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Assessment of Management Practices and Sweet Potato Productivity among Smallholders

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Abstract

Sweet potato is a productive crop and serves to mitigate food insecurity among smallholders; however, output from sweet potato production is low. This study analyzed sweet potato productivity and practices among smallholders in Bokkos, Plateau State, Nigeria. Primary data collected via multi-stage sampling was analyzed using descriptive statistics, farm budget and Total Factor Productivity (TFP) techniques. The results revealed that 78.7% of the respondents were subsistent farmers; 53.2% practiced mixed cropping. Also, net farm income and percentage profit margin were ₦108,500/ha and 60.3% respectively; and benefit-cost ratio was 1.52. Furthermore, 57.5% of the respondents were sub-optimally productive as indicated by the index of TFP. The constraints of production in the area include agricultural technology/input costs (94.7%); financial constraints (87.2%); storage facilities (75.5%); cost of labour (69.1%); access to agricultural technology/inputs (56.4%); pest and diseases (48.9%); low patronage due to predominance of similar crop(s) (39.4%); and inadequate extension contact (36.2%). Improved access to agricultural technology, credit, farm labour supply, extension services, cooperative formation, development and adoption of agricultural technology and improved market linkages are strongly recommended.

Keywords: agricultural practices; constraints; productivity; profitability; root crop; yield

1. Introduction:

Sweet Potato (*Ipomoea Batatas*) is a root vegetable that produces tuberous roots (World atlas, 2019). It is a tropical root crop, with more than 100 million tons produced globally per annum (Waramboi *et al*., 2011); FAOSTAT, 2007). Propagation is by adventitious roots, stem, or root cuttings (World atlas, 2019). China currently accounts for more than half of the total global sweet potato output at 55 million metric tons per annum. Nigeria is among the world's largest producers of sweet potato with an average of over 1 million metric tons produced annually (World atlas, 2019), yet the average yield of 7 tons/ha in Nigeria were below the yield potential of about 35 tons/ha in China using similar labour intensive and technology (FAOSTAT, 2007). However, 15 tons per hectare is attainable by farmers in Nigeria using improved varieties (Okonkwo and Okoli, 2000). Also, research works including those of Okonkwo and Okoli (2000) revealed that while irrigated Irish potato production is an economically viable venture, it is more economically reasonable to cultivate (grow) sweet potato under rain fed condition in the study area: which implies that farmers here monopolize the agro-ecological environment in growing this crop during the rainy season. Despite the importance of sweet potato, it is considered a minor crop in terms of production and consumption in Nigeria (Adewumi and Adebayo, 2008; Woolfe, 2002). According to FAOSTAT (2007), 115 countries produced 106,569,572 tons of Sweet potatoes in 2010. However, supply remains very concentrated; 82.3% of the global production being in Asia with 81,175,660 tons, China produced by far the largest part and possesses a little less than half of the global acreage dedicated to the sweet potato. Indonesia is the second Asian producing country and the 4th in the world with more than 2 million metric tons of production, for example in the Papua province in Indonesia, 90% of the dishes contain sweet potato. The second continent in the world of sweet potato production is Africa. Africa contributed up to 14% of the global production with more than 14.2 metric tons. Contrary to the main producing countries

