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RESEARCH ARTICLE

TECHNICAL EFFICIENCY AND PROFITABILITY OF ORANGE FLESHED SWEET POTATO PRODUCTION (OFSP) WITHIN THE BENIN REPUBLIC

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ABSTRACT

This research work examined technical efficiency and profitability of orange fleshed sweet potato production (OFSP) and within Benin Republic**.** The data was analyzed using the following analytical tools: Likert type scale, budgetary technique, stochastic frontier production function, and descriptive statistics. Finding showed that due to the demanding tasks involved in producing OFSP, 94.55% of the respondents were married men, suggesting that men made up the majority of respondents. The study area's average respondent age was 42.1 years, suggesting that the majority of OFSP farmers were youthful, agile, and in productive age. This could potentially increase the productivity of OFSP in the area. The average size of an OFSP farm was 0.66 hectares, indicating the extent to which OFSP production in the study area is subsistence level. The gross margin was 226610.19 CFA and the total revenue was 424515 CFA. These figures demonstrate how profitable OFSP production was in the survey region. The average cost per kilogram indicated that 1631.67CFA, or 0.8% of the total cost, was needed to produce 1 bag of OFSP, while the average revenue per bag indicated that selling 1 bag of the produced OFSP brought in 3500CFA. Given that the benefit cost ratio is greater than 1, the OFSP farmers stand to gain 2.15 CFA for every CFA invested. This is indicated by the benefit cost ratio of 2.15. As a result, the study area's OFSP production is profitable. Additionally, the results of the stochastic frontier analysis showed that the amounts of fertilizer, vine/seed, and herbicide were significant at (1%), demonstrating the impact of these inputs on the output of OFSP farmers. The mean technical efficiency was 88%, indicating that the farmers' output was below the frontier. The modal technical efficiency was above 90%. This indicated that there is wider distribution of technical efficiencies in the production level in the study area, which revealed that there is a considerable room for effective improvements in the technical efficiency of the farmers in the study area. From the inefficiency model, farm size, gender, level of education and cropping pattern were negatively significant which have effect on technical inefficiency. Transportation problem (3.709), theft (3.555) Lack of Institutional support/adequate funding (3.455), pest and diseases (3.409) and natural disaster (3.091) are the major restraints faced by OFSP farmers in the study area. In conclusion, OFSP farmers need to improve their technical efficiency. Government or NGO should look into the problems facing the farmers in the study area.

KEYWORDS

OFSP, Budgetary technique, Vine, CFA

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Introduction

Orange-fleshed sweet potatoes (*Ipomoea batatas)*, are one of the world's main staple crops and a key crop for promoting food security, particularly in sub-Saharan Africa (Low et al 2009). Due to its excellent adaptation to tropical and subtropical climates, it offers both rural and urban residents a greater nutritional advantage (Ingabire & Hilda 2011). Orange fleshed sweet potato, is a warm-season tropical tuber crop that ranks second in the world in terms of economic importance, behind Irish potatoes (Abubakar *et al* 2010). It is one of the tuber crops that small-scale farmers in Sub-Saharan Africa most commonly grow, with the third-highest production level after yams and cassava (Kaguongo *et al* 2010). Though grown by small-scale farmers for subsistence, its importance is rising as an attractive income generator. Its ability to give satisfactory yields under adverse climatic and soil condition as well as under low or no use of external inputs has made it gain popularity among many farmers (Nungo et al, 2007). In addition, its flexibility in mixed farming systems and ability to take short period to mature thus offering household food security which has made it an important livelihood strategy for small scale farmers.

