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Research Article

Effects of Adoption of Cassava Technologies on Farmers from Southern Zones of Nigeria

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Abstract

Cassava is a major food crop in sub-Saharan Africa. Increases in its productivity and processing can be a driver for higher food security and commercialization of its products. The study assessed the effect of adopting production and processing technologies and profitability of cassava in southern Nigeria. Poverty status of the users and non-users of the technologies was also estimated. Data were obtained using structured questionnaires from 480 farming households from the three southern geographical zones of Nigeria using a multistage sampling technique. Data were analyzed using descriptive statistics, budgetary analysis, P-Alpha Measures of Poverty (FGT) and Logit model. Results showed that of all production technologies disseminated, awareness and adoption of improved cassava varieties both in intervention villages (IVs) and non-intervention villages (NIVs) were the highest compared to other technologies. The IVs had 93% awareness rate and 72% adoption rate, while NIVs had 81% awareness rate and 64% adoption rate on improved cassava varieties. On processing technologies among farm households, grating machine had the highest level of awareness and adoption rate in both IVs and NIVs. However, apart from grater, presser, fryer and grinder which were common before interventions by Integrated Cassava Project (ICP), participants in training (PARTI) were more exposed to other machines and adopted more of them than any other groups.

On budgetary analysis, the return per capital outlay (RPN) for improved practice was 3.1 compared to that of local that was 2.3. The implication was that by investing N1 (one naira) in production, local cassava producer made a N2.3 gain on average, while the improved cassava variety producer would make N3.1; with the difference being attributed to the relative use of both improved cassava varieties and various management techniques extended to and used by the farmers. Poverty status estimation revealed that 57.4% of farm households from IVs and 46.6% of farm households from NIVs were above the poverty line. The percentage of households below poverty was lower for IV (42.6%) than for NIV (53.4%) if compared along village type's line. When compared along participation in training, it was lower for participants (45.9%) than for non-participants (52.3%); and when compared along adoption status for improved variety line, it was lower for adopters (45.9%) than non-adopters (51.7%) and in case of adoption status for the grater machine, it was lower for adopters (45.3%) than non-adopters (59%). Poverty depth index and poverty severity estimates also buttressed that respondents that were from intervention villages, which participated in extension training and adopted new technologies, had lower poverty values than their counterparts. The Logit model revealed that adoption of a grater machine ($P < 0.01$), non-farm income ($P < 0.05$), medical expenses ($P < 0.01$), social contribution ($P < 0.05$), and level of education ($P < 0.01$) had a poverty reducing effect among the households. The study concluded that the technologies adopted impacted positively on farmers' yields and varieties of different products made from cassava and reduced the poverty in the study area. The study, therefore recommended increased promotion of the technologies through farm demonstration by relevant stakeholders and agricultural institutions

Keywords: Food Security; FGT; Productivity; Poverty Status

Introduction

Nigerian agriculture and the status of the cassava crop

Nigeria is a nation of peasant farmers who account for over 90% of the country's total agricultural production. These farmers cultivate small land holdings that are often less than 2 ha in area and in fragmented plots. The traditional system of agricultural production still predominates, with its characteristically low technological base, high reliance on manual labour, and hence low resource productivity. Cassava (Manihot esculenta) is a major food crop in sub-Saharan Africa. The root is an important calorie provider [1-3]. Africa produces about 88 million tonnes of cassava which is equivalent to about 55% of the world's cassava production. This output is projected to be more than double by 2020 [4]. Trends in cassava production indicate a steady growth over time. About two-thirds of that increase was due to the expansion of the area cultivated; the remaining third was the result of increased yields from new improved varieties; these improved varieties can have yields nearly 1.5 times higher than the local varieties [5].

Poverty is the main development problem confronting the world, and agricultural growth is seen as a best-bet strategy for poverty reduction. An increase in productivity in agriculture can reduce poverty by increasing farmers' income and thereby, enhancing increments in consumption. In DFID (2003), it is estimated that a 1% increase in agricultural productivity reduces the percentage of poor people living on less than 1 dollar a day by between 0.6 and 2 percent; thus cassava can be a powerful poverty fighter in Africa. Cassava plays a vital role in the food security of the rural economy because of its capacity to generate a reasonable level of output under marginal soil conditions and its tolerance to drought [3]. Data from the Collaborative Study of Cassava in Africa (COSCA) showed that 80% of Nigerians in the rural areas eat a cassava meal at least once a week [2].

Prior to the year 2000, there was a report on the reduction in cassava yield especially in the southern zones of Nigeria [6,7]. The declining yield led to declining per capita cassava production and has been largely attributed to attack by the cassava mosaic disease (CMD). It was reported that the outbreak of this severe form of CMD led to the loss of US$60 million every year, as well as several thousands of famine-related deaths, the death of 3000 people in a country like Uganda [8,9]. According to Echendu., et al. [7], by 1998, root yield losses due to cassava mosaic disease were as high as 70% on susceptible genotypes in Nigeria. The reduction in production loss due to CMD in Nigeria has been more realistically estimated at 6.78–9.69 million tonnes in 1998 when the total harvest for the country was 33.56 million tons [7]. This translates to a direct loss to the Nigerian economy of millions of naira.

