	AEDGs	Membership/Gender		Total
		M	F	
Rachuonyo North	27	107	211	318
Homabay township	23	113	188	321
Rangwe	20	125	270	395
Ndhiwa	25	84	127	211
Total	95	429	796	1229

Source: Survey 2021

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR1401

- *Sweet Potato Seed Vines Received and Distributed for Production by Sub-County - Homa Bay County*

Homa Bay County has semi-arid climatic conditions. It rainfall of receives about 250mm and 1200mm per year, with an estimated mean annual rainfall of about 1,100mm. It has a bie-annual rainfall system in March to May (long rains) and September to November (short rains).

Sweet potato varieties promoted in the region by KALRO through Caritas-Homabay include: Spk004, Kenspot5, Kabode and Vita - received from KALRO-Njoro.

Table 2: Quantity of Seed Vines Distributed in 2020/21

County	Varieties	Quantity (No. seed vine cuttings)	Seed Source
Homabay	Kenspot-5	80 bags	KALRO-Njoro
	Spk 004	50 bags	
	Kabode	160 bags	
	Vita	60 bags	

These varieties take 3 to three and a half month, this enables SP growers to feasibly reach three cycles annually: In general, Men undertake activities such as Land preparation, mounding and ridging while women do planting of the vines, weeding, and cleaning of the roots after harvesting. The roots are harvested throughout the year where the crop is planted in two seasons per year.

Table 3: Production Trend 2020/21

Sub County	Area in acres			Production in Bags 90 kg			Yield in t		
	Long rains	Short rains	LR+SR	LR	SR	LR+SR	LR	SR	LR+SR
Ndhiwa	74	79	153	2,054	2,113	4167	184	190.2	374.2
Rangwe	42	30	72	420	379	799	37.8	34.11	72
Rachuonyo		88	145	2,325	1,850	4,175	254.3	166.5	421
Homabay town	22	33	55	301	520	821	27.1	47	74.1
Total	**226**	**199**	**425**	**5100**	**4862**	**9962**	**503.2**	**438**	**941.3**

Source: Survey 2020

Table 4 presents estimates of economic efficiency of production trends in selected sub-counties. The Table shows an estimation of the production cost function of farmers of Homa bay County, Kenya. The sigma square (σ2) is 3.2218 and the gamma is 1.2737, they are significant at one percent probability level. The sigma square (σ2) significant value stipulates that the goodness of fit and the accuracy of the designated premise of the compounded error term distribution [24]. The gamma [26] shows that about 97% disparity in the overall production cost is brought about by the differences in in-efficiencies of their costs.

The explanatory variable coefficients have positive sign that agrees with inferred expectation. The inference is that one percent increase in plot hire; seed vines price, wage rate, cost of herbicide and fertilizer the total cost of SP vine production would increase by 26.27, 16.87, 12.44, 1.97, and 3.93 percent respectively. These high coefficients values indicate the variables of cost structure in the vine farm business were significant. The majority of the 2nd order coefficients were statistically significant, insinuating that the suitability of the translog function indicates a direct association with total cost of SP vine production. [25].

Table 4: Approximations of the Cost Function for Sweet Potato Seed Vine Producers

Factor of Production	Parameter	Coefficient	Standard Error	t-value
Constant	β_0	5.2383	1.2632	5.4761***
Land rent	B_1	26.2710	2.7313	9.9131***
Price of planting material	B_2	16.8721	2.2763	7.5621***
Wage rate	B_3	12.4448	5.4421	2.4748**
Price of Fertilizer	B_4	1.9714	0.9173	2.3723***
Price of pesticide	B_5	3.9305	1.1235	3.5841***
Output (y*)	B_6	3.3172	0.8193	3.4946***
Land rent x price of planting material	B_7	1.1301	0.1332	5.5923***
Land rent x wage rate	B_8	0.3411	0.4312	0.9221
Land rent x price of fertilizer	B_9	1.2043	0.2215	3.4742***
Land rent x pesticide	B_{10}	1.4122	0.3732	3.2442***
Land rent x output (y*)	B_{11}	0.3039	0.5811	0.5371
Price of planting material x wage rate	B_{12}	0.22352	0.1411	1.5272*
Cost of planting material x price of Fertilizer	B_{13}	0.3952	0.2323	1.4213*
Cost of planting material x cost of Pesticides	B_{14}	-0.2026	0.2821	-0.5792
Cost of planting vine cuttings x Yields	B_{15}	3.2512	1.3722	2.2214**
Wage rate x price of fertilize	B_{16}	0.4521	0.5232	0.7847

