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by Oluwakemi Obayelu, Abiodun Obayelu, and Ifeoluwase Awoku

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Oluwakemi Adeola **Obayelu**[1], Abiodun Elijah **Obayelu**[2] **and** Ifeoluwase **Awoku**[1]
[1]Department of Agricultural Economics, University of Ibadan, Nigeria
[2]Department of Agricultural Economics and Farm Management, FUNAAB, Nigeria
Email:jkemmyade@yahoo.co.uk

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Abstracts

Despite the large scale public and government investment to improve the livelihoods of smallholder farmers, rural poverty remains widespread in Nigeria. However, efficiency effects on the transitory poverty has not received much attention in the poverty literature in Nigeria due to lack of nationally representative panel data that can track the poverty status of households over time. Using a two-wave panel data between 2010 and 2015, technical efficiency effects on poverty dynamics of cassava-based rural households in Nigeria was therefore investigated. Results showed that 14.9 % of the cassava farming households moved into poverty while 31.6 % exited from poverty. In the long run, the probability that rural cassava-based farmers would be non-poor (74 %) was higher than those remaining in poverty. Two out of five (42.2%) cassava-based farmers who were always poor exited technical inefficiency. A large number of farmers were actively involved in mono-cropping and mixed cropping but 29.7%, 26.0% and 16.6% of those involved in mono-cropping were always poor, entered and exited poverty, respectively. Tertiary education, marital status, access to extension farm size, membership of association, farming systems and technical efficiency were factors influencing poverty transitions in rural Nigeria.

Keywords: Cassava farms, farming systems, poverty transitions, production efficiency, rural households, socio-economic characteristics.

Introduction

Nigeria is the largest producer of cassava in the world, producing about 21.5% of world cassava production in 2018 with about 59 million metric tonnes annually from about 3.7 million hectares of land (FAOSTAT, 2019). The country however exported about 9628 tonnes of cassava equivalent, valued at US$1.43 million in 2018, suggesting that the Nigeria is dormant in cassava trade but remains largely self-sufficient (World Atlas, 2020). About 66% of total production is in the southern part of the country, while about 30% and 4% are produced in the north-central and in other parts of the north, respectively (FAO, 2020). While large scale commercial farms of cassava are rare, the crop is largely grown by smallholder farmers on small plots for family consumption and local sale. The drift for cassava production in the agricultural sector is rapidly increasing and the utility expansion has been relatively steady in Nigeria (Adebisi *et al.,* 2015). This is because Nigeria utilises cassava crop to diversify and improve its economy through efforts transmitted towards making cassava production sustainable with economic edge over other developing countries. Although there has been a consistent growth of cassava production in Nigeria and production grew at a rate as high as 10.6% per annum, this growth has been largely due to 10.9% per annum growth in expanded harvested area of cassava (Ikuemonisan *et al*., 2020). Furthermore, the national average yield of cassava (3.63 MT per ha) is lower than the potential yield 40 metric tons per ha (FAO, 2020). This is because cassava production in Nigeria is still fully in the hands of small scale farmers who depend solely on traditional means of propagation, resulting in reduction in the general level of productivity and efficiency (Nwaiwu *et al*., 2010;).

The economic theory of production provides the analytical framework for most empirical research on efficiency. Efficiency means the realization of a production goal without waste. Farrell (1957) identified three types of efficiency: technical efficiency, allocative efficiency (price efficiency), and economic efficiency (overall efficiency). Technical efficiency (TE) refers to the ability of a decision making unit to produce the maximum feasible output from a given bundle of inputs, or the minimum feasible amounts of inputs to produce a given level of output (Orewa and Izekor, 2012). The former definition is referred to as output-oriented TE, while the latter definition is referred to as input-oriented TE. Allocative efficiency (AE) refers to the ability of a technically efficient DMU to use inputs in proportions that minimize production costs given input prices. Economic efficiency (EE) is the product of both TE and AE (Farrell, 1957). Thus, a DMU is economically efficient if he/she is both technically and allocative efficient. Owing to lack of complete information on prices, this study focused on technical efficiency of the cassava-based farming households.

Poverty status and challenges of measuring poverty transitions in Nigeria

Despite the chains of anti-poverty programs by successive Nigerian governments, poverty reduction still remains a serious challenge (Olarinde *et al.,* 2020). About 40.1 percent of total population were classified as poor by national standards, which translates to over 82.9 million Nigerians, suggesting that four 4 out of 10 individuals in Nigeria are poor (NBS, 2020). Poverty in Nigeria is recognized as mostly rural phenomenon representing over 70 percent of the Nigerian poor population (Obayelu and Awoyemi, 2010; NBS, 2020). The inability of previous programmes and strategies to put a proportionate dent on the issue of poverty in Nigeria suggests that the major issue is not that households are poor but the probability that a household if currently poor, will move above the poverty line or if currently non-poor will fall below the poverty line vice versa (Agunbiade and Oke 2018).