Despite this development, the demand for cassava is mainly for food and domestic consumption; and opportunities for commercial development to various processed products and exportation to earn foreign exchange for Nigeria remain largely undeveloped, in contrast to the other major regions of cassava cultivation in Asia (like Indonesia and Thailand) and South America (like Brazil). The absence of agro industrial markets remains the major constraint to further development of the crop. Cassava production exhibits high levels of variability and cyclical gluts, due mainly to the inability of markets to absorb supplies. As a result, prices of cassava roots decline sharply and production levels are reduced in succeeding years before picking up again. Such factors cause price instability over the years and this significantly increases the income risk to producers. Insufficient processing options for storage roots, inadequate marketing channels, and a lack of linkages between producers and end-users are major factors preventing greater profitability for producers and processors. There is a potential to generate from one crop multiple economic benefits through improved postharvest handling and processing of fresh storage roots.

To address the problem of sustainable increased cassava production and processing for both domestic and export purposes and then contain the problem posed by CMD in Nigeria several initiatives were enacted by government. Among these efforts was the inauguration of the Integrated Cassava Project (ICP) in 2002 by the Federal Government of Nigeria under the platform of the "Presidential Initiative (PI) for Cassava", Shell Petroleum Development Company (SPDC), State Governments from the southern zones of Nigeria, the Niger Delta Development Commission (NDDC), and the United States Agency for International Development (USAID). The project was implemented by IITA along with her national partners such as ICP to act as a platform to address the dual problems of cassava yield of cassava by first eradicating CMD and ensuring sustainable cassava production yield, and secondly by promoting cassava postharvest handling through processing of cassava into different products and promoting their marketing within and outside Nigeria. Based on these ICP has two components: the Cassava Mosaic Disease Pre-emptive Project (CMD) and the Cassava Enterprises Development Project (CEDP). The CMD project aimed to develop and disseminate high yield and CMD-resistant cassava varieties; while CEDP sought to promote the development of enterprises associated with cassava processing and utilization [10,11]. The improved cassava development and production by the CMD project was complemented with the promotion of cassava processing machinery by CEDP; machines promoted included the improved grater, presser, and sifter. Improved cassava varieties (both of high yield and resistant to mosaic disease) with some other production technologies were disseminated and demonstrated to farmers in ICP project selected villages termed 'Intervention Villages' in the southern zones of the country based on the recommendation from Agricultural Development Programs (ADPs) from the zones [12,13]. ICP also strengthened the formation and stabilization of the cassava growers association, the cassava processors association, and the cassava equipment fabricators association to serve as good platforms for the private sector's interest and a driving force to sustain the cassava industry [11,14]. In addition participants in intervention villages were trained on crop management (cropping density, weed management, fertilizer application, etc). Through IITA (IITA-ICP) research efforts, more than 40 CMD-resistant and high-yielding cassava varieties were successfully introduced and promoted to farmers in Nigeria and the establishment of many processing centers and fabricating enterprises was facilitated between 2002 and 2010 by ICP. However, available literature suggests that little or nothing has been documented on the impact of ICP and what it stands for. It is now of interest to assess the level of, and the extent to which farmers have realized the yield potentials of the improved cassava varieties and the effects of adopting other technologies on farm households' welfare and on the processors.

According to Von Braun (1988), agricultural growth via technological transformation leads to an expanded food supply which presupposes complementarity of production and processing operations in agriculture. To date, little evidence exists regarding the individual effect and productivity of certain improved farming technologies and practices on targeted respondents in Nigeria. Therefore, this study was carried out to provide credible evidence of the impact of the ICP on the cassava farming households and cassava processors. The study addresses the following research questions:

- What is the level of awareness and adoption of various production and processing technologies?
- What are the effects of the adoption of production and processing technologies on farmers' cassava output and livelihood?

These lead to the following objectives, to: describe socioeconomic characteristics of cassava farmers, determine the levels of awareness and adoption of cassava production technologies by farmers, determine the levels of awareness and adoption of cassava processing technologies by farmers, estimate the profitability of the cassava production technology and estimate the poverty status of cassava farmers in areas and non-areas of cassava intervention programs and determine the factors influencing it.

Methodology

Study area

Nigeria is divided into six geopolitical zones. The zones are: South-West (SW), South-East (SE), South-South (SS), North Central (NC), North West (NW), and North East (NE) (http://www.articlesbase.com/politics-articles/the-geopolitical-zones-that-make-up-Nigeria-Parti-one-791496.html). This study concentrated on the SW, SE, and SS as the ICP project was located in southern Nigeria, more so, 64% of cassava tubers are produced in these zones; most of the work done by the PI through IITA-ICP was done mostly in SS, SE, and SW, in descending order - thus the reason for choosing them. States randomly selected from SW zone were Ekiti and Ogun states; states randomly selected from SE zone were Enugu and Abia States and states randomly selected from SS zone were Rivers and Akwa Ibom.

Sampling technique/procedure

To provide a basis for the findings a structural questionnaires were used for the cassava producers/farm families to capture their production and processing activities on cassava. Field enumerators conversant with the local languages and customs from the SW, SE and SS were trained at different ADP locations in the zones prior to the commencement of the detailed survey. The survey was a recall question based and administered by enumerators and the researcher. Information was also elicited from village chiefs, ADPs, EAs through focus group discussion (FGD), and the literature to complement the study.

