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IMPACT OF CULTIVATED LAND AREAS ON THE PRODUCTION OF SELECTED VEGETABLES IN PLATEAU STATE, NIGERIA

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ABSTRACT

Agricultural growth in most countries of sub-Saharan Africa has been attributed to cultivated land expansion. This indicates that availability of arable land remains an important and determining factor of agricultural production. This study evaluates the impact of cultivated land areas on the production of selected vegetable crops in Plateau State of Nigeria. The study made use of secondary data which were obtained from Plateau State Agricultural Development Program (PADP). The data were analysed using Pearson Product-Moment Correlation (PPMC), descriptive statistics, F-test statistics, t-test, Multiple Linear Regression (MLR) using backward elimination procedure. The results of PPMC indicate that cultivated land areas of carrot and okra are strongly positively correlated (0.973) with the total production of the vegetables, the cultivated land areas of onion were negatively correlated (-0.610) with the response variable. Coefficient of multiple determination of the MLR model (R-square) revealed that 98.9% of variability in total production output of the selected vegetables was due to cultivated land areas of carrot, onion and okra. Initial investigation of the MLR model did not give the most statistically significant predictor of the response variable hence backward elimination procedure was applied twice. The results showed that the cultivated land area of carrot is the most significant factor influencing the output of selected vegetables in Plateau State. It is therefore imperative for policy strategy that will facilitate carrot farmers' access to land to boost total production of vegetables in Plateau State.

Keywords: Cultivated land area, Carrot, Onion, Okra, Vegetables.

Introduction

Vegetables are essential source of vital nutrients which are needed for adequate functioning of human body. As prescribed by World Health Organization (2003), the minimum recommended daily intake of fruits and vegetables is 400g/day. In order to meet the minimum requirement as the population increases, there is need to fill the vegetables' production gap that exists worldwide as many countries of sub-Saharan Africa have not been able to produce enough vegetables to meet the micro-nutrient needs of their growing population (Pem and Jeewon, 2015). Major producers of vegetables are China and India with India producing 169.478 million tonnes of vegetables from an area of about 9.542 million hectares thereby making India the second largest producer of vegetables after China (Surbhi *et al.*, 2018). However, production of vegetables is limited by several problems such as low soil fertility.

Low soil fertility - among others - is one of the many problems facing production of vegetables in Plateau State. Use of fertilizer

offers solution to the problem of low soil fertility of a parcel of land which might have been cultivated continuously over a certain period of time. This will assist in improving soil fertility and increase yield of vegetables. Since fertilizer is made to be applied to soil or any medium through which plant roots can draw their nutrients and not made for particular type of crops, hence its application to soil or any such medium has high tendency to improve yield of crops. Other problems leading to poor harvest of vegetables in Plateau State include flood, drought, weeds, insects and communal clashes.

Farmers whose farmlands are less than two hectares of land are usually referred to as smallholder farmers (Rapsomanikis, 2015; Nagayets, 2005). These smallholder farmers have the advantage of making reasonable returns from vegetable farms since small cultivated land areas could be used for vegetable cropping system. Involving large number of smallholder farmers together with large scale farmers could reasonably increase quantity of vegetable production which again can lead to uninterrupted supply of vegetables to the consumers (Kuivanen, 2016). Carrot (Daucus carota L.) is a biennial vegetable plant and a source of vitamin A, vitamin C, vitamin E, carotene, thiamine, niacin, carbohydrate, iron, riboflavin, magnesium and other essential minerals (Surbhi *et al*., 2018). The research of Scarano *et al*. (2018) showed that some varieties of carrots contain more bioactive compounds with inclusion of high antioxidant capacity than other varieties of carrots. By-products of carrot such as carrot peel can be combined with other materials to produce jam as a food component rich in high dietary fibre (Hussein *et al*., 2015).

Okra is a vegetable which has considerable land areas cultivated in the world with production estimated at 6 million tonnes per year (Burkil, 1997) with total production projected to have increased over the years. Nigeria has areas of land cultivated for okra of about 387,000 ha with production of about 1,039,0000 metric tonnes (MT) between 2008 and 2009 (Benchasri, 2012). Okra as vegetable has various uses such as keeping stomach clean and preventing destructive culture by eating it as natural vegetables as against processed vegetables (Mihretu, 2014; Messing, 2014; Zaharuddin, 2014).