Previous studies have analysed the status of relative poverty in Nigeria (FOS, 1999; Okojie *et al*., 2000; Aigbokhan, 2000; Obayelu and Awoyemi, 2009; Agunbiade and Oke,2018) having their subject based on the static aspect of poverty and its trend. Farming households can be poor at a particular point in time, either because they own fewer production assets, or poor harvest, climate change effect, inefficient production system, seasonality in agricultural production, financial and other types of constraints that limit their use of the assets for efficient production (Zuhumnan, 2018). However, a static poverty estimate from cross-sectional surveys cannot provide information on individual poverty experiences across time and across space. For some farmers, poverty is dynamic and transitory and they are moving in and out of poverty over time, while it is chronic rather than transitory for others (Baiyegunhi and Fraser, 2011). An understanding of the socioeconomic factors that determine these poverty dynamics/transitions have important implications for the design of effective poverty reduction strategies (Sindi and Kirimi, 2006).

Motivation for the study and the objective

Most of the earlier empirical micro-level poverty research in Africa were static (based on cross-section studies). However, static poverty studies cannot distinguish between transitory and chronic poverty. This study conceals a dynamic reality, one where there is a substantial flow of households into and out of poverty. People who are poor during a particular period (cross-sectional or current poverty) provide an incomplete picture of the prevalence of poverty in a population. People who are persistently poor or who cycle into and out of poverty should be the main focus of anti-poverty policies. Understanding the characteristics of the persistently poor, and the circumstances and mechanisms associated with entry into and exit from poverty, can help to inform governments about options to reduce persistent poverty (IZA, 2014).

It is clear that efficiency in cassava production is a crucial factor of productivity growth especially in developing agrarian economies, where resources are scarce and opportunities for developing and adopting better technologies are unstable. Despite various programmes and policies put in place by government to improve cassava production efficiency, which will in turn alleviate poverty, the full yield potential has not been realized since small holder production by rural farmers rarely exceed 11MT per hectare compared to the 25 to 40MT given by experts (Eze and Nwobi, 2014).

Babatunde *et al.*, 2016; Olarinde *et al.,* 2020 analysed poverty among cassava farmers in Nigeria. Other studies had analysed efficiency in cassava farming in Nigeria (Adeyemo *et al.,* 2010; Atagher and Orkorji, 2014; Biru *et al.*, 2018). Others had also analysed poverty transitions among rural households (Baiyegunhi and Fraser, 2010; Adepoju, 2012; Muyanga and Musyoka, 2014). Poverty had been reported to be higher among non-cassava farming households than among their cassava farming counterparts (Babatunde *et al*., 2016). Poverty and household socioeconomic characteristics have also been established to affect technical inefficiency of farmers and farmers that are technically efficient has the likelihood moving out of poverty but there are fewer evidences in literature (such as: Sanusi *et al.,* 2015) that have empirically looked into the effects of poverty on technical inefficiency of farmers and the effects of technical efficiency on poverty status of the rural farm households (Islam et al., 2018, Oladeebo, 2012). There is also a paucity of studies as far as we know that have worked on the effects of technical efficiency and farmers' socioeconomic characteristics on poverty dynamics in rural Nigeria. Hence, more studies to track the experience of farming households over time are needed to enlarge our comprehension of the complex forces that direct this group into conditions of short-run or long-run hardship.

This study therefore assessed the effects of technical efficiency and socioeconomic characteristics on poverty dynamics among the cassava farmers in Nigeria to guide agricultural policies that aim at poverty alleviation of rural farmers. The results will this contributes to the growing literature on poverty dynamics in Nigeria among rural farming households.

Brief Literature review of the relationship between technical efficiency, socioeconomic characteristics of households and poverty

Poverty is a complex; multifactorial concept reflecting a low level of well-being (Barrett, 2005). Poverty is not statics but dynamics. The study of poverty dynamics provides information about whether and how poverty status changes over time, (that is, whether people move out of poverty, whether they stay poor, or whether they become poor or poorer). Poverty dynamics is based on longitudinal data which tracks the same households (or individuals) over time. Rural farming households in developing countries often suffer from income poverty because their farm and non-farm incomes cannot meet the cost of basic needs (Islam and Haider, 2018). Since agriculture is the main livelihood activity of rural households, a marginal increase in technical efficiency in agricultural production increases output growth, farm income and consequently reduces rural poverty. Poverty is thus expected to be inversely related to technical efficiency (Ishani *et al*., 2020). Thus, any effort to enhance the productivity of existing lands also increases technical efficiency in production (Kumbhakar *et al*., 2015). Socioeconomic characteristics of the poor households have significant influence on households' transition in and out of poverty and are pivotal to development of policies to reduce poverty either at its chronic or transient state. (Umeh *et al.,* 2013). Literature is in favor of an inverse relationship between efficiency and poverty (Adeyemo *et al*., 2010; Umeh and Asogwa, 2011; Islam and Haider, 2018). Therefore, improvement in technical efficiency may be a viable poverty alleviation policy option (Islam and Haider, 2018).

