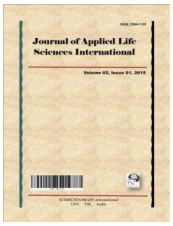

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Impact of Improved Cassava Technology Adoption on Farmers Output in Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author JOO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author NSC performed the statistical analysis and managed the analyses of the study. Author KMT managed the literature searches and Author MT supervised the research work. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of the study was to ascertain the impact of the adoption of improved cassava technology on the output of farmers in Benue state, Nigeria.
Study Design: The study used Survey design.
Place and Duration of Study: The study was carried out in Benue State, between November 2018 and May 2019.
Methodology: Cluster and simple random sampling techniques were used to select 366 respondents for the study. Primary data were collected using Semi-structured questionnaire.
Objective 1 was achieved using descriptive statistics such as percentages, frequencies and means while Objective 2 was achieved using multiple regression model.
Results: The findings showed that the adoption of improved cassava technologies influenced the farmers in a number of ways which included increased farmers income (56%: $\bar{x}$ =2.10), acquired new skills (75%:$\bar{x}$ = 2,42); increased output (76%: $\bar{x}$ = 2.61); expanded production (67%: $\bar{x}$ = 2.20); ensured more food at home (food security) (85%: $\bar{x}$ = 2.76); and increased well being of adopters

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(80%: $\bar{x} = 2.68$). The result also revealed that improved cassava technologies adoption have significant impact on farmers output in Benue State was accepted. This was indicated by F-stat value of 33.42 and F-probe value of 0.000 of less than 0.05, indicating that the estimated regression model adopted in this study was statistically significant at 1%. The R^2 value of 0.75 implied that 75% of dependent variable (farmers output) was explained by the independent variables (TSM0505, TSM0581, TSM0572, TMS011368, TMS961632, TMS920326 TME 419, NR8082).

Conclusion: Thus it was concluded that improved cassava technologies adoption have significant impact on farmers output in Benue State The study thus recommend that Extension agencies should ensure that improved cassava technologies are accessible by farmers and that farmers acquire the necessary knowledge and skills in using such technologies. This will ensure high adoption and high impact as well.

Keywords: Impact; improved cassava technologies; adoption; output.

1. INTRODUCTION

The development and introduction of improved cassava varieties has long been recognized as one of the key strategies for transforming the cassava industry and for enhancing the wellbeing of Nigeria's rural population [1]. The other key strategies applied include value addition, as well as markets and an enabling policy environment. Cassava breeding programs in the country initially addressed viral disease epidemics. With close and strategic collaborations between the International Institute of Tropical Agriculture (IITA), the International Centre for Tropical Agriculture (CIAT), and national agricultural research programs, about 59 early-bulking, disease-resistant, and high-yielding cassava varieties have been officially released since 1977. These varieties include the Tropical Manioc species (TMS) varieties from the IITA and the National Root Crop Research Institute, Umudike (NRCRI) materials (or NR varieties). From 1990 to 1998, about 14 percent of the germplasm incorporated into the development of varieties released from IITA across Africa was sourced from landraces, while 2 percent and 80 percent were sourced from CIAT and IITA, respectively [2].

Recent innovations in cassava breeding have enabled new varieties to be released to address food inadequacy in Nigeria. In close collaboration with Harvest Plus, IITA and NRCRI recently released six new bio fortified yellow cassava varieties that are conventionally bred to have high beta-carotene content (TMS 01/1371, TMS 01/1412, TMS 01/1368, TMS 07/593, TMS 07/539, NR 07/0220) as a strategy to address vitamin A deficiency in Nigeria. Dissemination of these varieties is ongoing. The adoption of these innovations by farmers has been a constraint to improved cassava production in Nigeria. This is largely due to socio-economic factors such as, age of the potential adopters, sex, and education level, farming experience, farm size and labour availability. The study will therefore assess the impact of cassava technology adoption on farmers' production in Benue State.