Anjum and Barmon (2017) studied profitability and comparative advantage of onion production in Bangladesh and concluded that the problem relating to production, technology and marketing should be solved for more availability of the product, Ansari(2007) studied onion cultivation in Iran and concluded that one of the main reasons for onion research in Iran is to produce cultivars and hybrids with increased quality and yield. Studies on onions for other regions of the world also exist in literature (Mamiro *et al*., 2014; Maman *et al.*, 2018). However, for Plateau State using adequate agronomic practices, onion - an important spice crop – can yield quality bulb as a source of vitamins and essential minerals for Plateau State residents. Cost of land preparation is one of the limiting factors that can also affect the size of land cultivated, countries in tropic regions with about 45% of the world's arable land grows about 35% onions across the globe (Kariuki and Kimani, 1994). The research question is which of the cultivated land areas of carrot, onion and okra has the most significant impact on vegetable production in Plateau State?

Cultivated land expansion is one of the sources of growth in crop production. About 80% of the projected crop production growth in developing countries has been attributed to crop increase in farm size. Arable land expansion will remain an important factor in crop production growth in many sub-Saharan Africa (FAO, 2003). It is therefore important to conduct study on the impact of the cultivated land areas on the production of selected vegetables in Plateau State. The selected vegetables considered for this study are carrot, onion and okra. The information from this study would help to gain insight into which extent the size of land areas cultivated influence total production of selected vegetables in the study area.

Methodology

Study Area

Plateau State is one of the 36 States situated in the middle belt of Nigeria on coordinate 9° 34' N and 9° 04' E. It consists of cities that are significantly much cooler than other cities in Nigeria as its average monthly temperature range between 21^oC and 25^oC. Although Jos Plateau is known for mining activities, agriculture is still the major occupation of the people.The crops grown include vegetables, acha, potatoes, cowpeas etc.

Secondary data for this study were obtained from the production output and cultivated land areas of Plateau State Agricultural Development Program (PADP). This is an agency of government saddled with the responsibility of carrying out research in order to aid development of agricultural practices in Plateau State. Data on production output of three types of vegetables were obtained in thousands metric tonnes and data on land areas cultivated were also obtained in thousand hectares of land. The available data at the time of carrying out of this study covers the period of six years (2012-2017). The three types of vegetables considered include: carrot, onion and okra.

Data Analysis

Data collected were analysed using Pearson Product-Moment Correlation (PPMC), descriptive statistics, F-test statistics, t-test statistics and Multiple Linear Regression (MLR) with backward elimination procedure using the aid of Statistical Package for Social Sciences (SPSS) and Excel software package.

Specification of the Model

Three independent variables and one dependent variable were considered for the model in this study. The focus is to determine which independent variable has significant impact on the production output of carrot, onion and okra. The multiple linear regression equation is

$$Y = b_3X_3 + b_2X_2 + b_1X_1 + b_0 + \epsilon \quad (1)$$

where Y is total production output of carrot, onion and okra in '000 MT , X_1 is carrot cultivated area in '000 HA, X_2 is onion cultivated area in '000 HA , X_3 is okra cultivated area in '000 HA, b_0 is a constant term,b_3, b_2 , b_1 are coefficients of land areas of carrot, onion and okra respectively and the PPMC is $r = \frac{N\sum X_iY-(\sum X_i)(\sum Y)}{\sqrt{[N\sum X_i{}^2-(\sum X_i)^2][N\sum Y^2-(\sum Y)^2]}}$ (2)

where, $X_{i,}(i = 1,2,3)$are the cultivated land areas of carrot, onion and okra respectively, r is the correlation coefficient and Y is the total production output of carrot, onion and okra.

Results and Discussion

The strength of relationship between the total production output of vegetables (in '000 MT) and cultivated land areas (in '000 HA) of the vegetables was first examined using Pearson Product- moment correlation.