Methodology

The scope of the study is rural Nigeria representing 51.7% of the country's population (UNDESPD 2017). General Household Survey-Panel (GHS-P), sourced from National Bureau of Statistics in conjunction with the Federal Ministry of Agriculture and Rural Development, the National Food Reserve Agency, the Bill and Melinda Gates Foundation and the World Bank, was used for the study. The GHS-P is a nationally representative survey of approximately 5000 households consisting of urban and rural enumeration areas. The data consists of three waves, 2010/2011, 2012/2013 and 2014/2015, and each wave consists of two seasons, post-planting and post-harvest. However, this study was restricted to rural farmers (1,491) who were actively involved in cassava production in the first and third waves of the survey.

Foster *et al*., (1984) poverty line was constructed as two-thirds of the Mean Per Capita Household Expenditure of all the rural cassava-based farmers. Hence, non-poor households were those whose per capita expenditure was above or was equal to two-third of the mean per capita expenditure of all households, while those whose per capita expenditure was below two-third of the mean per capita expenditure were classified as poor.

Approaches to efficiency measurement are broadly specified into parametric (example, stochastic frontier analysis) and non-parametric (example, the data envelopment analysis) approaches. The nonparametric approach is used when the production process cannot be identified by a functional form. Since this was identified in this study, the stochastic frontier analysis was used to estimate the technical efficiency of the farmers. The model controls for random unobserved heterogeneity among the firms which is an indication that the inefficiency effect can be separated from statistical noise. The Markov transition chain was used to estimate technical technical efficiency-based poverty transitions among cassava farmers in rural Nigeria. The items in the transition matrix will be shown in simple first-order Markov model following Bernstein *et al.,* 2018) and later converted into probability values of entering and exiting poverty by dividing each item by the corresponding row total to give the transition probability matrix below:

$$\begin{pmatrix} X_{11} & X_{12} \\ X_{21} & X_{22} \end{pmatrix}$$

In the same vein, vector of initial probability P(0) was obtained by dividing each column total by the grand total. Thereafter, the proportion of households that was in each category was expressed in the subsequent periods by using

$P(k) = P(0) P^k$

Where: k is the time period in seasons. The long term equilibrium (when the proportion of households entering poverty equals the proportion exiting it) will be obtained by using

eP =e

$$(e_1, e_2,) \begin{pmatrix} X_{11} & X_{12} \\ X_{21} & X_{22} \end{pmatrix} = (e_1, e_2)$$

The solution to the above matrix produced e_1, e_2, which are the proportion of households that was non-poor, and chronically poor at equilibrium in the long run.

Where:

e_1 = probability of households that will be non-poor at equilibrium

e_2 = probability of households that will be always poor at equilibrium

The multinomial logit model was used to examine the determinants of poverty transitions between the two waves following Bhatta and Sharma, (2006). The model predicts the probabilities of the different possible outcomes of a categorically distributed dependent variable when given a set of independent variables. The multinomial logit regression model is given as:

$$\pi_j(Y) = \frac{exp\,[\alpha+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n]}{1-exp\,[\alpha+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n]} \quad 1.$$

Where π_j is the multinomial probability of jth unordered poverty transition categories (j = 0, 1, 2, 3 representing always non-poor; transition into poverty; transition into non-poor; and chronically or always poor, respectively); X_i (i = 1,2,3,…, n) is the vector of explanatory variables (described in the Appendix); n is number of independent observations; $exp\beta_i$ is the multiplicative effect on the odds of a unit change in X_i at fixed level of X_j; while β denotes the effect of explanatory variables on poverty transition status. Since there was no ordering, the never poor group was considered as the base level k and all the logits were constructed relative to it. The equation was given as:

$$\text{Log}\left[\frac{\pi_j(Y)}{\pi_k(Y)}\right] = exp\,[\alpha+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n] \quad 2.$$

Because all π must add to unity, equation reduces to:

$$log(\pi_j(Y)) = \frac{exp\,[\alpha+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n]}{1+\sum_{j=1}^{k-1} exp\,[\alpha+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n]}$$