The coordinates of the zones were verified using GPS instruments. This was used in drawing the map of study area shown in Figure 1. Random and multi-stage sampling techniques were adopted. The distribution of farm household respondents across zones is shown in Table 1. In each zone/region, two states were randomly selected; in each state, four LGAs were selected. Two LGAs that had been working with IITA in collaboration with the ADPs were chosen based on the recommendation of ADP agents and two LGAs that had no contact with IITA-ICP but were recommended by the ADP as being high cassava producing areas were selected. Two villages per LGA were selected to give four intervention/contact villages and four non-intervention/non-contact villages. There were a total of four LGAs and eight villages per state. In each of the villages 10 cassava producing households were chosen from the list provided by village head to give a total of 80 respondents per state. Two states per region resulted in 160 respondents per region, and for the three regions—SS, SE and SW—480 respondents were interviewed using structured questionnaires to obtain information on their cassava farming activities. Although 480 farming household respondents were covered, only data on 466 respondents were found useful for the analysis.

Figure 1: Study areas in the Southern Zones (South-West; South-East and South-South zones) of Nigeria.

Methods of analysis

In addressing the objectives for the study, the following analytical procedures were used; descriptive statistics, gross margin analysis (GM), P-Alpha Measures of Poverty (FGT) index and Logit model (LM). GM, FGT and LM are discussed in details below.

Zones	States	LGAs	Villages		HH/Village	HH		Total HH
			IV from 4LGAs/State	NIV- from 4LGAs/State		IV	NIV	
SS	2	8	8	8	10	80	80	
SE	2	8	8	8	10	80	80	
SW	2	8	8	8	10	80	80	
Total						240	240	480

Table 1: Distribution of household respondents across southern zones.

NB: Intervention Village = IV, Non- Intervention Village N = NIV; HH = Farming Households.

Empirical models

Gross margin analysis

A gross margin for an enterprise is its financial output minus its variable costs [15]. The use of gross margins became widespread in the UK from about 1960, when it was first popularized amongst farm management advisers for analysis and planning purposes (Barnard and Nix, 1979). The gross margin per hectare for crops can be compared with 'standards'. Gross margins, however, should only be compared with figures from farms with similar characteristics and production systems. With this reservation in mind, the comparisons can give a useful indication of the production and economic efficiency of an enterprise. This study used GM for evaluating the profitability of farm production activities. The budgetary analysis was done involving the computation of gross margin (GM) and returns per naira outlay (RPN). This was carried out for farming households engaging in production of local cassava and improved cassava. The monetized values of variable inputs and incidental production costs such as costs of cassava bundles planted, NPK and Urea fertilizers, herbicides, insecticides and manure were subtracted from gross revenue (GR) which was a product of quantity of cassava in tons harvested and price per ton of cassava tuber to arrive at GM estimates for both production methods.

The RPN was calculated by finding the ratio of the GM to the total variable cost (TVC) in each case. That is:

GM = GR – TVC (1)

and RPN = GM/TVC (2)

P-Alpha measures of poverty

To determine the poverty status of households in the study area, a poverty line was constructed, using two-thirds of the mean per adult equivalent expenditure, below which a household will be classified as being poor and above which a household was classified as being non-poor. The use of monetary income or consumption to identify and measure poverty has a long tradition, right from the study of Rowntree (1901) up to the World Bank's (1996) study on global income poverty. This study is based on household income and expenditure surveys and these have made the approach to become the standard for quantitative poverty analysis (World Bank 2001).

The respondents' per capita expenditure is used in classifying them into two, namely:

- Non-poor: These are farmers whose per capita expenditure is above two-thirds of the poverty line, i.e., NP> 2/3 of the mean expenditure.
- Poor: These are farmers whose expenditure is below the poverty line, i.e., P < 2/3 of the mean expenditure.

The poverty line is set at two-thirds of the mean per capita expenditure. (World Bank/FOS/NPC, 1998; FOS, 1999).

The first three poverty means of the so-called FGT class [16] namely; the poverty headcount, the poverty gap, and the squared poverty gap are estimated.

- **Poverty Headcount:** This is the share of the population which is poor, i.e., the proportion of the population for whom consumption or income is less than the poverty line.
- **Poverty Gap:** This is often considered as representing the depth of poverty, that is the mean distance separating the population from the poverty line, with non-poor given a distance of zero.

$$P_\alpha = 1/n\sum_{i=1}^{q}\left(\frac{Z-Y_i}{Z}\right)^\alpha \qquad (3)$$

Where P_α is the weighted poverty index of the i^{th} population; q is the number of households in poverty; n= the total number of household; Y_i is the consumption expenditure of individual i, the sum is taken only on those individuals who are poor, α is the FGT parameter, which takes the values of 0, 1 or 2 depending on whether we are measuring the incidence, depth or severity of poverty and Z is the poverty line. When there is no aversion to poverty, α = 0, index reduces to

P_o = 1/Nq = q/N = H (4)

This is called headcount ratio or incidence of poverty; N is the total number of population [16]. If the degree of aversion to poverty α = 1 then index will be

$$P_\alpha = 1/n\sum_{i=1}^{q}\left(\frac{Z-Y_i}{Z}\right)^1 = HI \quad (5)$$

I = (Z – Y_q)/Z where Y_q = 1/q∑ Yi i=1 (6)

Y_q is the average expenditure of the poor. HI is referred to as poverty gap (World Bank, 2004). The Poverty Gap is a useful statistic to assess how much resources would be needed to eradicate poverty through cash transfers perfectly targeted to the poor.