Table 1: PPMC of the predictors with the response variable

	Carrot Area Cultivated (in '000 HA)	Onion Area Cultivated (in '000 HA)	Okra Area Cultivated (in '000 HA)
Total production ouput(in '000 MT)	0.973	- 0.610	0.973

From Table 1, Pearson product-moment correlation analysis for pairwise comparisons of the predictors and the response variable shows that the cultivated land areas of carrot and okra are positively correlated with total production output. This implied that cultivation of more land areas of the associated variables tend to lead to higher production of the vegetables in Plateau State. However, the cultivated land areas of onion are negatively correlated with the total production output of the vegetables. This can be attributed to the significant drop in the cultivated land areas of onion between certain years as depicted in Figure 2.

Results in Table 2 shows that 98.9% of variation that exist in the production of vegetables in the study area was due to cultivated land areas of carrot, onion and okra. It should be noted that the r- value of 0.995 is a good indicator of significantly strong multiple correlation coefficient and it measures the quality of prediction of the multiple regression model equation of this study as adequate in the context of its usage.

Table 2: Model summary for the area of land (in '000 HA) cultivated and production output (in '000 MT, 2012-2017)[b].

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1	0.995[a]	0.989	0.973	0.91690

a. Predictor: (constant) area cultivated of carrot, onion, okra in '000 HA

b. Dependent variable: Total production output in '000MT

Usually, in order to determine significant predictors of response variables in MLR, two steps are involved. The first step is to perform F –test statistics and note that if there is no significant predictor, there would not be any need to continue the analysis, but if there is significant predictor, there would be need to proceed to the second stage. The second stage is to perform a t-test on each predictor variable (Jobson, 1991). Thus, results for F-test statistics are shown in Table 3 revealed that at least one of the land areas of carrot, onion and okra is a significant predictor of vegetable output in the study area.

Table 3: F-test statistics for land areas of carrot, onion and okra and total production output of vegetables , a = 5% level of significance.

Model	Sum of squares	df	Mean square	F	p-value
Regression	155.961	3	51.987	61.838	0.016[b]
Residual	1.681	2	0.841		

Total	157.642	5

a.. Dependent variable: Total production output in '000 MT
b. Predictors: (Constant), Okro Area Cultivated 000 HA, Onion Area Cultivated 000 HA, Carrot Area Cultivated 000 HA

From Table 3, we reject the null hypothesis as F- test statistics suggests evidence that at least one of the land areas of carrot, onion and okra is a significant predictor of total production output of vegetables ($p < 0.05$). However, the significant F-value ($P < 0.05$) did not tell us which one or how many of these variables were significant predictors of total production output of vegetables. To determine which one or how many predictor variables are significant, t- tests was estimated to identify the predictor variable as shown in Table 4.

Table 4: Multiple linear regression model parameters for three independent variables of equation (1)[a] , a = 5% level of significance.

Model	B	Std Error	Beta	t	p-value	LBound	UBound
(constant)	- 4.855	15.838		-2.832	0.105	-113.002	23.292
Carrot Area Cultivated in '000 HA	217.876	87.350	13.162	2.494	0.130	-157.959	-593.712
Onion Area Cultivated in '000 HA	- 8.162	2.915	-0.535	-2.800	0.107	-20.702	4.379
Okra Area Cultivated in '000 HA	-518.087	222.933	-12.475	-2.324	0.146	-1477.292	441.119

c. Dependent variable: Total production output in '000 MT

It was observed that F- test statistics in Table 3 indicated that land areas of at least one of carrot, onion and okra was a significant predictor of total production output of vegetables, on the other hand t- test statistics in Table 4 indicated that none of them were significant after checking for the effects of the other predictor variables. It should be noted that the t-test statistics is conducted as many times as the three predictor variables which are land areas of carrot, onion and okra as shown in Table 4. This suggests that if a predictor variable that is not contributing significantly well to the model is removed, then the remaining two predictor variables will not give exactly the same model as when all the three predictor variables are present whenever re-fit of the model is carried out. The question now is how do we know the predictor variable that is not really contributing well to the model without removing one of the land areas of carrot, onion and okra? Even, if we are going to remove land areas of any predictor which one do we remove? This therefore necessitates backward elimination procedure (Jobson, 1991; Halinski and Feldt, 1970) in which all land areas of carrot, onion and okra are included at initial time but the least significant predictor variable is removed from the model and the model is re-fit with the remaining predictor variables. This process is continued until all remaining land areas of vegetables are significant predictors of the total production output of vegetables. How then do we identify the least significant predictor variable? It should be noted that the least significant predictor variable is the one with

highest p-value from t-test which in Table 4 is okra and after further analysis we obtain Table 5.