Results and Discussion

Determination of poverty line of cassava based rural farmers in Nigeria

The poverty line constructed as two-third of the mean per-capita expenditure of all the households was ₦3,034.02 in wave 1 while ₦26,808.17 was obtained in wave 3 (Table 1). Poverty incidences (P_0) in 2010 and 2015 were 0.42184 and 0.59963, respectively, implying that about 42.2 % and 60.0% of the cassava-based farmers were poor in both waves, respectively. However, the poverty incidence was higher in 2015, owing to economic recession in Nigeria during the period. The poverty depth (P_1) implied that the cost of eliminating poverty relative to the poverty line was 27.9% and 46.3% of poverty lines in 2010 and 2015, respectively. This shows what proportion of the poverty threshold would have to be transferred to the poor to bring their expenditure up to the poverty line. The poverty severity among cassava based farmers was lower (0.2109) in 2010 than in 2015 (0.2998) suggesting higher disparity in the distribution of income in 2015 than in 2010.

Table 1: Poverty status of cassava farmers using poverty line for 2010 and 2015

	Wave 1	Wave 3
Estimation of poverty line		
Household total expenditure	22008785.95	64379831
Mean Per capita household expenditure	4551.03	40212.26
2/3 MPCHE (Poverty line)	3034.02	26808.17
Poverty Status		
Incidence	0.4218	0.5996
Depth	0.2789	0.4627
Severity	0.2109	0.2998

Poverty Transition matrix

Results showed that the incidence of transit into poverty (28.2%) was higher than that of exit from poverty (14.9%) (Table 2). Specifically, about a quarter (25.3%) of the cassava farmers remained non-poor, while 28.2 % moved into poverty and 14.89% moved out of poverty. However, 31.6% were perpetually in poverty. Thus, 47.2% of cassava farmers who were non-poor in 2010 remained non-poor in 2015, while 52.8 % of those who were non-poor in 2010 transited into poverty in 2015. Similarly, 32 % of those who were poor in 2010 exited poverty in 2015; while 68 % of those that were poor in 2010 were chronically (always) poor in 2015. There was therefore a high level of poverty transition among cassava farmers in rural Nigeria, which conforms with the works of Sodangi, (2011) that poverty is predominantly chronic in rural area of Nigeria. The probability that a cassava farmer would be poor (59.8 %) was higher than being non-poor (40.1%) in the short run. Conversely, the probability that rural cassava farmers would be non-poor (74 %) was higher than the probability that they will remain poor in the future (26 %) in the long run (Table 2).

Table 2: Poverty Transition matrix of cassava based farmers between 2010 and 2015

Wave 1	Wave 3		Total
	Non-poor	Poor	
Non-poor	377	421	798

	(0.2528)	(0.2824)	
Poor	222 (0.1489)	471 (0.3159)	693
Total	599	892	
Vector of initial probability	0.4017	0.5983	
Steady state probability	0.074	0.026	

**Figures in parenthesis represent the probability transition matrix

Poverty transition profile by demographic characteristics.

About 27.3% of male-headed households were never poor, while 26.7% transited into poverty and 14.3% exited poverty but 31.6% remained always poor (Table 3). Among the female-headed cassava households, the 16.5% remained non-poor, while 34.8% entered into poverty and 17.2% remained always poor. Thus, the rate of transition into poverty was higher among female-headed cassava farming household heads than among their male counterparts. Poverty transition occured in both male- and female-headed households in rural Nigeria with a higher proportion of households transiting into poverty or were chronically poor, which corroborates with the findings of Jennifer (2005) that female-headed households are more likely to fall into chronic poverty than their male counterparts. Additionally, the highest proportion of never-poor (27.2%) households were married, while the highest proportion of those who transited into poverty (33.7%) were unmarried. About 15.8% of cassava household's head who were married transited out of poverty, while 35.1% remained in poverty. Moreover, aging household heads (above 65 years) had a higher proportion of members entering into poverty (36.6%). Meanwhile, the highest proportion (20.92%) of those exiting poverty were 36 to 45 years old, while the highest proportion (44.4%) of the chronically poor farmers were less than 25 years old. The high level at which aging farmers transited into poverty may be due to high level of technical inefficiency and insufficient profit (Dauda et *al*., 2016).

Furthermore, the modal household size was three to six members in all the poverty transition categories (Table 3). However, the largest proportion of households with less than three (37.5%) and those with three to six members (32.3%) were chronically poor. This conforms with the findings Woolard and Klasen (2005) that large households were more likely to move into poverty than smaller ones in South Africa. Additionally, 51.2% of those with seven to ten members were never poor. Thus, large households with fewer dependent members may improve chances of transition out of poverty (Agolli, 2017). A majority (79.4%) of the farmers had less than equal proportion of working population the household and also represented the highest proportions in all the poverty transition groups. However, the largest proportions of cassava-based farming households with less than one (33.6%) and greater than one (31.6%) dependency ratio were chronically poor, while the highest proportion of those with unity dependency ratio (31.3%) were never poor. This implied that higher dependency ratio reduces the likelihood of slipping out of poverty.