Orange fleshed sweet potato is particularly rich in β-carotene which is the most important pro-vitamin A carotenoid. It is one of the bio-fortified crops being currently as part of the global effort to control deficiency (Abubakar, *et al* 2010). It is also one of the starchy staple crops which contain ascorbic and amino acid, lysine that are deficient in cereal-based diets such as rice in addition to appreciable amounts of β-carotene. It also contains soluble fiber which helps in reducing cholesterol level and anti-oxidant nutrient which inhibit the development of coronary heart diseases. Recently, researches programs are focusing on orange-fleshed sweet potato with great potential to prevent and eradicate hunger and poverty among farm householder and means of food security in the West African sub-region (Ingabire & Hilda 2011). However, the production of orange fleshed sweet potatoes in the Benin Republic faces a number of challenges due to the prevalence of pests and diseases, which can result in up to 78% of the crop being lost each year, negatively affecting the household that grows orange fleshed sweet potatoes on farms. (Laurie *et al* 2012). Orange fleshed sweet potato is produce in Benin Republic among farm householders with the majority living below average standard. Orange fleshed sweet potatoes have enormous potential to reduce nutritional deficits, increase income, and promote food security. The technical efficacy of growing orange-fleshed sweet potatoes in Benin is unknown, despite the importance of farm productivity. (Adekanye and Oyekale 2015).

However, this is yet to be fully exploited in the developing countries including Benin. Therefore, it is relevant to examine the effect of orange fleshed sweet potato's production among small holder farmers in Benin. The aims of this research include to determine the profitability level of orange fleshed sweet potatoes production, evaluate the determinant of technical efficiency among orange fleshed sweet potatoes farmer and identify the constraints to production of orange fleshed sweet potatoes. Ouémé Department receives less rainfall than the rest of the country, which averages 1,200 mm (47 in) annually.

Materials and Procedures

Area of the study

The study was carried out in the Benin Republic's Bonou commune in the Ouémé Department. One of Benin's twelve departments is Ouémé. It is divided into nine communes: Adjarra, Adjohoun, Aguégués, Akpro Missérété, Avrankou, Bonou, Dangbo, Porto-Novo, and Sèmè-Kpodji. Each commune is centered at one of the major towns. The nation's capital is located in Porto-Novo. The study town, Bonou commune, is 1,865 square kilometers (720 sq mi) in size. The department had 1,100,404 people living in it overall as of the 2013 Benin census, 534,814 men and 565,590 women. There were 51.40% more women than men. There were 37.20% more people living in rural areas than in urban ones

Sources of Data

Primary data was used through the structured questionnaire augmented with personal interview.

Sampling Procedure

The study's target population was in Bonou commune of Oueme department of Benin Republic. For this study, a three-stage sampling strategy was used. The first step comprised the deliberate selection of Bonou commune in the Oueme department of the Benin Republic because OFSP production is concentrated in that region. The

second phase involved choosing one-eighth of the study area's communities, based primarily on the list of registered OFSP farmers, and having them cultivate orange-fleshed sweet potatoes. The last stage also involved a random selection of 20 farmers within each community in Bonou commune.

Analytical Techniques

The study employed various analytical tools, such as likert scale, stochastic frontier function, gross margin analysis, and descriptive statistics.

Gross Margin Analysis

Gross Margin is given as:

GM = TR – TVC

Where:

GM = Gross margin (fcfa /hectare)

TR = Total Revenue (fcfa /hectare)

TVC = Total Cost (fcfa /hectare)

Stochastic Frontier Approach

Stochastic frontier analysis approach is used to analyses the level of technical efficiency of orange flesh sweet potato production among smallholder farmers in the study area. This involves the analysis of inefficiency in production. Following Folayan (2013), stochastic frontier model is represented as:

$$Yi = f(Xi; \beta) \exp(Vi - Ui) \quad i = 1, 2, \ldots, n. \quad \ldots\ldots\ldots\ldots (1)$$

Where: Yi = Output of ith farmer;

Xi = Vector of input quantities used by the ith farmer;

β = Vector of unknown parameters estimated;

f (.) = an appropriate function (in this case, translog frontier);

Vi = the symmetric component of the error term, associated with random factors not under the control of the farmer.

Ui = the nonnegative random variable under the control of the farmer. It represents inefficiency in production relative to the stochastic frontier quantity defined by f (Xi, β) exp (Vi). The random errors, Vi's are assumed to be independently and identically distributed with constant variance and zero means.

LIKERT TYPE SCALE ANALYSIS

Likert type scale is used to examine the constraints faced in orange flesh sweet production in the study area. The study shall employ a 5-point Likert scale, which was assigned weights of 5, 4,3,2,1 respectively.