Table 5: Multiple linear regression model parameters for two independent variables in equation (1) using backward elimination procedure[a] , a = 5% level of significance.

Model	B	Std Error	Beta	t	p-value	LBound	UBound
(constant)	-45.944	24.866		-1.848	0.162	-125.077	33.190
Carrot Area Cultivated in '000 HA	14.906	2.230	0.900	6.685	0.007	7.810	22.003
Onion Area Cultivated in '000 HA	- 2.110	2.056	-0.138	-1.026	0.380	-8.652	4.433

a. Dependent variable: Total production output in '000 MT

On further application of backward elimination procedure to values shown in Table 5, we obtain Table 6 with p value as 0.001 which indicate that carrot is the most statistically significant predictor of the production output of the selected vegetables in Plateau State (2012 - 2017) at 5% level of significance.

Table 6: Multiple regression model parameters for one independent variables in equation (1) using backward elimination procedure[a] , a = 5% level of significance.

Model	B	Std Error	Beta	t	p-value	LBound	UBound
(constant)	-61.125	20.119		-3.038	0.038	-116.983	-5.267
Carrot Area Cultivated in '000 HA	16.106	1.911	0.973	8.427	0.001	10.800	21.413

a. Dependent variable: Total production output in '000 MT

On assumption of linear relationship among the variables and using Table 4, the multiple linear regression equation (1) becomes

$$Y = -518.09\, X_3 - 8.16\, X_2 + 217.88\, X_1 - 44.86 \qquad (3)$$

Where, the variables are as defined in (1). Equation (3) is the full multiple linear regression model equation for predicting Y from X_1, X_2, X_3.

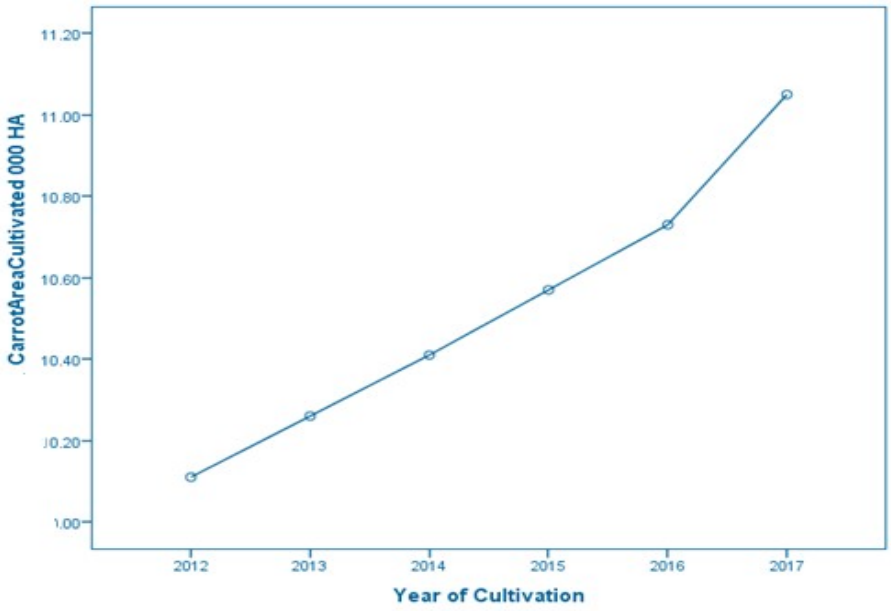

Figure 1: Area of land (in '000 HA) cultivated for carrot production (2012-2017).