- **Squared Poverty Gap:** This is often used to describe the measure of the severity of poverty. While the poverty gap takes into account the distance separating the poor from the poverty line, the squared poverty gap takes the square of that distance into account. Here, the poverty gap is weighted by itself so as to give more weight to the very poor (World Bank, 2004).

$$P_\alpha = 1/n \sum_{i=1}^{q} \left(\frac{Z - Y_i}{Z} \right)^2 \quad (7)$$

Logit model (LM)

LM is for analyzing relationships whose dependent variables assume a discrete or dichotomous value, qualitative choice models are used. In such relationships, the probability of an event occurring is a function of a set of non-stochastic explanatory variables and a vector of unknown parameter. Following Amemiya [17] the general form of the univariate dichotomous choice model can be expressed as:

$P_i=P_i(Y=1)=G(X_i\Phi)(i=1,2\cdots n)\cdots(8)$

Where:

$P_i = P_i\ (Y_i=1)$ is the probability of an outcome. It is a function of the vector of explanatory variables X_i and unknown parameter Φ.

X_i = Explanatory variables.

Φ = Unknown parameters.

Because the functional form of G is unknown, practical applications of the model are not feasible [17] so an explicit functional specification of G becomes necessary.

Three functional relationships, often specified are the linear probability, probit and logit models. The dichotomous dependent variable model that will be used in this study is the logit model (LM) (the standard normal distribution function).

LM is given in its estimable form as

$LM = Ln\ (P_i/1- P_i) = Z_i = \beta_i + \beta\sum kX_{ik} + \varepsilon$ (9)

Where:

$Ln\ (P_i/1- P_i)$ = log odd ratio

Pi = probability that a household is poor or non-poor; it ranges from 0 to 1, and is non-linearly related to Z_i; β_i = constant term/intercept; β_k = coefficients of regressors; X_{ik} = K= 1, 2, ……n = independent variables (with i^{th} observation); ε = error term with zero mean' as Z_i ranges from -∞ to ∞, Pi ranges from 0 to 1; thus the dependent variable 'P' is 1 if non-poor and is '0' if poor using maximum likelihood estimation method, X is given as below for poverty determinants.

Variables for Poverty (Xs)	Descriptions	Apriori Signs
X_1 Village	Village type (farmers from intervention village = 1; otherwise = 0)	+
X_2 Improve cassava	Use of improved cassava variety = 1; otherwise = 0	+
X_3 Grater (Adopt=1)	Use of improved cassava grater machine =1; otherwise=0	+
X_4 Gender (Male=1)	Gender of house head (Male = 1; female = 0)	±
X_5 Medical expenses	Expenses on medication in Naira	+
X_6 Non-farm income	Income earned from non-farm activities (in Naira)	+
X_7 Educated	Level of education(Educated = 1, Non-Educated = 0)	+
X_8 Household size	Family size in number	±
X_9 Age	Age of househead in years	±
X_{10} Participant (participate =)	Participation in training (participated =1 ; otherwise = 0)	+
X_{11} Social contribution	Annual social contribution in Naira	+

Table a: Variables for Logit model

Result and Discussion

Background information

The central theme of the study being reported is to assess the impact of cassava production and processing technologies in the southern zones of Nigeria among cassava farm households. This section presents results of various descriptive and quantitative analyses carried out in pursuit of the study objectives. The description for farm households is based on all respondents (pooled data), respondents disaggregated into types of villages [Intervention (IV) and Non-Intervention (NIV) villages], and where necessary if the household respondent was a participant (Parti) or non-participant (NParti) in the research for development training in cassava production and processing given by either ICP project or its partners. Disaggregating based on participation in a training program is to further see the effect of the intervention on the participating farmers vis-à-vis non participating ones.

Household characteristics

Socioeconomic characteristics

Demographic and socioeconomic characteristics play a key role in determining the livelihood of rural people. The result from Table 2, indicates that 40% of respondents came from the SE, 32% from the SS, and 28% from the SW; there were more people from non-intervention villages compared to intervention ones. The number of participants in training was generally small.

The gender of household heads was approximately in the ratio 7:3 in favour of male household heads. The average age of house heads was 51 years, this was still within economic active age of the respondents, with farming experience of 24 years, when compared with experience in cassava production, it was 21 years; with a house size of 8. Average years of education was 10, and this indicated that the majority of the respondents had more than primary school education, and with their levels of education, they would be able to decide and adopt technologies that will improve their livelihood. Although, househead respondents under different villages and criterion of participation had similar socioeconomic features as indicated in Table 2, they had almost the same opportunities to develop if new technologies are introduced. However, househeads from intervention villages had the upper hand in that they were more educated and younger, thus full of energy to be more productive, in addition to the fact that the family size was larger meaning more family labour to take care of farm work. The fact that househeads were mostly main decision makers compared to NIVs might enable them to adopt improved agricultural techniques easily without consultation with anybody.

Technological awareness and adoption

Production technologies for farm households

The approach under the agronomy component has been to deploy resistant varieties quickly and aggressively to replace susceptible ones through planned demonstrations, on-farm multiplication, and multilocational trials. Some of the cassava varieties promoted were: 98/2226, 98/0002, 97/4779, 98/2101, 99/2123, 98/0581, M98/0068, 96/1569, 97/4763, 96/0523, 99/3073, 97/0211, 96/1632, 92/0067, 92B/00061, 95/0289, 96/1642, 91/02324, 96/0603, 97/3200, 94/0561, 97/2205, 94/0026, 95/0166, 94/0039, 96/1565, 96/1089A, 95/0379, 98/0505, 92/0057, 99/6012, 92/0325, TME419, 92/0326, 98/0510, M98/0040, 92B/00068, 97/0162, M98/0028, and 97/4769.