Table 3: Poverty transition profile by Demographic characteristics.

	2011- 2016

Demographic characteristics	Always Non-poor (n= 377)	Entering poverty (n= 421)	Exiting poverty (n= 222)	Always poor (n= 471)
Gender				
Male	331(27.31)	324 (26.73)	174 (14.3)	383 (31.60)
Female	46 (16.49)	97 (34.77)	48 (17.20)	88 (31.54)
Marital status				
Married	308 (27.21)	300 (26.50)	179(15.81)	345(30.48)
Unmarried	69 (19.22)	121(33.70)	43 (11.98)	126(35.10)
Age of household head				
< 25	4 (44.44)	1 (11.11)	0 (0.00)	4 (44.44)
26 – 35	18 (25.00)	20 (27.78)	11(15.28)	23 (31.94)
36 – 45	69 (22.55)	61(19.93)	64 (20.92)	112(36.60)
46 – 55	74 (18.55)	111(27.82)	75 (18.80)	139(34.84)
56 – 65	120(30.69)	113(28.90)	39 (9.97)	119(30.43)
Above 65	92 (29.30)	115 (36.62)	33 (10.51)	74 (23.57)
Household size				
< 3	57 (15.16)	112(29.79)	66(17.55)	141(37.50)
3 – 6	228(24.46)	263(28.22)	140(15.02)	301(32.30)
7 – 10	86(51.19)	46 (27.38)	14(8.33)	22(13.10)
Above 10	6 (40.00)	0 (0.00)	2(13.33)	7 (46.67)
Dependency ratio				
< 1	281(23.73)	333 (28.13)	172(14.53)	398(33.61)
1	63(31.34)	62 (30.85)	32(15.92)	44(21.89)
> 1	33 (31.13)	421(28.24)	222(14.89)	471(31.59)

** Figures in parentheses represent % of the distribution

Poverty Transition Profile by Economic characteristics

The largest proportion of the farmers had primary education, while a minority had no formal education. The largest percentages of those with primary (35.4%) and secondary (30.6%) education were chronically poor, while 46.6% of those with tertiary education were never poor (Table 4). Educated farmers have higher opportunity cost of labour and are more likely to diversify their labour into more lucrative non-farm and off-farm labour markets, increase household income and reduce poverty (Barrett *et al*., 2001; Anang and Yeboah, 2019). Education is also expected to enhance entrepreneurial abilities and self-employment, which may enhance the level of income from off-farm work. However, less educated farmers may not have the requisite skills to diversify their labour into high-paying non-agricultural wage employment (Anang and Yeboah, 2019). A minority (5.5%) of the farmers also had agricultural extension contact, of which a half were never poor and 45.1% were in poverty transition and vulnerable to poverty (Table 4). However, about a third of those without access to extension contact were chronically poor, while one out of five were never poor and 43.0% were in poverty transition. This underscored the importance of agricultural extension service to improved production technical knowledge and efficiency. Although a higher percentage of the cassava-based farming households had access to credit, this did not translate to poverty reduction among them. Similar percentages of those with access (31.5%) and those without access (32.0%) were chronically poor, while poverty transition was slightly lower among households without access (43.0%) than those with access (44.1%) to credit. Thus, access to credit did not give a large margin in the poverty outcomes of the farming households, possibly because the micro-credits were too small for increasing cassava production or they were diverted to other needs.

Table 4: Poverty transition profile by economic variables

	2011-2016			
	Always Non-poor+ (n= 377)	Entering poverty++ (n= 421)	Exiting poverty+++ (n= 222)	Always poor++++ (n= 471)
Extension services				
No	336(23.85)	400(28.39)	206 (14.62)	467 (33.14)
Yes	41 (50.00)	21(25.61)	16 (19.51)	4 (4.88)
Access to credit				
No	96 (28.40)	88 (26.04)	46 (13.61)	108 (31.95)
Yes	281 (24.37)	333 (28.88)	176 (15.26)	363 (31.48)
Education				
No formal Education	0 (0.00)	0 (0.00)	0 (0.00)	2 (100)
Primary Education	171 (19.48)	281 (32.00)	115 (13.10)	311 (35.42)
Secondary Education	110 (27.16)	109 (26.91)	62 (15.31)	124 (30.62)
Tertiary Education	96 (46.60)	31 (15.05)	45 (21.84)	34 (16.50)

