EFFECTS OF AGRICULTURAL COMMERCIALIZATION ON SMALLHOLDER RICE FARMERS' VULNERABILITY TO FOOD INSECURITY IN EKITI STATE, NIGERIA

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Abstract

This study examined the effects of agricultural commercialization on smallholder rice farmers' vulnerability to food insecurity in Ekiti state, Nigeria. The study employed a multi-stage sampling procedure to select the respondents. A well-structured questionnaire was used to collect data from the study area. While descriptive statistics were employed for the analysis of respondents' socio-economic variables, feasible generalized least square (FGLS) and endogenous switching regression (ESR) models were used in determining vulnerable respondents and the effects of agricultural commercialization on respondents' vulnerability to food insecurity respectively. The FGLS result showed that 40.5% and 68.2% of commercialized and non-commercialized respondents were vulnerable to food insecurity respectively. Furthermore, the results of the ESR revealed that factors such as age, adult equivalent, contact with extension workers, savings and sex were significant factors influencing respondents' vulnerability to food insecurity regardless of their commercialization status. However, factors such as dependency ratio, credit and trust in grain traders significantly influenced vulnerability to food insecurity of the commercialized respondents, and value of livestock possessed exclusively influenced vulnerability to food insecurity of the non-commercialized respondents. The ESR results further showed that respondents who commercialized would have been 20.3% more vulnerable per adult-equivalent per day had they not commercialized while those non-commercialize would have been 26% less vulnerable had they commercialized. The study concluded that to reduce vulnerability to food insecurity among the respondents, stakeholders in the study area should promote factors that could reduce vulnerability to food insecurity and discourage pro-vulnerability factors through direct targeting of vulnerable respondents for possible intervention.

Keyword: Commercialization; Endogenous Switching Regression; Feasible Generalized Least Square; Vulnerability

INTRODUCTION

Food insecurity alleviation has been attracting global attention particularly in the developing countries, including Nigeria where many people are food insecure. According to a report by Federal Government of Nigeria FGN (2017), 26.4% of Nigerians suffer severe food insecurity based on the food insecurity experience scale. Inadequate food intake is a public health challenge because it promotes vulnerability to a variety of physical, mental and social health problems (Nord, 2014). Even children and youth who are hungry frequently are susceptible to poorer health (Kirkpatrick, Mcintyre, & Potestio, 2010).

As the threat of hunger and food insecurity continues unabated in most part of sub-Saharan Africa (SSA) countries, Nigeria already embarked on programmes with a view to achieving a zero-hunger target of the 2nd SDGs (FGN, 2017). The programmes are designed with a view of running agriculture as a business by producing for the market (agricultural commercialization) so that nutrition can be improved, and sustainable agriculture can be promoted, as well as addressing the overlap between food insecurity and vulnerability to food insecurity (VtFI).

According to Pritchett et al. (2000), VtFI is the likelihood that a household would experience a short fall in its food consumption in the future. Notable among the programmes are the Green Alternative Agriculture Promotion Policy (GAAPP); Staple Crops Processing Zones (SCPZ); Nigeria Incentive-Based Risk-sharing System for Agricultural Lending (NIRSAL); Rural Finance Institution Building Programme (RUFIN); Anchor Borrowers' Programme (ABP) and Commercial Agriculture Credit Scheme (CACS). Despite the efforts towards alleviating food insecurity, the incidence still persists. This is because the focus of the government programmes until recently, has been on reducing ex-post food insecurity with little or no consideration for ex-ante food insecurity. Following the results of empirical studies carried out by different researchers, making ex-post and ex-ante food insecurity issues a priority policy imperative are crucial rather than a peculiar policy prescription. Therefore, for ex-ante food insecurity issue, social safety nets, social security benefits (Azeem, 2016) and accumulation of assets associated with agricultural commercialization would suffice rather than prescribing policy of economic growth in both cases (Vandemoortele, 2011). According to Gabre-medhin et al. (2009) and Ochieng et al. (2015), agricultural commercialization occupies a central position in terms of enhancing food security, nutrition and incomes owing to increased purchasing power after reducing market barriers. Relatedly, Ojo (2020) posits that escaping vulnerability may involve accumulation of assets through participation in agricultural commercialization.

However, studies evaluating the effects of agricultural commercialization on households' vulnerability to food insecurity are limited due to the overlap between food insecurity and vulnerability to food insecurity (VtFI) i.e ex-post and ex-ante food insecurity (Alayande & Alayande, 2004). The static approach of food insecurity which measures whether a household's current food consumption is below a pre-defined line (benchmark) such as 2850kilocalories/ Adult Equivalent per day according to FAO-UNU-WHO (1985) had been used by many studies. For instance, studies such as: Oparinde, et al. (2020); Kirimi et al. (2013) and Olanrewaju (2015), have investigated agricultural commercialization in relation to food security, and have found positive relationship between agricultural commercialization and food security. However, these studies failed to explain how agricultural commercialization affects households who are not food insecure yet but are at the risk of being food insecure in the future. A problem with this approach is that it excludes a substantial proportion of households who are vulnerable to becoming food insecure in the future. Feeny and Mc Donald (2016) posit that the weakness of the ex-post food insecurity measurement adversely affected the success of achieving the MDGs due to targeting error (Eyob, 2012). Hence, increased emphasis has been placed on accounting for people who are at the risk of food insecurity alongside those who are currently food insecure to accomplish a total targeting (Eyob, 2012). Therefore, this study investigates the effects of agricultural commercialization on smallholder rice farmers' vulnerability to food insecurity in Ekiti state, Nigeria.