which have seen their production level decline over the years, some Africa countries have increased their production level from 2 metric ton in 1999 to 2.83 metric ton in 2010 (FAOSTAT, 2007). Nigeria and Tanzania produce 1.43Mt and 1.4Mt respectively (FAOSTAT, 2007). This expansion in Africa is linked to a strong demographic growth. However, Latin America, which is the global sweet potato arena, produced 1.97mt in 2010, that is, a little more than 2% of the global supplies. FAOSTAT (2007) reported that in 2010, Nigeria was ranked the second largest producer of sweet potato after Uganda in Africa (Tewe *et al.,* 2003). FAOSAT report of 2007 indicates that sweet potato production in terms of land size used from 2002 to 2012 depicts a law of diminishing returns. In this report, from 2003 to 2006, there were increased and moderate relationships between production per tones and land sizes used, but in 2007 there was a sharp decrease in production even though the land size was increased to about 10.8%. This increase was the biggest in the whole decade while the 2008 gave a remarkable change. Production figure rose to about 36.4% and land size declined to about 2.2%. But the periods 2009, 2010 and 2011 show that production and land size used remained unchanged with yields figures of 15000 tons/ha. Lastly, in 2012 the yield figure was increased to 1.6%. The cultivation and utilization of sweet potato have not received appropriate attention of the Nigerian populace despite its nutritional constituents, ease of propagation, soil conservation attribute and industrial use (Woolfe, 2002). It was regarded as a crop with little economic importance. Its consumption was surrounded by the erroneous idea that it caused amoebic dysentery (Woolfe, 2002). The minimal utilization of sweet potato in Nigeria may also be attributable to non-availability of adequate sweet potato- based recipes that satisfy the food habits of Nigerians (Adewumi and Adebayo, 2008; Warammboi *et al*., 2011). Of the estimated 150 million tons of all root and tubers produced in Nigeria annually, sweet potato contributes only 13% (Horton, 2008; Ekwelle *et al*., 2001). In Nigeria, the production, marketing and utilization of sweet potato have expanded to almost all the ecological zones within the past decade (Ekwelle *et al*., 2001; Adu-Kwarteng *et al*., 2002; FAOSTAT, 2007). Sweet potato is the second highest source of energy crop after cassava producing 465KJ, that is, only 125KJ less than cassava (SPU, 2013). Industrially, sweet potatoes flour can be used to substitute wheat flour in bread making or maize flour in balanced feeds. Energy is measured in kilocalories (Kcal), calories or Kilojoules (KJ), and 1 kilocalorie = 4.2 kilojoules.).However, industrial potentials of sweet potato have not been exploited due mainly to a chronic lack of awareness about the numerous commercial benefits derived from it (Horton, 2008).

Cost- return analysis usually forms the basis for farm profitability analysis. This involves itemizing costs and returns of production and using them to arrive at such estimates as the return to one unit of the resources used. The gross margin and net returns analysis are techniques usually adopted. In some cases, these values are subjected to test of statistical significance to verify differences between them. Adeleke *et al*. (2008) developed a farm level model to evaluate alternative cropping mixtures and patterns. The major problems associated with cost-return analysis as basis for profitability assessment are: it does not indicate the relative importance of each of the resources in production and its location bound and specific in applicability due to use of money as common unit of measurement and the prevailing price for the estimates. Adeleke *et al*. (2008) posited that in spite of the limitations, cost and return analysis is a useful tool in enterprise comparison and in indicating a profitable pattern of aggregate input use. This method was used by Tewe *et al*. (2003); Gyang and Wuyep (2005). According to Olukosi and Ogungbile (1989), gross margin is a very useful planning tool in situation where fixed cost is negligible portion of the farming enterprise as in the case of subsistence agriculture. It is easily computed and represents the most relevant economic indicator to draw the attention of the farmer to the problem of his farm and offer solution to them. As with any economic analysis, the profitability of an investment is based on a comparison of the returns and cost of the investment. Another way to add value on the production side would be to reduce processing costs by increasing the efficiency (and thus the profitability) of production (Tewe *et al.*, 2003). Hence, the profitability of crop production depends on reducing the farming cost as much as possible, and at the same time maximizing the income from the sale of the crop. Profitability in some farm business exists because they are managed more efficiently than others. The reward for doing the job better is usually profit. The prospect of earning and maintaining profitability serves as the incentives for creativity and efficiently among farmers. One serious problem facing Nigeria today is chronic and transitory food insecurity (World Bank, 2003). Sweet potato is highly regarded as a food security crop and it is the most productive crop among all the other staple crops and tolerates occasional dry spells and yields even on less fertile soil in contrast to other crops such as maize (Woolfe, 2002; Zuraida, 2003). World Bank (2003) opined that, despite the fact that Nigeria was found to be the second highest producer of sweet potato in Africa, it was ranked 17th in terms of output produced per land area, suggesting that sweet potato producers in Nigeria are quite inefficient in relation to farmers in other African countries. There is great need to improve the national production from over 1 million to 5 million tons per annum (World Bank, 2003). In Nigeria the output from sweet potato production is low and therefore there is needed to empirically analyze sweet potato productivity and systems among farmers. This study will also provide policy makers, development planners and other stakeholders with necessary data and insight for effective and sustainable policies and programmes that would facilitate and boost farm productivity and profitability. The study would, add to the existing body of knowledge in rural sociology and economics of root crop production. Raising agricultural productivity, reducing food insecurity and poverty is an important policy goal for concerned government since agriculture plays a major role in the economy of many developing countries, as it is a significant source of nourishment for citizens and a means of livelihood for the most vulnerable members of this country Adewuyi (2006). Therefore, increasing agricultural productivity requires one or more of the following; an increase in output and input with output increasing proportionately more than inputs; an increase in output while inputs remain the same; a decrease in both inputs and output with input decreasing more; or decreasing input while output remains the same (Adewuyi, 2006; Oni *et al.*,2011). Hence, the broad aim of this study was to analyze productivity and practices among sweet potato farmers, while attempting to address the following research questions;

1. What are the prevalent management practices?
2. What are the costs and returns in sweet potato production?
3. What is the level of productivity among farmers?