Note: Figures in parentheses represent % of the distribution

Poverty Transition profile by technical efficiency

The highest percentage (37.0%) of technically efficient cassava farmers was never poor, while the highest proportions of farms that exited technical efficiency (42.2%) and the chronically technical inefficient (31.3%) farmers were chronically poor (Table 5). This suggested that improving technical efficiency in cassava farming would keep farmers out of poverty, which is consistent with the findings of Biru *et al.,* (2018). Furthermore, the highest percentage of farms exiting technical efficiency (36.6%) was entering poverty. Thus, farmers without access to improved production inputs and technologies would have low technical efficiency and wallow in chronic poverty (Ogboso, 2005). Moreover, the largest proportion of the farmers were into mixed cropping of cassava. The highest percentages of farmers practicing mono cropping (56.7%), mixed cropping (31.6%) and inter-cropping (29.7%) were chronically poor. This suggested that mono-cropping was the least pathway to poverty reduction among the cassava farmers. However, 61.1% of farmers practicing relay cropping system were never poor, indicating that soil conservation farming systems is a viable pathway to reducing poverty among cassava farmers.

One out of four smallholder cassava farmers with less than five hectares of farmland were never poor, while 29.8%, 15.4% and 29.0% entered, exited and were chronically poor, respectively. Conversely, 45.3% of larger farms with more than five hectares were chronically poor, while 22.7%, 19.7%, 12.4% were never poor, entered and exited poverty, respectively. This suggested inefficient use of land either by over-utilisation or under-utilisation, thus reducing the likelihood of slipping out of chronic poverty.

Table 5: Poverty Transition profile by Technical efficiency and Farming systems

Efficiency and farm characteristics	Always non-poor (n= 377)	Entering Poverty (n= 421)	Exiting poverty (n= 221)	Always Poor (n= 472)
Technical efficiency				
Always Efficient[1]	27 (36.99)	13 (17.81)	12 (16.44)	21 (28.77)
Entering Inefficiency[2]	102 (21.84)	171 (36.62)	53 (11.35)	141 (30.19)
Exiting Inefficiency[3]	39 (33.62)	8 (6.90)	20 (17.24)	49 (42.24)
Always Inefficient[4]	209 (25.03)	229 (27.43)	136 (16.29)	261 (31.26)
Farming System				
Inter – cropping	144 (27.75)	135 (26.01)	86 (16.57)	154 (29.67)
Mono – cropping	9 (13.43)	19 (28.36)	1 (1.49)	38 (56.72)
Relay cropping	11 (61.11)	7 (38.89)	0 (0.00)	0 (0.00)
Mixed cropping	212 (24.42)	254 (29.26)	128 (14.75)	274 (31.57)
Alley cropping	1 (5.26)	6 (31.58)	6 (31.58)	6 (31.58)
Farm size (Hectares)				
< 5	324 (25.78)	375 (29.83)	193 (15.35)	365 (29.04)
>5	53	46	29	106

	(22.65)	(19.66)	(12.39)	(45.30)

Note: Figures in parentheses represent % of the distribution
[1] = technically efficient in both waves
[2] = efficient in wave 1; inefficient in wave 2
[3] = inefficient in wave 1; efficient in wave 2
[4] = inefficient in both waves

Determinants of Poverty Transitions

The multinomial regression model passed the minimum requirement for robustness where the log likelihood (-1780.9295) was significant at one percent and the choice of each alternative is independent of other alternatives meaning that IIA has not been violated (Table 6). Age was negatively related to the log-likelihood of farmers being never poor indicating that an additional year in farmer's age will lead to a 0.01 unit decrease in the log-likelihood of being never poor relative to the chronically poor farming households. However, the coefficient of age squared reveals that elderly cassava farmers were always non-poor indicating that there the effect of age on poverty transition becomes stronger as household heads increases in age. This result conforms to the life-cycle hypothesis that labour income follows a hump shape pattern in which labour and income attain the peak of economic activities at middle age but low at young and old ages (Jappelli and Modigliani, 2003). Aging of agricultural labour implies shortage of agricultural labour which has negative consequences on technical efficiency and agricultural production (Liu *et al.,* 2019) resulting in low income and diminishing poverty status. Being married reduced the likelihood of exiting poverty possibly owing the burden of reduction in per capita expenditure with increased household size. Similarly, an additional member of household decreased the odds of exiting poverty. This implied an additional household member would decrease the likelihood of exiting chronic poverty by 14.9% because increased household size decreases per capita expenditure thereby aggravating poverty in the household (Haddad and Ahmed, 2003; Adepoju, 2012).

Primary education attainment was positively related to the probability of households transiting into poverty but had a negative effect on chronically poor households. Both secondary and tertiary education of the cassava household head had strong positive influence on the likelihood of exiting poverty, while the negative sign of the chronically poor would decrease the odds of exiting poverty. Thus, education has a strong causal influence on household poverty status (Adepoju, 2012). However, the negative effect of primary education on the probability of transiting poverty due to the fact that households whose head had completed primary school were less likely to be poor. (Woolard and Klasen 2005; Bhatta and Sharma, 2006).