Variables	Pooled	IV	NIV	Parti	NParti
N	466	202	264	86	380
Region %					
South-South	32	47	21	13	37
South-East	40	29	47	50	37
South-West	28	24	31	37	26
Village Type %					
Intervention Villages	43	100	-	49	42
Non-Intervention Villages	57	-	100	51	58
House head Gender %					
Male	72	72	73	72	73
Female	28	28	27	28	27
Marital Status %					
Single	2	2	3	2	2
Married	86	88	84	85	88
Divorced	1	2	1	1	1
Separated	1	1	-	1	-
Widowed	10	7	12	10	9
Age of Households Head %					
<20	1	-	1	-	1
21-40	16	8	22	13	17
41-60	64	67	62	70	62
61-80	19	25	15	17	20
Age (Average)	51 ± 13.5	50 ± 12.6	52 ± 14.1	52 ± 13.1	51 ± 13.5
Household size (Average)	8 ± 3.7	8 ± 3.6	7 ± 3.7	9 ± 5.1	7 ± 3.2
Dependency Ratio (Average)	1.46 ± 1.34	1.46 ± 1.41	1.46 ± 1.20	1.42 ± 1.31	1.47 ± 1.40
Years of cassava processing experience %					
<21	69	68	70	70	69
21-40	28	30	26	27	28
41-60	2	2	3	3	2
>60	1	-	1	-	1
Years of processing experience (Average)	18.6 ± 11.30	18.1 ± 12.20	19 ± 13.30	19.6 ± 12.40	18.4 ± 10.40
Years of Farming Experience%					
01-10	20	20	20	13	21

11-20	33	35	31	33	33
21-30	24	25	23	16	26
31-40	16	14	18	24	14
>40	7	6	8	14	6
Years of Farming Experience (Average)	24 ± 13.50	23 ± 13.10	24 ± 13.7	27 ± 14.00	23 ± 13.3
Farming experience in Cassava production (Average)	21 ± 13.00	21 ± 11.50	22 ± 14.01	25 ± 13.51	21 ± 12.82
Level of Education%					
Educated	72	78	66	62	74
Non Educated	28	22	34	38	26
Average Year of Education	10 ± 5.80	11 ± 5.70	10 ± 5.80	10 ± 6.40	10 ± 5.61
Main Decision Maker%					
Household Head	70	74	67	69	70
Spouse	2	2	2	2	2
Household and Spouse	21	19	23	24	21
Household Head and Children	3	4	4	-	3
Spouse and Children	1	-	1	-	1
All Members	3	1	3	5	3

Table 2: Socioeconomic characteristics of farming household respondents.

Note: IV farmers in Intervention villages, NIV farmers in Non-Intervention villages; Parti farmers participating in research in development training; NParti farmers not participating in research in development training.

CMD, in close partnership with a wide range of stakeholders from both the public and private sector institutions—relevant government institutions such as the International Fund for Agricultural Development-Root and Tuber Expansion Project (RTEP), National Root Crops Research Institute (NRCRI), Agricultural Development Projects (ADPs), strategic private industries, non-governmental organizations (NGOs), and individuals helped in the dissemination and promotion of the varieties. Under this CMD component of ICP, the approach has been to teach farmers, processors, and small and medium-scale investors how to run cassava businesses. Different management techniques on cassava were introduced to farmers and were also encouraged to form cooperative and associations as form of safety net to promote their farming business (IITA, 2004, http://www.cassavabiz.org/abouticp/aboutus.htm).

Awareness and adoption of production technologies is shown in Table 3, descriptive statistics was used to estimate awareness and adoption status of various production technologies. Considering production technology from the descriptive output point of view, adoption rates were greater for farmers in IVS and participants under Na/N (adoption rate/proportion of adopters) for NPK, improved cassava and urea only when compared to NIVS and non-participants, respectively. Adoption of field management practices (Table 4) shows that being from IVs and participants in training had better adoption rates than alternating groups. Field management practices adoption by farm households in Table 4 shows that the adoption was greater for intervention group in most of the cases.

Variable	Farmer Type	Awareness (Ne/N)	Adoption (Na/N)
Improved Cassava Varieties	POOLED	87	68
	IV	93	72
	NIV	81	64
	PARTI	87	78
	NPARTI	86	65
NPK	POOLED	67	43
	IV	67	47
	NIV	65	39
	PARTI	74	61
	NPARTI	64	38
UREA	POOLED	39	11
	IV	38	12
	NIV	38	9
	PARTI	40	16
	NPARTI	37	9
INSECTICIDE	POOLED	43	16
	IV	41	15
	NIV	44	15
	PARTI	38	1.2
	NPARTI	44	16
HERBICIDE	POOLED	49.5	18
	IV	44	14
	NIV	52	21
	PARTI	49	24
	NPARTI	48	16

MANURE	POOLED	49	25
	IV	47	23
	NIV	49	25
	PARTI	47	27
	NPARTI	48	23

Table 3: Awareness and adoption of cassava production technologies by farmers.
Note: IV Intervention village, NIV Non-intervention village Parti Participant NParti Non Participant, Ne/N – awareness rate, NA/N – adoption rate.
Source: Ayedun, B, 2015.