Not complex –5

Fairly complex –4

Undecided –3

Very complex –2

Complex –1.

Results and Discussion

The data collected is based on details regarding the socioeconomic profile of the respondents in Benin Republic. Table 1's age distribution of respondents revealed that 34.55% of respondents were between the ages of 31 and 40. Given that the study area's respondents have an average age of 42.1 years, it is likely that the productivity of OFSP in the area will increase as a result of the majority of the farmers being young, nimble, and in productive age. Also, from table 1 which shows that 90.91% were males while 9.09% were females. This implies that majority of OFSP farmers were dominated by males, which support the indication that male had greater control over land than women in the study area. This consistent with Idoma & Ismail (2013).

According to Table 1, 48.18% of individuals had completed their tertiary education, 43.64% had completed their primary education, 7.27% had completed only their secondary education, and 0.91% had not received any formal education at all. This implies that more than 90%t of the OFSP farmers is literate and had formal education. This is line with the result of Akinleye (2006). The results also showed that the majority of respondents (67.27%) had households with six to ten people. The average household size in the study area was found to be roughly eight, indicating a moderate number of household members in farming households.

Table 1 shows the respondents' distribution based on marital status which shows that 94.55% were married. This implies that majority of OFSP farmers were married which confers emotional stabilities of the respondents.

This corroborates with the research of Bamire and Amujoyegbe (2005). The table 1 below shows the distribution of the respondents by farm experience which reveals that most of respondents have farm experience above 20 years (49.09 %), the mean farm experience was 26.29 years. This suggests that the bulk of responders were experienced farmers. They therefore possessed the necessary farming experience to recognize and manage the OFSP production in their regions. This conformed to the findings of Ashaolu, *et al.,* (2010). The distribution of respondents by farm size is also displayed in Table 1, indicating that 1.61 hectares was the mean farm size. This implies that majority of the OFSP farmers are peasant farmers. This corroborates with the result of Ohajianya *et al.,* (2012) where 63% of farmers had between (0.6-1) hectares of land.

Table 1: Socioeconomics Characteristics of the Respondents N = 120

	Frequency	Percentage
Age group		
≤30	27	24.55
31-40	38	34.55
41-50	20	18.18
51-60	16	14.55
≥61	9	8.18
Mean = 42.1		
Gender		
Female	10	9.09
Male	100	90.91
Education	48	43.64
Primary Education		
Secondary Education	8	7.27
Tertiary Education	53	48.18
No formal Education	1	0.91
Household size		
≤5	23	20.91
6-10	74	67.27
≥11	13	11.82
Marital Status		
Single	4	3.64
Married	104	94.55
Widowed	2	1.82
Farming Exp(year)		
6-10	5	4.55
11-15	23	20.91
16-20	28	25.45
≥21	54	49.09
Farm size (ha)		
Not more than 1	48	43.64
1-2	46	41.82
Above 2	16	14.55
Mean 1.61		

Source: Field Survey, 2022

Profitability Analysis

The costs and returns of producing OFSP in the study area are shown in table 2 below. The total variable cost was 158009.81CFA, or roughly 97% of the total cost of production, while the fixed cost was 39895CFA, or roughly 3% of the total cost. Hence, 197904.81CFA (TVC + TFC) was the total cost (TC) of farming. The gross margin was 226610.19 CFA and the total revenue was 424515 CFA. The average revenue per bag indicates that 3500CFA was made from the sale of one bag of the produced OFSP, whereas the average cost per kilogram indicates that 1631.67CFA were used to produce one bag of OFSP. The OFSP farmers will earn returns of 2.15 for every CFA invested, according to the benefit cost ratio, since the BCR is greater than 1. As a result, the study area's OFSP production is profitable.