Furthermore, being a female-headed household increased the probability of slipping into poverty than their male counterpart. This result aligns with Jennifer *et al.,* (2005) that male-headed households have a higher probability of being non-poor than their female counterparts. This may be because female-headed households are usually occupied with home chores and raising children, which limit their involvement in income generating activities compared to their male counterparts. Likewise, an additional hectare of farmland would decrease the likelihood of being never poor by 0.0276 unit. A similarly increase in farm size will lead to 0.0504unit decrease in the likelihood of cassava farmers moving out of poverty. It implies that the expansion of farmland will lead to a greater output and consequently enhances transition out of poverty (Nwaru, 2007). Moreover, an increase in access to extension services will lead to 0.2138 increase in the level of adoption of new technology among the non-poor category. A positive relationship between cassava farmers transiting into poverty and being a member of a cooperative society shows the tendency of farmers remaining in poverty if funds meant for agricultural purpose is diverted for personal use.

Cassava farmers transiting into technical inefficiency and those that were always technical inefficient experienced decline in production; which in turn increased the rate of poverty transition among the non-poor category. However, there was a negative relationship between entering technical inefficiency and poverty exit. This aligns with the findings of Adeyemo *et al.*, 2010 and Biru *et al.,* 2018 that the higher the rate of technical inefficiency the higher will be the rate of slipping into poverty. Finally, a negative relationship existed between inter cropping and the categories of farmers that were exiting the state of poverty. There was a negative relationship mixed cropping and farmers who were always non-poor, entering poverty and exiting poverty. This implies that cassava farmers who were practicing inter cropping and mixed cropping encountered a lower yield due to less understanding of the agronomical and biological state of crops which in turn has a negative impact on the rate at which farmers exit poverty which connotes with the work of Gliessman, 1982.

Table 6: Determinants of Poverty Transitions among cassava rural farmers in Nigeria.

Variables	Always Non-poor		Entering poverty		Exiting poverty		Always poor
	Coefficient	Marginal effect dy/dx	Coefficient	Marginal Effect dy/dx	Coefficient	Marginal Effect dy/dx	Marginal Effect dy/dx
Age	-0.0545 (0.0384)	-0.0101** (0.0051)	0 .0263 (0.0387)	0.0091 (0.0060)	-0.0172 (0 .0529)	-0.0008 (0.0055)	0.0018 (0.0063)
Age squared	0.0006** (0.0003)	0.0001** (0.0001)	-0.0001 (0.0003)	-0.0001 (0.0001)	0. 0001 (0.0005)	-0.0000 (0.0001)	-0.0000 (0.0001)
Farm size	-0.4328*** (0.1044)	-0.0276** (0.0159)	-0.2822*** (0.0999)	-0.0014 (0.01754)	-0.6716*** (0.1542)	-0.0504*** (0.0167)	0.0794*** (0.0150)
Gender	-0.1726 (0.3611)	-0.1302*** (0.0401)	0.2441 (0.3138)	-0.0521 (0.0506)	1.9746*** (0.5105)	0.2998*** (0.0837)	-1.1173*** (.04501)
Household size	0.1703*** (0.0275)	0.02480*** (0.0036)	-0.0518** (0.0269)	-0.0100** (0.0042)	-0.0057 (0 .0341)	-0.0088*** (0.0034)	-0.0149*** (0.0042)
Credit access	0 .0886 (0.1904)	0.0035 (0.0263)	0.0272 (0 .1793)	-0.0092 (0.0293)	0.2551 (0.2239)	0.0239 (0.02106)	-0.0183 (0.0295)
Access to extension	2.6571*** (0.5475)	0 .2138*** (0.0547)	1.7813*** (0.5753)	-0.0228 (0.0516)	2.4146*** (0.5770)	0.0808** (0.0464)	-0.2718*** (0.0297)
Marital Status	-0.2720 (0.3163)	0.0216 (0.0430)	-0.1306 (0.2862)	0.0555 (0.0472)	-2.2348*** (0.5037)	-0.1782*** (0.0291)	0.1011** (0.0471)
Primary Education	0 .2477 (0.4755)	```0.0106 (0.0585)	1.2237*** (0.4306)	0.1982*** (0.0424)	-0.6449** (0 .3680)	-0.1428** (0.0576)	-0.0659 (0.0662)
Secondary Education	1.1358** (0.4862)	0.1222** (0. 06146)	1.5709*** (0.4473)	0.1918*** (0.0461)	-0.2985 (0.3923)	-0.14621** (0.0586)	-0.1678** (0.0677)
Tertiary Education	1.9704*** (0.5078)	0.2528*** (0.0662)	1.3321*** (0 .4909)	0.0490 (0.0472)	0.7524 (0.4163)	-0.0512 (0.0628)	-0.2506*** (0.0693)
Membership of association	-0.0996 (0.2576)	-0.0363 (0.0389)	0.4086 (0.2685)	0.0812** (0.0381)	-0.1253 (0.2884)	-0.0244 (0.0325)	-0.0205 (0.0407)
Entering Technical Inefficiency	-0.7009** (0.3656)	-0.1297*** (0.0494)	0.6785** (0.4079)	0.1991*** (0.0659)	-0.7718*** (0.4285)	-0.0854** (0. 04215)	0.0161 (0.0603)
Exiting Technical Inefficiency	-1.3589*** (0.4337)	-0.0993 (0.0630)	-1.6187 (0.5787)***	-0.1972** (0. 0991)	-0.5152 (0.4836)	0.0489 (0.0495)	0.2476*** (0.0753)
Always Technical	-0.6301** (0.3537)	-0.1212*** (0.0477)	0.4269 (0.4021)	0.1293** (0.0653)	-0.2554 (0.4091)	-0.0205 (0.0399)	0.0123 (0.0593)