4. What are the constraints of sweet potato production in the study area?

2. Methodology:

2.1. Study Area:

This study was carried out in Bokkos Local Government Area (LGA) of Plateau State, Nigeria. The LGA has a total area of 1682km^2 and located between latitude 9^{0}15$^{'}$N and 8^{0}53$^{'}$E, with a total projected population of 392,026 in 2016 (NBS, 2012). The Local Government is made up of 8 districts which include; Mushere, Daffo, Richa, Sha, Manguna, Toff, Kamoi and Bokkos. The LGA is located at the central region of Plateau State and it is surrounded by rocks and scattered vegetation. Its Annual rainfall averages from 600mm-1000mm, with average temperatures of about 24^{0}C-29^{0}C annually (FAOSTAT, 2007). The major crops cultivated in the study area are irish potato, sweet potato, cocoyam, maize and red beans.

2.2. Sampling Technique:

Multistage sampling technique was used in selecting the respondents for the study. The first stage involved the Purposive selection of Bokkos LGA due to the prevalence of sweet potato production in the study area. The second stage involved the selection of three (3) districts out of eight (8) in the study area due to the prevalence of sweet potato farmers in the selected districts (Daffo, Sha and Bokkos districts). The third stage involved the collection of a compiled list of sweet potato farmers from Plateau state ADP extension agent at the LGA secretariat. In the last stage, using the list of estimated population of sweet potato farmers in the selected districts, respondents were randomly selected using 0.2 sampling proportion. Based on the foregoing, 94 respondents were randomly selected for the study. Table 1 presents the sample size distribution.

Selected Districts	Communities	Sample Frame	Sample size
Daffo	Ganda Magi Ngajul	135 64 37	27 13 7
Bokkos	Kunnet Mangar Tarangol	66 35 34	13 7 7
Sha **Total**	Manguna Tar **08**	61 38 **470**	12 8 **94**

Table1. Sample size
Source: Plateau State ADP, 2017

2.3. Method of Data Collection:

Data for this study was collected from primary source. Primary data was collected through the use of well-structured questionnaires in line with the specific objectives of the study.

2.4. Analytical Techniques:

The data were analyzed using descriptive statistics, farm budgeting model and Total Factor Productivity (TFP) analysis. Descriptive statistics (frequency counts and percentages) were used to describe the prevalent management practices and identify the constraints of sweet potato production. The farm budget technique (costs and returns analysis) was used to determine the costs, returns and profitability of sweet potato production in the area. The Total Factor Productivity (TFP) analysis was used to estimate agricultural productivity by comparing an index of agricultural inputs to an index of outputs.

2.4.1. Farm Budget model:

The farm budget model adopted for this study was the costs and returns analysis. Indicators such as net farm income, percentage profit margin and benefit-cost ratio were analyzed. The budgetary techniques are presented in equation (1) and (2);
Net farm income (N.F.I) = GFI –TC ……. (1)
Where;
GFI = gross farm income; TC = Total cost
TC = TVC = TFC ……. (2)
TVC = Total variable cost [Seed (₦), fertilizer (₦), labour (₦), and agrochemicals (₦)]
TFC = Total fixed cost [Land improvement (well, drainage, boundary mark, etc.) (₦) and depreciation of farm tools/equipment's (₦)].
The straight-line method of evaluating depreciation will be used to estimate the depreciation of farm assets (farm tools, equipment's, irrigation facility, etc.) (₦). The straight-line method of depreciation is specified in equation (3);

$$D = \frac{P - S}{N} \quad \ldots\ldots. (3)$$

Where;
D = Depreciation; P = Purchase price of the assets; S = Salvage value of the assets; and N = Number
of years of life of the assets
To further substantiate the profitability of this enterprise, profitability ratios such as: percentage (%)
profit margin and benefit-cost ratio were analyzed and specified in equations (4) and (5);
Percentage (%) Profit margin = (Net farm income ÷ Total revenue) 100% ……. (4)
Benefit-cost ratio = Net farm income ÷ Total cost ……. (5)

2.4.2. Total Factor Productivity:

Total factor productivity (TFP) is a method of calculating agricultural productivity by comparing an index of agricultural inputs to an index of outputs (Fakayode *et al*., 2008). This can be computed following Key and McBridge (2005) as the ratio of output to total variable cost (TVC) and specified in equation (6):

$$\frac{TFP}{TVC} = \frac{Y}{TVC} = \frac{Y}{\sum PXi} \quad \ldots\ldots\ldots (6)$$

Where:
Y = quantity of output; TFP = Total Factor Productivity; TVC = total variable cost; Pi = unit price of the ith variable input; and Xi = quantity of ith variable input.
This methodology ignores the role of total fixed cost (TFC) as it does not affect either the profit

maximization or the resource-use efficiency conditions (Fakayode *et al*., 2008).