Table 2: profitability of the OFSP Farmers

Items	Value (CFA)
Fixed cost	
Land	30200
Cutlass	2505
Hoe	945
Sprayer	6245
Total fixed cost	39895
Variable cost	
Fertilizer	18900
Seed/vine	55181.81
Chemicals	5672.73
Transportation	4328
Labour;	
Weeding	18167
Harvesting	10400
Land clearing	45360.27
Total variable cost (TVC)	158009.81
Total cost (TC = TVC+TFC)	197904.81
Total Revenue (TR): Output x price	121.29 bags x
Gross margin: **TR-TC**	3500 =
BCR $= \frac{424515}{197904.81}$	424515.00
	226610.19
	2.15

Source: Field Survey, 2022 1 bag = 50k

The outcome of the OFSP farmers' technical efficiency is explained in Table 3. The outcome demonstrates a positive correlation between the output of the OFSP and the herbicide regression coefficient, which was significant at the 1% level. This suggests that a unit increase in herbicide use will probably result in a 0.102 increase in OFSP production. This suggests that farmers will probably increase their output in proportion to how much herbicide they use. This is consistent with Zalkuwi & Dia's (2010) findings that herbicide improved maize yield. At the 1% level, the quantity of vine sown was significant and

showed a positive sign. This suggests that variations in output are significantly correlated with vine. Additionally, there was a positive correlation between the fertilizer coefficient and OFSP output, which was significant at the 5% level. This suggests that an increase in fertilizer application will raise OFSP productivity. The findings of Aung (2011), who noted that fertilizer application had a negative effect on rice production in the study area, are refuted by this result.

The inefficiency model, as shown in Table 3, showed a negative significant relationship with farm size, gender, education level, and cropping pattern. At the 5% level, farm size had a negative significant effect. This suggests that an increase in productive farmland will lessen OFSP farmers' technical inefficiencies. Technical inefficiency is negatively correlated with gender. This suggests that a decrease in technical inefficiency will result from an increase in the number of male farmers. The results of Adedapo (2008), which showed that male farmers were less technically proficient, are in conflict with this. Additionally, years spent in school had a 10% negative significance. This suggests that farmers with longer educational backgrounds are probably less inefficient technically. This is consistent with research by Oyewo (2011), which found a negative correlation between technical inefficiency and the number of years spent in school. Cropping pattern was significant at 1% and likewise showed a negative sign. This suggests that farmers who solely raised food crops were less inefficient in terms of technology.

Table 3: Maximum likelihood estimates of the stochastic frontier production function for OFSP farmers.

Variables	Coefficients	t value	Prob /t/
Constant	2.500 ***	12.56	0.000
Quantity of Herbicide	0.102***	2.59	0.010
Quantity of the vine	0.788 ***	10.76	0.000
Quantity of the Labour	0.066	0.75	0.451
Quantity of Fertilizer	0.089**	2.05	0.040
Inefficiency model			
Age	0.069	1.16	0.244
Farm size	-1.091**	-2.02	0.043
Gender	-1.976**	2.10	0.036
Farming experience	-0.019	-0.35	0.729
Years of schooling	-0.008*	1.85	0.067
Household size	-0.154	-1.32	0.186
Cropping pattern	-0.083***	-6.36	0.000
Constant	-2.509*	-1.69	0.090
Sigma	0.080		
Log likelihood	71.622		
Wald Chi 2	1909.06		
Pro > chi2	0.000		
Observations	110		

Source: Field Survey, 2022 *, ** and *** represents 10%, 5% and 1% levels of significance respectively

Technical Efficiency of Ofsp Production.

The result of the frequency distribution in Table 4 shows the estimate range from 0.00 to 0.99 and above. The least level of technical efficiency was 3%, and the best-performing OFSP farm achieved a technical efficiency of 99%. The mean technical efficiency was 88%, indicating that OFSP farmers produced below the frontier. The modal technical efficiency was above 90%.There is a significant amount of room for effective improvements in the technical efficiency of the farmers in the study area, as evidenced by the wider distribution of technical efficiencies in the production level in the area. As a result, there is room for the zone to produce more OFSP.