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR1401

Wage rate x pesticide	B_{17}	-0.1290	0.4219	-0.2783
Wage rate x Yields	B_{18}	0.64560	0.3223	2.1851**
Cost of fertilizer x pesticide	B_{19}	0.2105	0.3862	0.3723
Cost of fertilizer x Yields	B_{20}	0.7321	0.3862	3.4232***
Cost of Pesticides x Yield	B_{21}	2.4322	0.4442	5.9313***
Log-likelihood function		34.4872		
Sigma Square		3.2218	0.2411	15.9023***
Gamma		1.2737	0.3460	3.3931***

Sources of Cost Efficiency

Table 5 depicts factors influencing cost-effectiveness of SP vine producers in Homa bay County, Kenya. The constant sign of variables in the model is significant in describing the perceived cost-effectiveness of the vine producers. A positive constant sign suggested that the variable had effect in reducing cost-efficiency, while a negative costant implied reduction in cost efficiency. Results also reveals that the constant of education, age, extension visits, farming experience, credit availability, affiliation to producer groups and systems of production were positive. At 1.0% probability level the coefficient of education, age, farming experience, contact with extension, family size and systems of production were significant. This gives a suggestion all these variable have positive influence on cost- efficiency in the selected counties.

At 10% probability level, the sex coefficient is significant but negative. The implication is that sampled male headed families are cost in-efficient than their female gender. This implies that vine business is women's activity. Household size has a negative coefficient that is significant at 1.0 % probability level. It is believed that large household size, augment availability of farm labour. This might not be always not the case because majority of the family members might be children.

At 10% probability level, the coefficient of sex is significant and negative. Age is significant and positive at one percent level probability. This is an indication that older in age SP vine producers' and who have attained high education level, farming experience, contact with extension, credit, and are doing Mono-cropping system are more cost effective.

Table 5: Determinants of Cost Efficiency of Sweet potato Seed Vine Production

Efficiency Factors	**Parameter**	**Coefficient**	**Standard Error**	**t Value**
Constant term	F_0	11.9334	0.4958	22.9482***
Age	F_1	0.1825	0.0186	10.4343***
Education	F_2	0.3123	0.0463	4.7342***
Gender	F_3	0.1321	0.0375	1.5324*
Farm experience	F_4	0.3324	0.0483	5.6424***
Extension visit	F_5	0.4154	0.0484	6.5431***
Access to credit	F_6	1.1242	0.3942	2.2352**
Membership of Farmer groups	F_7	0.2814	0.4332	0.9551
Household size	F_8	2.1443	0.4363	4.4143
Production system	F_9	5.3421	0.7736	5.4751***
Off Farm Income	F_{10}	0.2132	0.4833	0.4341

IV. CONCLUSION

This research revealed that SP seed vine production was not totally cost-effective. For a SP seed vine grower to be cost-efficient, he/she should reduce production cost by 34.88 percent., education, age, farming experience, extension contact, availability of credit and systems of production were cited as the factors that positively influence the economic efficiency of SP producers.

The elements that require observation enhance on the cost-effectiveness of vine production. formal schooling, especially agriculture- associated training, can help SP vine growers increase their knowledge about cost-minimizing input use, which can improve cost-efficiency. An extension project could re-establish the methodology, timing, and inputs quantities and methods of production and credit access.

ACKNOWLEDGEMENTS

We want to thank sweetpotato seed vine farmers in Homa Bay County for voluntarily availing the data for this study. Catholic Diocese of Homabay for the guidance they gave during sampling and data collection. KALRO for giving the team an enabling environment for research and for funding this work.

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