Shideed [3] identified two general properties of technological improvement. The first is the development of a new production function such that a greater output is achieved from a given input level. The second property is that the technological improvement must monetarily increase the discounted profits (or decrease losses) of the firm. Adoption of new technologies normally involves two stages: the decision to either adopt or not and the second stage involves how much of the new technology to adopt or use (or extent of adoption) [4]. Farmers would never adopt an innovation if outputs are not increased from given resources, and/or if inputs are not decreased for a given output. Agricultural technology adoption is often a sequential process. Farmers may adopt a new technology in part of their land first and then adjust in later years based on what they learn from the earlier partial adoption [5]. There is a large literature on the adoption of agricultural technology [6,7,8]. Adoption of improved agricultural technology apparently offers opportunity to increase production and income substantially [9] and reduce food insecurity [10]. Adoption of agricultural technology depends on a range of personal, social, cultural and economic factors as well as on the characteristics of the innovation itself [11,12,13,14,15.16,17,18,]. The impact of adoption of improved agricultural technologies on either poverty or welfare has a positive impact on poverty reduction and human welfare. For example, [19] in Bangladesh reveals that the

adoption of improved varieties of cassava has a positive impact on the richer households but had a negative effect on the poor, [20,21,22] studies on the impact of improved cassava technologies in Nigeria, Uganda and Cote d'Ivoire also found that the adoption of cassava improved technology has a positive and significant influence on farmers welfare, poverty reduction and yield respectively. Likewise, [23] and [24] adopting the Propensity Score Matching (PSM) method and Local Average Treatment Effect (LATE) respectively confirmed the positive effect on household wellbeing arising from the impact of agricultural technology adoption on productivity and rural cassava farmers' welfare in Bangladesh and Nigeria respectively.

Adoption of agricultural technologies, such as the high yielding varieties could lead to significant increases in agricultural productivity and stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy [25]. Azillah [26] reported that, the adoption of cassava technologies is important in increasing household food security in Ghana, Nigeria and Malawi. [27] reported the improved technologies in cassava production include proper spacing, land preparation, timely weeding, use of fertilizers/manure, use of improved planting materials, use of manual and powered grater and chipper machines for cassava processing, use of insecticides and use of herbicides. Mkamilo and Jeremiah [28] asserted that the majority of farmers in Nigeria are still confined with traditional technologies such as use of local planting materials, improper spacing, no fertilizer application, land preparation, weeding and traditional cassava processing. [25] noted that if the demand for cassava and income generated from cassava production increase, farmers will be motivated to adopt productivity-enhancing technologies to increase yields and to expand cassava production.

The adoption of technologies by farmers is affected by socio-economic factors, institutional and intervening factors. Socio-economic factors include, age of the potential adopters, sex, education level, farming experience, farm size and labor availability. Institutional factors include market availability, access to credit facilities, extension service delivery mechanism and training on cassava production technologies [29]. Extension services tend to educate farmers and assist in solving their problems, thereby adopt improved cassava farming technologies hence increased production. However, the services are affected by inadequate number of extension officers and inadequacy of working facilities. Lack of transport for extension agents to reach farmers in remote areas affects delivery and adoption of technologies. Also, poor linkage between research, extension services and farmers is among the main cause for farmers not to adopt improved technologies. Another problem affecting farmer's adoption of technology is due to lack of involving farmers in the planning process [30]. Minten and Barret [31] found that communities with higher rates of adoption of improved agricultural technologies had higher crop yields and lower level of food insecurity. On the other hand, intervening factors include risk aversion, infrastructure, assets and government policy [32].For instance, farmer with high level of income may be less risk averse than low income farmers [33]. Moreover, the number of people in a household may influence the adoption of the technology, the bigger the size of the family in a household the higher the chance of adoption also as labor accessibility increases [34].

The major problem with the adoption of improved agricultural technology by cassava farmers in Nigeria as observed by KSADP, [35] is that of inadequate finance. [36], view finance as an issue crucial to entering processing and buying of farm inputs like herbicides, insecticides, and fertilizer in farming of which cassava is inclusive. Effective management of cassava farmers toward higher productivity is a function of the availability and level of finance or credit facility at the cassava farmers' disposal. Also, cassava farmers are faced with the problem of land tenure system. This is because land for agricultural production is predominantly acquired through inheritance or within the extended family. This problem of land tenure as observed by Adofu [37], robs a lot of people who are interested in the cultivation of cassava the opportunity to do that which now shift their interest to non-agricultural trade. In another thought, some land owners feel that it is unjust and immoral to sell their land to farm users since this may deprive their future generation of the inheritance opportunity.

Low level of literacy among cassava farmers is another major problem. Majority of farm populace are those who live in the rural areas and are mostly illiterates. This has adverse effect on the role they play in their different economic activities. Pandey [38] observed that the level of education of farmers plays a vital role and

accelerates the adoption rate of farmers, [39] suggested that education is believed to help develop managerial skills which lead to enhanced adoption index and adoption is positively related to education.