Inefficient							
Inter-cropping	-0.7567** (0.4099)	-0.0461 (0.0609)	-0.3552 (0.3264)	0 .0317 (0.0592)	-2.5258** (1.0315)	- 0.1463*** (0.02975)	0.1607*** (0.0615)
Relay – cropping	17.3923 (1050.511)	0.2612** (0 .1536)	17.2626 (1050.511)	0.1994 (0.1535)	0.3414 (2028.281)	- 0.1715*** (0.0170)	- 0.2890*** (0.0196)
Mixed cropping	-0.3724** (0.1685)	-0.0475** (0.0240)	0.0134 (0.1601)	0.0408** (0.0247)	-0.3967** (0.1930)	-0.0333* (0.0209)	0 .0400 (0.0256)
Alley cropping	-2.2998** (1.1373)	-0.2441*** (0.0442)	0.5021 (0.6469)	0.2096** (0.1258)	-0.2239 (0.6581)	0.0018 (0.0741)	0.0327 (0.1106)
Number of observations	1,458						
Log likelihood	- 1744.2293						
LR $chi^2(16)$	449.07						
Prob> chi^2	0.0000						
Pseudo R^2	0.1140						

Note: ***, ** & * indicate significant levels at 1%, 5% and 10% respectively
Figures in parentheses represent the standard errors

Conclusion

Based on the findings of this study, a conclusion can be drawn that technical efficiency is very helpful in improving the state of being always non-poor and reducing poverty duration (exiting poverty) of cassava-based farming households in rural Nigeria. Other socioeconomic factors found to have increased the rate of poverty transition were: age, gender, education, household size and access to credit. Furthermore, household heads having tertiary education improved the chances of exiting poverty, while an increase in household size was seen to increase poverty levels of households. Despite, a high technical efficiency among cassava rural households, a high proportion of them remained in poverty. Therefore, more intervention is needed to improve the socioeconomic conditions of rural cassava-based farmers to ensure that the chronically poor farming households move out of poverty and protect the non-poor from falling into poverty over time. From the foregoing, extension services should be intensified among cassava-based rural households so that farmers can have access to cassava production information, which will in turn increase their technical efficiency as well as the farmers' overall welfare. Households who are always poor should be identified and specifically targeted by the government for safety net such as access to credit facilities, subsidized agrochemicals, access to social amenities which can help to reduce the level of poverty.

Suggestions for further studies

Although this study considered the effect of TE on poverty dynamics of cassava-based farmers, further studies can be carried out to look at the effects of allocative as well as economic efficiency on income poverty dynamics

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Appendix

Appendix: A priori Expectation for Determinants of poverty Transitions in Rural Nigeria

Variable	HHs never poor	HHs exiting poverty	HHs entering poverty	HHs always poor	Reference
Age of Household Head	–	–	+	+	Bigsten and Shimeles 2003; Swanepoel 2005
Gender of Household head	–	–	+	+	Jenifer et al., 2005 Geldstein ,1997
Marital status of Household head	–	–	+	+	Amao and Ayantoye, 2015
Primary Education of Household head	+	+	–	–	Adepoju, 2012
Secondary Education of Household head	+	+	–	–	Adepoju, 2012
Tertiary Education of Household head	+	+	–	–	Adepoju, 2012, Lawson *et al*., 2004
Household size	–	–	+	+	Baulch and Vu (2011)
Dependency ratio	–	–	+	+	Adepoju , 2012; Haddad and Ahmed, 2003
Farm size	+	+	–	–	Ayantoye*et al*., 2011
Access to credit	+	+	–	–	Ayantoye*et al*., 2011