Table 4: Technical efficiency scores

Efficiency	Frequency	Percentage (%)
0.00-0.09	3	2.70
0.10-0.19	8	7.20
0.20-0.29	0	0.00
0.30-0.39	1	0.90
0.40-0.49	1	0.90
0.50-0.59	0	0.00
0.60-0.69	2	1.80
0.70-0.79	0	0.00
0.80-0.89	3	2.70
>0.90	91	81.90
TOTAL	110	100.00

MEAN: 0.88

MINIMUM: 0.03

MAXIMUM: 0.99

Constraints facing OFSP production in the study area

Constraint to orange flesh sweet potato production in the survey region was analyzed using a 5 point likert scale based on the finding from the survey area. Lack of Formal training (3.709) has the mean value placing it as the first major problems faced by the farmer that is the highest constraint faced by farmers in OFSP production. This is followed by lack of Storage facilities (3.554), lack of Institutional support/adequate funding (3.455), Shortage of land (3.409), unavailability of pesticide (3.282), inaccessibity to credit (3.091), Unavailability of fertilizer (3.073), High labour cost (3.073), inaccessibility to vines (1.818), Theft (1.600), Pest and diseases (1.527), Transportation problem (1.000) and Natural disasters (0.764). This shows that all these constraints were major problems hinder production of OFSP in the research area.

Table 5: Challenges faced by OFSP Farmers in the study area

Statement	Strongly Agree	Agree	Strongly Disagree	Disagree	Undecided	Mean score	Rank
Lack of Formal training	110 (100)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1.000	12th
Theft	0 (0.00)	0 (0.00)	49 (44.55)	61 (55.45)	0 (0.00)	3.555	2nd
Transportation problem	4 (3.64)	11 (10.00)	20 (18.18)	53 (48.18)	22 (20.00)	3.709	1st
Lack of Institutional support /adequate funding	0 (0.00)	29 (26.36)	16 (14.55)	51 (46.36)	14 (12.73)	3.455	3rd
Natural disasters	1 (0.91)	43 (39.09)	11 (10.00)	55 (50.00)	0 (0.00)	3.091	6th
Pest and diseases	0 (0.00)	14 (12.73)	37 (33.64)	59 (53.64)	0 (0.00)	3.409	4th
High labour cost	2 (1.82)	53 (48.18)	0 (0.00)	45 (40.91)	10 (9.09)	3.073	7th
Storage facilities	54 49.09	51 46.36	0 (0.00)	5 4.55	0 (0.00)	1.600	10th
Inaccessibility to vines	20 (18.18)	90 (81.82)	0 (0.00)	0 (0.00)	0 (0.00)	1.818	9th
Unavailability of pesticide	0 (0.00)	17 (15.45)	45 (40.91)	48 (43.64)	0 (0.00)	3.282	5th
Unavailability of fertilizer	0 (0.00)	43 39.09	16 (14.55)	51 (46.36)	0 (0.00)	3.073	7th
Shortage of land	64 (58.18)	40 (36.36)	0 (0.00)	6 (5.45)	0 (0.00)	1.527	11th
Inaccessibility to credit	60 (54.55)	0 (0.00)	0 (0.00)	6 (5.45)	44 (40.00)	0.764	13th

Source: Field Survey, 2022 (Percentage in parenthesis)

Conclusion

The study has been able to evaluate the technical efficiency of orange fleshed sweet potato production (OFSP) and its profitability in Benin republic. This study found out that orange flesh sweet potato is a profitable enterprise in the study area. Results show that OFSP production in the study area was dominated by male where majority were subsistence farmers based on their farm size. Variables which significantly affected their OFSP output include size of farm land, gender, years of schooling and cropping pattern. Challenges faced by OFSP farmers include transportation, theft, easy access to vine/seed, pest and diseases and natural disaster. It is therefore, recommended that female OFSP farmers should be encouraged into farming through the provision of incentives. Also, large scale production should be encouraged through awareness and provision of incentives for production. Provision of institutional credit to farmers on timely basis and with easy access to such credit facilities in other to increase production. Large farm lands should be provided to farmers and the use of herbicides and labour should be minimized to maximize profit.

Suggestion for Further Research

This finding raises the possibility that future research should concentrate on the difficulties farmers in the study area face, particularly with regard to credit availability, storage facilities, and transportation.

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