Research has shown that the age of farmer plays a significant role in his adoption decision. In accordance with this, the Kogi State Agricultural and Development Project [35] carried out a research work and the result showed that out of 1,500 respondents covering the whole Kogi State, 87% of the respondents were youths while the remaining 13% were old people. This implies that more youths respond to innovation than the older ones. Extension communication is highly correlated with adoption thus indicating the need to explain the technologies fully to the small-scale cassava growers.

With the implementation of the cassava transformation agenda in the country, cassava adoption in Nigeria has come to the fore in the policy debate. Policymakers, donors, and research institutions have many questions about producers' adoption of modern cassava technologies, especially with regard to the use and diffusion of improved varieties. These questions include how farmers perceive improved cassava varieties and whether they will be willing to experiment with, evaluate, and adopt a new variety. In addition, policy interest has risen around constraints to adoption and the impact of improved cassava varieties on commodity production, poverty, and input use. The study therefore investigated the impact of cassava technology adoption on farmers' productivity in Benue State, Nigeria. The objectives of the study were to ascertain perceived influence of improved cassava technologies adoption on farmers in Benue State and to determine the impact of improved cassava technologies adoption on farmers output in Benue State.

1.1 Research Hypothesis

$H0_1$: Improved cassava technologies adoption has no significant impact on farmers output in Benue State.

2. MATERIALS AND METHODS

The Survey design was adopted for the study.

The study was carried out in Benue State. Benue is a State in the North Central zone of Nigeria, it has a population of about 5,741,800people [40]; its total land area is 34,059km^2 and it is among the 11th in the country. Benue State has its capital at Makurdi.

Benue State falls within longitude $7^0 47^1$, $10^0 0$E and latitude $6^0 25^1$, $8^0 8^1$N, the State shares boundaries with five other states in Nigeria. It share boundary with Nasarawa State to the North, Taraba State to the East, Cross River State to the South, Enugu State to the South-West and also with Kogi State to the west, hence it shares International boundary with the Republic of Cameroon to the South-East. Benue State is one of the biggest states in Nigeria, it is also seen as richest in the country in terms of food; it is blessed with a lot of food produce, hence the State is refers to as the food Basket of the Nation, since it is known for its large food production throughout the year.

2.1 Map of Benue State

Cluster and simple random sampling techniques were used to select the respondents for the study. Benue State were clustered into three senatorial districts including North East senatorial district (Zone A) North West Senatorial District (Zone B) and Benue South Senatorial district Zone (C). One Local Government Areas was randomly selected from each of the clustered senatorial districts: Kastina-Ala selected from Zone A; Buruku selected from zone B; and Otukpo Local Government Areas selected from Zone C respectively.

Furthermore, two (2) council wards were randomly selected from each local government area with Mbacher and Mbajir Council Wards selected from Kastina-Ala Local Government Area, Binev and Shorov Council Wards selected from Buruku Local Government Area, Adoka-icho and Adoka-haje Council Wards selected from Otukpo Local Government Area respectively.

The total number of registered farm families in the twelve (6) selected council wards was 2,295. This figure therefore represents the sample frame. The sample size for each zone was determined by a mathematical formula given by Miller and Brewer (2003) as;

$$\mathrm{n} = \frac{N}{1+N(\alpha)^2}.. \qquad (3.1)$$

Where: N is the sample frame for the twelve communities,

n is the sample size and

α is the margin of error (fixed at 5%).

$n = \frac{2295}{1+210\ 7(0.0\ 9^2}$ = 366 farm families

A simple proportion formula was then used to calculate the number of farmers who were interviewed in each selected local government as follows;

2.1.1 Zone A

Kastina-Ala LGA:

Mbacher (441) $= \frac{3\ 6\ 6}{2295} \times 541 = 86$

Mbajir (232) = $\frac{3\ 6\ 6}{2295} \times 245 = 39$

2.1.2 Zone B

Buruku LGA:

Binev (600) = $\frac{3\ 6\ 6}{2295} \times 645 = 103$

Shorov (330) = $\frac{3\ 6\ 6}{2295} \times 364 = 58$

2.1.3 Zone C

Otukpo LGA:

Adoka-icho (144) = $\frac{3\ 6\ 6}{2295} \times 144 = 23$

Adoka-haje (360) = $\frac{3\ 6\ 6}{2295} \times 360 = 57$

The sample size for each community was randomly selected from the sampling frame of that community. This gave a total of 366 farm families. One farmer was purposively selected from each of the farm families, (these were farmers that have cassava as their major farm enterprise) and this gave a total sample size of 366 respondents for the study.