Management Practices	Pooled	IV	NIV	Parti	NParti
N	466	202	264	86	380
Weed management	46	57	38	37	48
Pest/disease management	21	22	20	38	17
Soil/fertility management	23	25	21	35	19
Timely planting/ harvesting	26	29	24	30	25
Crop rotation	14	13	14	19	13
Row planting	6	9	4	2	7
Erosion control	0.2	0.5	NA	NA	0.2
Spacing	8	10	6	NA	10

Table 4: Field management practices adoption by households. IV Intervention village, NIV Non-intervention village, Parti Participant, NParti Non Participant

Processing technologies for farm households

Processing technologies either developed or promoted by ICP are documented in Sanni., *et al*. [19]; topmost among them were graters and presser. Awareness and adoption of processing technologies by farm households is shown in Table 5. Generally, adoption rate (Na/N) was greatest for the 'grater', followed by 'presser' machines. The adoption rates were very close for all the groups for machines like grater, presser, fryer and grinder; this may be because these are the machines normally use for processing gari (local dry granulated food made from cassava) in the study areas. However, for other processing machines, farmers that participated in the training (PARTI) had higher awareness and adoption rates than other groups. In summary, adoption rates were greater for farmers that participated in training when compared with other groups under processing technologies for farming households.

Farm size and productivity

In Table 6, productivity was considered under three main groups 'ALL (using all data), VILLAGE TYPE, and PARTICIPATION. Under 'ALL', comparison between adopters and non-adopters' was direct; for 'VILLAGE TYPE' comparison was first made between IV and NIV, secondly, comparison between adopters and non-adopt-

Variable	Farmer Type	Awareness (Ne/N)	Adoption (Na/N)
Presser	POOLED	75	64
	IV	71	63
	NIV	76	62.5
	PARTI	69.8	63
	NPARTI	75	63
Grater	POOLED	88	78
	IV	86.1	78.2
	NIV	85.22	72.3
	PARTI	89.5	75.5
	NPARTI	84.7	74.7
Fryer	POOLED	41	22
	IV	45	26
	NIV	34	17
	PARTI	46	24
	NPARTI	37	20
Grinder	POOLED	33	23
	IV	27	21
	NIV	34	22
	PARTI	43	30
	NPARTI	28	20
Peeler	POOLED	45	22
	IV	43	22
	NIV	44	19.7
	PARTI	80	48
	NPARTI	35	14.5
Washer	POOLED	39	15
	IV	35	12
	NIV	38	16
	PARTI	61	32
	NPARTI	31	10
Milling	POOLED	20	10
	IV	16	9
	NIV	21	10
	PARTI	30	17
	NPARTI	16	8
Chipper	POOLED	20	3.98
	IV	19.8	3.96
	NIV	19	3.4
	PARTI	36	13
	NPARTI	15	1.6
Dryer	POOLED	19.7	7.96
	IV	17	59
	NIV	21	8.7
	PARTI	33	17
	NPARTI	16	5
Extractor	POOLED	17	4
	IV	18	3.5
	NIV	15	4.5

	PARTI	28	12
	NPARTI	14	2.4
Fermentator	POOLED	19	7
	IV	16	29.7
	NIV	19.7	9.5
	PARTI	31	14
	NPARTI	15	5
Sifter	POOLED	15	5
	IV	19	9
	NIV	9.8	2
	PARTI	19.7	8
	NPARTI	12	4
Pelleting	POOLED	8.6	0.99
	IV	5.9	0.99
	NIV	7	0.38
	PARTI	NA	NA
	NPARTI	NA	NA
Boiling	POOLED	17	5.4
	IV	14	2.5
	NIV	17	7
	PARTI	27	10
	NPARTI	13	3.9
Distiller	POOLED	8.6	0.7
	IV	7.9	1.5
	NIV	7.6	0.38
	PARTI	14	3.5
	NPARTI	6	0.3

Table 5: Awareness and patronage of cassava processing machines by farm households.
Source: Ayedun, B, 2015.

ers was made within IV, and then within NIV. The same method was applied to PARTICIPATION. Differences in yield between intervention (IV) and non-intervention (NIV) villages; and adopters and non-adopters are shown in Table 6. The results shows that intervention village had more yields than non-intervention villages at 1% significant level and the adopter group of improved cassava varieties had better yields than non-adopters, also at 1% significant level. The yield dominance of adopters was seen in all groups: IVs, NIVs, Parti, and NParti. Along village types, overall average yield (Pooled) was 14 t/ha; and it was greater for IVs (16 t) than for NIVs (13 t/ha).

Profitability of the production technology: gross margin analysis (GM)

For the purpose of evaluating the profitability of farm production activities, budgetary analysis was estimated. It involved the computation of gross margin (GM) and returns per naira outlay (RPN). It was carried out for cassava producers for households engaging in production of local cassava and improved cassava. The monetized values of variable inputs and incidental production costs was subtracted from gross revenue (GR) to arrive at GM estimates for both production methods. The RPN was calculated by finding the ratio of the GM to the total variable cost (TVC) in each case. The gross margin analysis of cassava production using traditional methods, planting local varieties, and that of improved techniques using improved cassava varieties and improved management practices is shown in Table 7. The yield difference between cultivation of improved cassava setts only and the local variety was 8.4 t/ha and was significant (P < 0.01) in favour of the improved variety. Also total variable cost (TVC) was higher for cassava production using the improved method, however, t-test value (1.07) shows that their difference(TVC_Diff) was not significant (b). The GM was higher for the improved method (N 217867.9/ha) than the traditional one (N118413.7/ha) with a difference of N 99454.2/ha (GM_Diff) and it was significant (P < 0.1). The RPN for improved practice was 3.1 compared to 2.3 of local one. The implication was that by investing N1 (one naira) in production, the local cassava producer made a N2.3 gain, while the improved cassava variety producer would make N3.1.