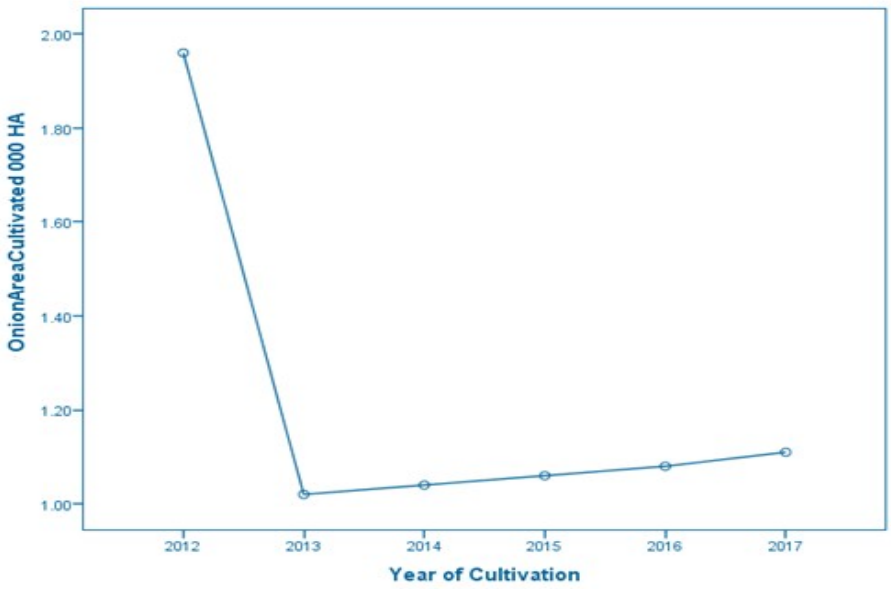

Figure 2: Area of land (in '000 HA) cultivated for onion production (2012-2017).

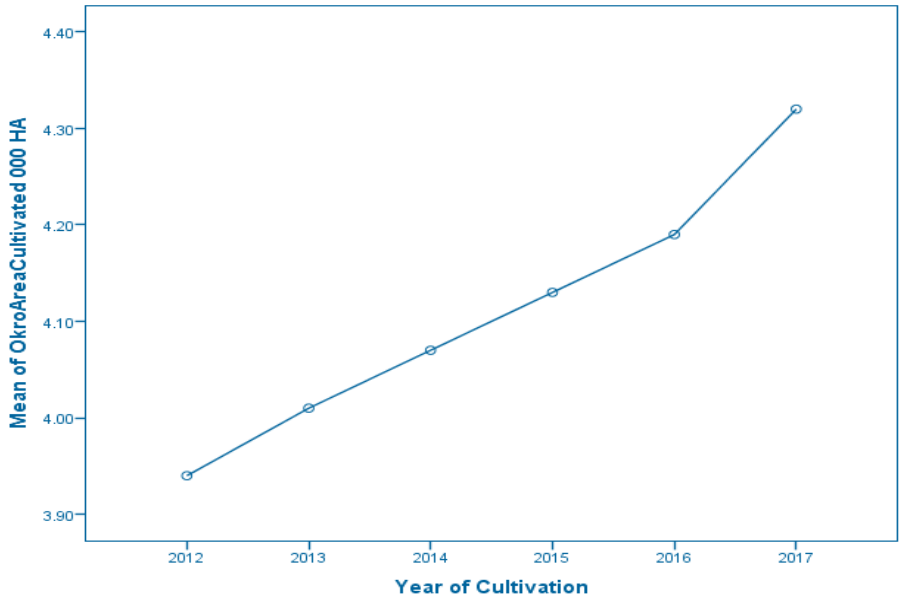

Figure 3: Area of land (in '000 HA) cultivated for okra production (2012-2017).