Table 1 captures the details of the sample frame and the sample size for the selected local government areas in all the zones in the study area.

For the purpose of this research, Primary data were collected using Semi-structured questionnaire. Objective 1 was achieved using descriptive statistics such as percentages,

Fig. 1. Map of Benue state adapted from Dzurgba (2012)

Table 1. Sample size selection plan

Zones	LGAs	Council wards	Sampling frame	Sample size
A	Kastina-Ala	Mbacher	441	86
		Mbajir	232	39
B	Buruku	Binev	600	103
		Shorov	330	58
C	Otukpo:	Adoka-icho	144	23
		Adoka-haje	360	57
Total			2,295	366

frequencies and means while Objective 2 was achieved using multiple regression model expressed as in equation as:

$$Y = \beta 0 + \beta 1 + \beta 2 + \beta 3 + \beta 4 + \beta 5 + \beta 6 + \beta 7 + \beta 8 + \mu \quad (1)$$

Where:

Y = Farmer output (kg)
β_1 = TMS 0505
β_2 = TMS 0581
β_3 = TMS 30572
$\beta 4$ = TMS 01/1368
$\beta 5$ = TMS 96/1632
$\beta 6$ = TMS92/0326
$\beta 7$ = TMS 419
$\beta 8$ = NR8082
Ut = error terms
B_0 =parameter estimate

3. RESULTS AND DISCUSSION

Perceived influence of Adoption of improved cassava technologies on Farmers.

The result in Table 2 Showed that the adoption of improved cassava technologies influenced the farmers in a number of ways which included increased farmers income (56%: $\bar{x} = 2.10$), acquired new skills (75%: $\bar{x} = 2{,}42$); increased output (76%: $\bar{x} = 2.61$); expanded production (67%: $\bar{x} = 2.20$); ensured more food at home (food security) (85%: $\bar{x} = 2.76$); and increased well being of adopters (80%: $\bar{x} = 2.68$). On the other hand, the result revealed that adoption of improved cassava technology did not reduce the stress in cassava production (48%: $\bar{x} = 1.86$); and also, adoption of improve cassava technology did not cause or trigger increased social status (46%: $\bar{x} = 1.72$).The overall mean score of 2.18 is an indication that adoption of improved cassava technology has influenced the famers positively, while the standard deviation of 1.13 indicates the closeness of the responses.

The result implies that if adoption is increased, the general welfare of the farmers will be bettered. Adoption of agricultural technologies, such as the high yielding varieties could lead to significant increases in agricultural productivity and stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy [25]. [26] reported that, the adoption of cassava technologies is important in increasing household food security in Ghana, Nigeria and Malawi.

The result is consistent with the findings of Bakut [41] in his study of factors influencing adoption of

Table 2. Perceived influence of improved Cassava technologies adoption on farmers in Benue State

Influence of adoption	Frequency	Percentage	Mean ($\bar{x}$)	SD
Increased income	211	56	2.10	0.85
Acquired new properties	76	21	1.04	0.41
Acquired new skills	274	75	2.42	1.22
Increased output	291	76	2.61	1.10
Production expansion	245	67	2.20	1.23
More food at home	311	85	2.86	1.45
Reduced stress	174	48	1.86	1.32
Increased social status	167	46	1.72	1.29
Increased well being	294	80	2.88	1.35
Overall mean score			2.18	1.13
Number of respondents			366	
Bench mark			2.0	

Source: Field survey 2018

recommended cassava production practices in Bwari and Kuje area of Abuja who reported that the adoption of recommended cassava production practices resulted in an increase in total production by improving yield and income of farmers. Also [42] in his study of factors influencing adoption of improved cassava processing technologies by women processors in Akoko-Edo Local Government Area, Edo State found that adoption of improved cassava processing technologies resulted in increased output, income and level of living for the women cassava processors. The result is alos consistent with the findings of Bakut [41] in his study of factors influencing adoption of recommended cassava production practices by farmers in Bwari and Kuje Area Councils, Abuja found that output and income of respondent's increased after adoption.

3.1 Test of Hypothesis

$H0_1$: Improved cassava technologies adoption has no significant impact on farmers output in Benue State.