Group Type		Area_Ha	Yield_ (Tons)	Yld_diff_ (Tons)	t-test value
All	Pooled	2.1 ± 2.0	14 ± 5		
	AD	2.1 ± 2.0	16.9 ± 4	5***	5.9
	NAD	2.1 ± 2.0	11.9 ± 5		
Village type	IV	2.2 ± 2.2	16 ± 5	3***	6.3
	NIV	2.0 ± 1.8	13 ± 5		
Participation	Parti	2.3 ± 2.2	15.4 ± 4	1.6**	2.12
	NParti	2.0 ± 2.0	13.8 ± 6		
IV	AD	2.2 ± 1.9	19 ± 3		
	NAD	2.2 ± 1.9	13 ± 3		
NIV	AD	2.1 ± 2.1	16 ± 3		
	NAD	1.7 ± 1.2	10 ± 7		
PARTI	AD	2.2 ± 1.9	17 ± 3		
	NAD	2.7 ± 2.4	12 ± 5		
NPARTI	AD	2 ± 2.1	16 ± 5		
	NAD	2 ± 1.9	11 ± 5		

Table 6: Cassava farm size and productivity.
Note: IV Intervention village, NIV Non-intervention village, AD Adopters, NAD Non-adopters; **, ***, value is significant @ 5% and 1% respectively. Source: Ayedun, B, 2015.

Farm households' estimation
P-Alpha measures of poverty

In the context of this study, poverty is defined as the inability of a household to satisfy its basic needs for food, clothing and shelter, its inability to meet its social and economic obligations, its lack of gainful employment, its deprived access to basic facilities such as education, health, potable water and sanitation, and, hence its restricted welfare status [20,21]. To determine the poverty status of households in the study area, a poverty line was constructed, using two-thirds of the mean expenditure, below which a house-

Variable	Traditional method			Improved Method		
Input	Quantity	Amount ₦	% of TVC	Quantity	Amount (₦)	% of TVC
Cassava (bundle/ha)	41	4038.6	8	43	6322.5	9
NPK (Kg/ha)	60	3533.8	7	150	14050.0	20
Urea(Kg/ha)	95	3029.0	6	100	6322.5	9
Herbicide (liter)/ha	5	3029.0	6	3	2810.0	4
Insecticides (liter/ha)	1	504.8	1	2	2107.5	3
Manure (kg)	2400	2524.2	5	1340	2107.5	3
Total labour cost		33823.6	67		36530.0	52
Total variable cost (TVC)		50483.0			70250.0	
TVC_Diff		19767[b]				
Area (ha)	2.1			2.0	2.6	
Yield (tons/ha)	11.9	8.4***		20.3		
Price (Naira/ton)		14193.0			14193.0	
Revenue		168896.7			288117.9	
Revenue_Diff		119221.2***				
GM		118413.7			217867.9	
GM_Diff		99454.2*				
RPN		2.3			3.1	
B:C		3.3			4.1	

Table 7: Gross margin analysis per ha of harvested farms.

Note: Revenue_Diff is the revenue difference between traditional & improved methods, while GM_Diff is the difference between GMs traditional and improved methods; * it is significant @10%, with t-value of 1.78. *** Significant @1% with t-value of 3.5.

Source: Ayedun, B, 2015.

Variable	Poverty Headcount		Poverty Depth		Poverty Severity	
Poverty status	Poverty Headcount %	Mean difference on per capital expenditure	Poverty Depth	Mean difference	Poverty Severity	Mean difference
All(466)	48.7		0.47		0.27	
Village types						
Non-Intervention village(264)	53.4	1095 (0.68)	0.48	-0.0189 (-1.673)	0.29	-0.01536 (-0.437)
Intervention village(202)	42.6		0.46		0.26	
Participation in training						
Non-Participant(352)	52.3	2607 (1.486)	0.48	-0.05386 (-1.316)	0.28	-0.04345 (-1.039)
Participant(78)	45.9		0.42		0.22	
Adoption status(variety)						
Non-Adopter (cassava) (207)	51.7	2849*** (2.558)	0.51	-0.061* (-2.357)	0.32	-0.791** (-2.006)
Adopter(cassava)(257)	45.9		0.44		0.24	
Adoption status(grater)						
Non-Adopter (Grater) (117)	59	3175** (2.044)	0.52	-0.06855* (-1.867)	0.32	-0.07875** (-2.074)
Adopter(Grater)(349)	45.3		0.45		0.25	
Poverty line	N42016/annum					

Table 8: Poverty status of farm households and its determinants.

Legend: Significance level *10%, **5%, and ***1%.

Source: Ayedun, B, 2015.