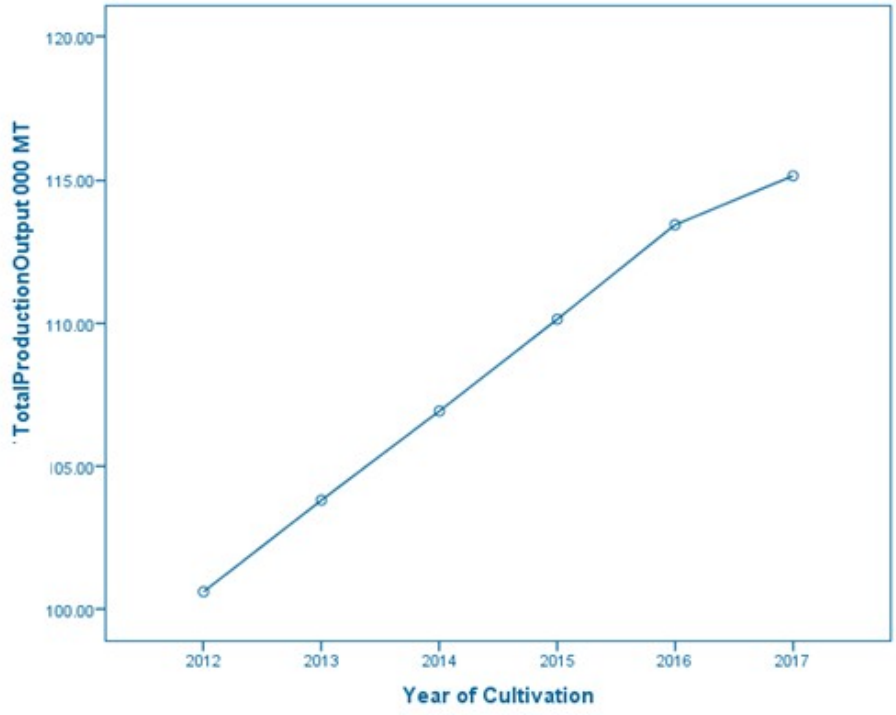

Figure 4: Total production output of vegetables (in '000 MT) in Plateau State (2012-2017).

Figures l and 3 show consistent increase in the areas of land cultivated for carrot and okra production in Plateau State. However, Figure 2 shows initially large cultivated areas for onion production in the year 2012 followed by a drop in the size of the areas cultivated in the year 2013 before a gradual increase in the subsequent years (2013-2017). While Figures 1, 2 and 3 indicate the land areas cultivated for carrot, onion, okra, the total production of the selected vegetables consistently increase to about 115,000 metric tonnes in the year 2017.

Table 7: Mean of land areas cultivated (in '000 HA) for the vegetables (carrot, onion and okra, 2012-2017).

Year	N	Mean	Std Deviation	Std Error	Lbound	Ubound	Min	Max
2012	3	5.3367	4.2507	2.4542	-5.223	15.896	1.96	10.11
2013	3	5.0967	4.7149	2.7221	-6.616	16.809	1.02	10.26
2014	3	5.1733	4.7845	2.7606	-6.705	17.051	1.04	10.41
2015	3	5.2533	4.8535	2.8022	-6.804	17.310	1.06	10.57
2016	3	5.3333	4.9256	2.8438	-6.903	17.569	1.08	10.73
2017	3	5.4933	5.0728	2.9288	-7.108	18.095	1.11	11.05
Total	18	5.2811	4.0126	0.9458	3.286	7.277	1.02	11.05

Data Source: Plateau State Agricultural Development Programme (PADP).

Although there is a decrease in the total land areas cultivated (in '000 HA) for the production of the selected vegetables in Plateau State (2012 – 2016) as shown in Table 7, total production of vegetables (in '000 MT) is still growing for the specified range of years as seen in Figure 4. This is probably due to improved agronomic practices brought about through the research development of PADP. However, there is need to increase the total cultivated land areas with improved agronomic practices to further boost production of carrot, onion and okra in Plateau State.

Conclusion

The findings of this study revealed that there is a good indicator of significantly and strong relationship between cultivated land areas and output of vegetables in the study area. This suggests a measure of quality prediction of the multiple regression model. Using backward elimination procedure, cultivated land area for carrot was observed as the most statistically significant predictor of the production output of the selected vegetables (in '000 HA) in Plateau State. Therefore, we recommend policy strategy that will facilitate carrot's farmers accessibility to land. Extension efforts should also be directed to promotion of onion and okra cultivation.

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