Therefore, equation (6) can also be presented as follows in equation (7);

TFP=$\frac{Y}{AVC}$ ……. (7)

The interpretations of TFP index are as follows;

(< 0.1) = Sub-optimal; (1.0 – 1.09) = Optimal; and (≥ 1.10) Super-optimal

3. Results and Discussion:

3.1. Management Practices:

3.1.1. Farming System:

Farm system	Frequency	Percentage (%)
Subsistent	74	78.7
Commercial	20	21.3

Table 2: Distribution based on Respondents Farming Systems
Source: field survey, 2017

Table 2 revealed that most (78.7%) of the respondents in the study area were subsistent farmers, while 21.3% were commercial farms which were mostly communal farms; This predominant farm system was attributable to the prevalent tenure policies which caused fragmentation of most potential farms lands; resulting to a prevalence of small farm holdings among most farmers in the study area. This corroborates with the findings of Tewe *et al.,* 2003 who also reported similar results in their study on Sweet potato production, utilization and marketing in Nigeria.

3.1.2. Cropping System:

System	Frequency	Percentage (%)
Monoculture	44	46.8
Polyculture	50	53.2

Table 3: Distribution based on the Respondents Cropping System
Source: field survey, 2017

Table 3 revealed that most (53.2%) of the respondents in the study area adopted mixed cropping systems, while 46.8% adopted monocropping systems. This predominant cropping system is attributable to the farm size of the respondents; hence most farms combined cultivation of sweet potato production with other crops so as to maximize a variety of farm output relative to their small farm holdings in the study area. This corroborates with the findings of Tewe *et al.,* 2003 who also reported similar results in their study on Sweet potato production, utilization and marketing in Nigeria.

3.2. Farm Budget Analysis:

Input	N/ ha	%
Returns: Mean output/ha = 3,000kg Unit price/50kg bag = ₦3,000 Total Revenue (TR)	180,000	
Variable cost (VC): Labour	15,000	21
Seed (vines)	7,000	9.8
Fertilizer	18,500	25.9
Herbicide	2,500	3.5
Empty bag(s)	3,000	4.2
Market levy Transportation/Storage cost	500 5,000	0.7 7
Total Variable Cost(TVC)	51,500	72
Fixed Cost(FC): Farm implements (Hoes, wheelbarrows, etc.)	20,000	28
Total Fixed Cost(TFC)	20,000	28
Total Cost(TC)	71,500	100
Net profit margin (TR - TC)	108,500	
Percentage (%) Profit margin Benefit-Cost ratio: 1.52		60.3

Table 4: Net Profit Analysis of Sweet Potato Farmers per Hectare (ha)
Source: Field survey, 2017

Table 4 revealed that the net farm income of sweet potato production in the study area was ₦108,500/ha, suggesting that sweet potato production was a relatively profitable venture with prospects for improved economic potentials. The estimated total variable and total fixed cost were ₦51,500/ha and ₦20,000/ha respectively, suggesting that a significant proportion of the gross farm income (total revenue) was expended as production cost. The estimated total cost for sweet potato production was ₦71,500/ha. Cost of implements (28%) and cost of fertilizer (25.9%) constituted the most significant production cost components. The estimated percentage profit margin was 60.3%, which suggests the percentage net margin accruable to the farmer from the estimated gross margin. The benefit-cost ratio was 1.52, which is indicative that for every naira (₦1) invested in cucumber production ₦1.52 can be accruable in return. These ratios are indicative of the profitability index of cucumber farming in the study area. This corroborates with the findings of Olarinde *et al*., (2005) who also reported similar result on the profitability of arable crop production.