When compared along participation in training, it was lower for participants (45.9%) than for non-participants (52.3%); and when compared along adoption status for improved variety line, it was lower for adopters (45.9%) than non-adopters (51.7%) and in case of adoption status for the grater machine, it was lower for adopters (45.3%) than non-adopters (59%). This is in line with the work of

Amao and Awoyemi (2007). Poverty depth index also buttressed that respondents that were from intervention villages, which participated in extension training and adopted new technologies, had lower poverty depth ratios than their counterparts. A poverty depth of 0.46 for IVS implied that average expenditure of the poor in the area was 46% less than the poverty line, and that an average poor man in the area will need an increase of 46% in his annual expenditure to escape from poverty. Also 0.26 poverty severity estimates for IVS shows 0.26 degree of dispersion in the distribution of the poor around poverty line in the area, it shows concerns for the poorest of the poor by giving more weight to the very poor. It can also be said that 26% of the sampled population were the poorest of the poor for IVs. However by testing for the significance of the differences between beneficiaries between IV and NIV, participants and non-participants, adopters and non-adopters; the t-test using SPSS only supported adopters of both improved cassava setts and users of grater machines among the households. Differences among per capita expenditure among adopters and non-adopters was significantly different for improved cassava at 1% and for the grater at 5% levels of probabilities. The same applied to poverty depth and severity.

Logit model: determinants of poverty status

In analyzing factors affecting poverty status among households, a logit regression model was estimated using dummy (1, 0) for poverty status as dependent variable; where 1 is classified as households that were not poor and 0 as households that were poor. Household socioeconomic characteristics became explanatory variables. Table 8 throws light on factors influencing household poverty status. The result shows that being from intervention villages, adoption of grater machine for processing cassava, medical expenses of farming households, having non-farm income, being educated, yearly social contributions, and total arable land cultivated, had significant effects on poverty status. All these variables have a poverty reducing effect. However, number of household size has a poverty increasing effect. In fact, the marginal effect estimates (dy/dx) indicated that farmers from IVs have a 12% reduction in their probability of being poor compared to farmers from NIVs; adopters of grater machines have 21% reduction in their probability of being poor compared to non-adopters; the educated farmers have 53% reduction in their probability of being poor compared to non-educated; land ownership caused a 2.1% reduction in farmers' probability of being poor, among others.

Variable	Coefficient	z-value	dy/dx
Village (IV=1)	1.494*	1.91	0.12176
Improve cassava (Adopt=1)	0.306	0.42	0.02946
Grater (Adopt=1)	2.306***	3.05	0.20948
Gender (Male=1)	0.593	0.88	0.06094
Medical bill(expenses)	0.0001***	4.4	0.00001
Non-farm income	0.0001	2.02	0.00001
Educated (Educated=1)	3.057***	3.11	0.53174
Household size	-0.790***	-4.55	-0.07178
Age	-0.020	-0.65	-0.00178
Participant (Participate in training=1)	0.868	1.04	0.06428
Social contribution	0.000**	2.03	0.00001
Total land	0.236**	2.06	0.02146
Constant	-3.486	-1.58	
LR chi^2	122.000		
Log likelihood	-41.600		
Pseudo R-square	0.590		

Table 9: Determinants of households' poverty status.
Legend: Significance level *10%, **5%, and ***1%;
Source: Ayedun, B, 2015.

Conclusion

Between 2002 and 2010, IITA implemented the Integrated Cassava Project (ICP) to support the Presidential Initiative (PI) for cassava launched in 2002 to boost cassava production and processing in Nigeria. This study examined 'Effects of adoption of cassava technologies on farmers from southern zones of Nigeria'. The study assessed the effects of adopting technologies on cassava; which can be production or processing types by cassava farmers from villages that had contact with International Institute of Tropical Agriculture and the Integrated Cassava Project (IITA-ICP) and villages that did not. Data were obtained using multistage sampling techniques and structured questionnaires from 480 farming households from contact villages termed 'Intervention Villages (IVs)' and non-contact villages, termed 'Non-Intervention Villages (NIVs)' of IITA.

There was an awareness gap in both production and processing technologies among the farming households. Adoption rate was generally poor except for a few technologies like improved cassava setts, and the grater, presser and sometimes fryer. Also, the result was better for intervention groups than non-intervention ones in general. Adoption of improved cassava varieties varied among the farming households; 72% in intervention villages going up to 78% among those that had attended research-for-development training and 64% for non-intervention ones. Except for insecticide adoption, other production technologies had the highest adoption rates among participants in training. On the adoption of processing machines by farm households, the grater was the most important with 78% adoption in Intervention Villages and 76% among those that had attended research-for-development training and 72% for Non-intervention Villages. It was followed by the presser while adoption of other processing machines was found to be generally low.

Adoption of improved cassava setts led to higher yields for adopters than non-adopters; for farmers from intervention than non-intervention villages; and for participants than non-participants in training. Using average price for a ton of fresh cassava tuber, the gross margin (GM) per hectare values and the benefit cost ratios show that production of improved cassava was profitable. Cultivation of improved cassava led to GM of N217,868/ha for improved method of farming and N118,414/ha for traditional methods, and their difference (N99,454.2/ha) was significant at 10% probability level. The return per capital outlay (RPN) for improved practice was 3.1 compared to that of local that was 2.3. The implication was that by investing N1 (one naira) in production, local cassava producer made a N2.3 gain on average, while the improved cassava variety producer would make N3.1; with the difference being attributed to the relative use of both improved cassava varieties and various management techniques extended to and used by the farmers.

Poverty status estimation reveals that less people were below the poverty line among adopters compared to non-adopters, and among intervention villages compared to counterfactuals. In estimating factors influencing poverty using Logit model, variables that had a poverty reducing effect included 'being from intervention villages, adoption of grater machine for processing cassava, medical expenses of farming households, having non-farm income, being educated, yearly social contribution and large total arable land cultivated'. It might be concluded that higher yield from cassava production translated into better revenue and thus improved welfare at least in the intervention villages and among those who adopted grater machines.

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