From Table 3 the coefficient of TMS 0505 was statistically significant and positively related to farmers output in Benue State at 1% significant level. This implies that a unit increase in the adoption of TMS 0505 will lead to a corresponding increase in farmers output in Benue State with 1.622 units.

The coefficient of TMS 0581 was statistically significant and positively related to farmers output in Benue State at 5% significant level. This implies that a unit increase the adoption of TSM0581 will lead to a corresponding increase in farmers output in Benue State with 2.411 units.

The coefficient of TMS 0572 was statistically significant and positively related to farmers output in Benue State at 1% significant level. This implies that a unit increase in the adoption of TMS 0572 leads to a corresponding increase in farmers output in Benue State with 3.365 units.

The coefficient of TMS 96/1632 was statistically significant and positively related to farmers output in Benue State at 5% significant level. This implies that a unit increase in the adoption of TMS 96/1632 will lead to a corresponding increase in farmers output in Benue State with 0.784 units.

The coefficient of TMS 92/0326 was statistically significant and negative related to farmers output in Benue State at 1% significant level. This implies that a unit increase in the adoption of TMS 92/0326 leads to a corresponding increase in farmers output in Benue State by -192.561 units.

The coefficient of TME 419 was statistically significant and positively related to farmers output in Benue State at 1% significant level. This implies that a unit increase in the adoption of TME 419 leads to a corresponding increase in farmers output in Benue State with 3.2084units.

The R^2 value of 0.75 implies that 75% of dependent variable (farmers output) can be explained by the independent variables (TSM0505, TSM0581, TSM0572, TMS011368, TMS961632, TMS920326 TME 419, NR8082). F-stat value was 33.42 and F-probe value of 0.000 was observed from the analysis which is less than 0.05, indicating that the estimated regression model adopted in this study was

Table 3. Impact of adoption of improved cassava technologies on farmers output in Benue State

Variable	Parameters	Coefficient	Std error	t – value
Constant	β_0	1.284	.772	1.663
TMS0505 (X_1)	β_1	1.622	.314	5.166***
TMS 0581 (X_2)	β_2	2.411	1.005	2.399**
TMS 0572(X_3)	β_3	3.365	.244	26.70***
TMS011368 (X_4)	β_4	-.632	.487	-1.298
TMS961632 (X_5)	β_5	.784	.314	2.497**
TMS920326 (X_6)	β_6	.-192.561	103.450	-1.861*
TME 419 (X_7)	β_7	3.2084	1.764	3.150**
NR8082 (X_8)	β_8	-2.385	1.728	-1.381
R-Square	0.75			
Adjusted R-Square	0.74			
F-statistic	33.42***			

****, **, and * denotes significance of coefficient at 1%, 5%, and 10% level respectively*
Source: Field Survey, 2018

statistically significant at 1%. With this, the null hypothesis was rejected and the alternative hypothesis which state that improved cassava technologies adoption have significant impact on farmers output in Benue State was accepted.

According to Heady [43], farmers would never adopt an innovation if outputs are not increased from given resources, and/or if inputs are not decreased for a given output. This study agrees with [9], (2002) and [44] who opined that adoption of improved agricultural technology apparently offers opportunity to increase production and income substantially and reduce food insecurity.

Also, [45]; and [46] asserted that technological improvement (such as improved cassava varieties) is the most important factor in increasing agricultural productivity and reduction of poverty in the long-term. To increase productivity, technology must be adopted in the production process and the rate of adoption of a new technology is subject to its profitability, degree of risk associated with it, capital requirements, agricultural policies and socioeconomic characteristics of farmers [47]. This study is of significance because eradication of rural poverty through adoption of new agricultural technologies has been a major concern for the underdeveloped and developing countries and donors for many decades.

Adoption of improved agricultural technology apparently offers opportunity to increase production and income substantially [9] and reduce food insecurity [44].

4. CONCLUSION

The study identified the influence of adoption of improved cassava technologies on farmers to determine the impacts of cassava technology adoption on farmers' output as well as the adoption of improved cassava technologies influenced the farmers in a number of ways which included increased farmers income, acquired new skills, increased output, expanded production, ensured more food at home, and increased well being of adopters in Benue State. The regression analysis showed that, of the eight variables studied under the adoption model, six variables (TMS0505, TMS0581, TMS0572, TMS96/1632, TMS92/0326, and TME 419) significantly influenced the output of farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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