3.3. Total Factor Productivity of Sweet Potato Production:

Variable	Frequency %
Sub-optima (<1.00)	54 57.5
Optima (1.00 -1.09)	30 31.9
Super-optima (>1.10)	10 10.6

Table 5: Distribution Based on Total Factor Productivity of the Respondents Source: Field survey, 2017

The summary statistics of the TFP result in Table 5 revealed that most (57.5%) of sweet potato farmers were sub-optimally productive as their TFP indices were below the optimal scale, which indicated sub-optimal input mix allocation in the production process; 31.9% were found to be optimally productive as indicated by their TFP indices and 10.6% were super-optimally productive as their TFP indices were above the optimal scale. The low productivity could be attributed to the sub-efficient management practices adopted by the sweet potato farmers and utilized in their input mix, which yielded low sweet potato output in their respective farms in the study area. This corroborates with the findings of Fakayode *et al*., 2008 who also reported similar results in their study on Agricultural Productivity Profiles in Nigeria.

3.4. Constraints of Sweet Potato Production:

Constraints	Frequency	Percentage (%)*
High cost of labour	65	69.1
Financial constraints	82	87.2
Poor storage facility	71	75.5
Pest and diseases	46	48.9
Poor access to agricultural technology/inputs	53	56.4
Inadequate extension contact	34	36.2
Low patronage due to predominance of similar crop(s) High cost of agricultural technology/inputs	37 89	39.4 94.7

Table 6: Constraints of Sweet Potato Production
Source: field survey, 2017; * = Multiple responses allowed

The result of Table 6 revealed that the constraints of sweet potato production in the study area include; high cost of agricultural technology/inputs (94.7%); attributable to poor access and non-subsidization of productive resources. Also, most of the farmers wish to wait for government subsidized and qualitative fertilizer and inputs which are grossly inadequate. Financial constraints (87.2%); attributable to poor access to financial institutions and agricultural credit among the respondents; hence their meager savings are not sufficient to cater for their farm activities in sweet potato production. Poor storage facilities (75.5%); attributable to poor access to modern agricultural technology, high cost of labour (69.1%); attributable to non-availability and inadequate supply of farm labour; family labour was predominantly used in the study area resulting in acute shortage of labour. According to the farmers, during active period of production-every household would have been engaged in his family farm work. The demand for labour is normally very high and expensive during the peak period of land clearing, ridging, harvesting, processing and weeding in the study area. Poor access to agricultural technology/inputs (56.4%); attributable to non-availability of agricultural technology/inputs in the study area, according to the respondents they make use of seeds from their previous harvest which is not reliable and can jeopardize improved and sustainable productivity. Pest and diseases (48.9%); attributable to the adoption of poor management practices among the respondents, the farmers also revealed that pest and diseases were responsible for pre-harvest and post-harvest losses in sweet potato production in the study area. Low patronage due to predominance of similar crop(s) (39.4%); attributable to increased demand for alternative root crops in the study area and poor access to market linkages to sell their agricultural produce. Lack of extension contact (36.2%); attributable to poor and inadequate extension services in the study area. All the constraints identified by the farmers significantly affected sweet potato production in the study area. This result is in line with the findings of Benjamin et al. (2014); Nwankwo (2008); National Root Crop Research Institute (NRCRI) (2000), who opined similar Constraints in Root Crop Production.

4. Conclusion and Recommendations:

This study analyzed productivity and systems adopted among sweet potato farmers in Bokkos, Plateau State, Nigeria. The results revealed that most of the respondents were subsistent farmers and adopted mixed cropping systems. In addition, sweet potato production was relatively profitable in the study area. Furthermore, the result revealed that most of the sweet potato farmers were sub-optimally productive as their TFP indices were below the optimal scale. The low productivity could be attributed to the sub-efficient management practices adopted by the sweet potato farmers. All the constraints identified by the farmers were economically important and significantly affected sweet potato production in the study area; hence effort should be made to minimize the constraints faced by the farmers so as to increase their farm output using available resources. Based on the findings of this study, the following recommendations are made for policy actions to improve farm output and incomes derivable;

1. Formulation of policies to subsidize cost of improved production technology and inputs.
2. Formulation of policies that will make credit facilities accessible and affordable to the farmers; cooperative formation to improve farmers' access to agricultural credit.
3. Formulation of policies that provide incentives that support farm labour supply.
4. Formulation of policies to encourage development and supply of modern production, storage and processing technologies using indigenous methods.
5. Extension activities in the study area should be intensified for delivery of improved farming techniques to the famers.
6. Formulation of policies to encourage efficient adoption of improved management practices, pest and disease control measures.
7. Formation of farmers group or cooperatives that will handle the supply and improve market linkages for their harvested produce and dissemination of practices that will enable farmers utilize their available resources efficiently and optimally to maximize profit.

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