Literature Review

Vulnerability management strategies are premised on the life cycle theory. According to Deaton (2005), the life cycle theory posits that households pursue the objective of consumption smoothening so that their marginal utility of consumption can be maintained even in the face of

shock (a realization of risk). Households can experience shock either in an idiosyncratic form or covariate form, or even in both forms. Idiosyncratic shock is household specific, and it includes death of head of household/ breadwinner, accident, sickness, or loss of job (Azam and Imai, 2012; Yusuf, 2023). Idiosyncratic shock is prevalent in the developing economies because of lack of basic infrastructure, market failure and poor capital endowment (Gaiha & Imai, 2004; Azam & Imai, 2012). On the other hand, covariate shocks manifest as natural disasters such as epidemics, drought, earthquake, hurricane, flood and so on (Azam & Imai, 2012; Yusuf, 2023). These shocks have bad consequences on income accruable to the household, thereby making households vulnerable to poverty or food insecurity.

Vulnerability to poverty and extension food insecurity are situations whereby individuals or households are exposed to an uninsured risk capable of making them live below a threshold of acceptable wellbeing (Grosh et al., 2008). According to Yusuf (2023), vulnerability connotes a forward-looking (ex-ante) and dynamic measure of well-being with a view to determining a condition in a future time of the household's life cycle. Vulnerability describes household's capacity to manage the welfare-related bad consequences of shocks (Mthethwa & Wale, 2020). Previous efforts geared towards understanding the household's capabilities to manage shocks had benefitted from the "Sustainable Livelihood Framework" (SLF) which projects capabilities, capital assets (financial, human, natural, physical, and social) including activities needed to earn a living even in the face of stresses and shocks now and in the future (DFID, 2000). Sustainable Livelihood Framework is made up of five elements viz: vulnerability context, capital endowment, institutions and policies, livelihood strategies and livelihood outcomes (DFID, 2000).

Vulnerability context relates to shocks that may negatively affect households' store of assets and ultimately expose them to risk of living below an acceptable welfare threshold. While acquisition of assets by households is a function of policy and institutions, livelihoods strategies relate to choices made by households within the limit of their capitals/resources as influenced by the surrounding institutions and these interactions finally determine households' livelihood outcomes. So, from the SLF, it can be inferred that households' assets endowment confers on them the ability to withstand, cope and recover from shock through both ex-ante and ex-post risk management strategies such as prevention, mitigation, adaptation and coping.

Risk management refers to actions taken by farmers to increase the chances of success of the farming business and invariably prevent or reduce the negative welfare consequences of the occurrence of risks. Like diversification, asset accumulation which derives from agricultural commercialization had been reported in development literature as capable of serving either as ex-ante or ex-post risk management strategies (e.g: Birhanu, Tsehay & Bimerew, 2021; Cazzuffi, Mckay & Perge, 2020; Schulfe, Mumber & Nguyen, 2023). However, asset accumulation does not stand on its own but it is derived from the income of an enterprise. In agriculture, empirical literature had confirmed assets accumulation as one of the benefits of agricultural commercialization (Poulton, 2017). Ojong, Hauser and Mauseh (2022) investigated whether agricultural commercialization increase asset and livestock accumulation on smallholder farms in Ethiopia. They found that smallholder commercialization increases assets and as a consequence, contribute to welfare improvements in the long term. Similarly, Cazzuffi, McKay and Perge (2020) examined the impact of agricultural commercialization on household welfare in rural Vietnam, they found evidence of positive influence of agricultural commercialization on asset accumulation. Also, Birhanu, Tsehay and Bimerew (2021) studied the effects of commercialization of cereal crops on multidimensional poverty and vulnerability to

multidimensional poverty among farm households in Ethiopia, and found that farm household commercialization had a negative and significant effect on the living standard dimension of multidimensional poverty index. Schulte, Mumber and Nguyen (2023) conducted research on agricultural commercialization, asset growth and poverty in rural Vietnam, and found that an increase in the level of commercialization led to a decrease in households' multidimensional poverty level through the income and asset growth channel. Asset accumulated from agricultural commercialization can serve as springboard when sold for vulnerable households to bounce back to a condition where they no longer entertain the fear of running out of food in the future (Addal, Ngombe & Temoso, 2022; Gebre, Isoda, Amekawa, Rahut, Nomura & Watanabe, 2021; Azeem, 2016; Tesmesgen, Ketema & Ademe, 2022; Woldeyohanes, Heckelei & Surry, 2017). Therefore, agricultural commercialization impacts vulnerability to food insecurity through the asset accumulation pathway.

METHODOLOGY

Study Area

The study was carried out in Ekiti State, Nigeria. The state is situated in the South-West geo-political zone of Nigeria. It is located between longitudes 7°45′ and 5°45′ East of greenwich meridian and latitudes 7°45′ and 8°05′ North of equator. It lies South of Kwara and Kogi States as well as East of Osun State. It is bounded in the East by Edo State and in the South by Ondo State. The state has sixteen local government areas. It enjoys tropical climate with two distinct seasons: the rainy season (April – October) and dry season (November – March). The temperature ranges between 21°C and 28°C with high humidity. Tropical forest exists in the South and guinea savannah in the north. The state is endowed with water resources like Ero, Osun, Ose and Ogbese rivers. The people of the state are culturally homogenous, and they speak a dialect of Yoruba language known as 'Ekiti'.

The major food crops grown in the state include yam, maize, cassava, cocoyam, and rice, and the tree crops grown include cocoa, kolanut, and oil palm tree. The main livestock species include sheep, goat, pigs and poultry. The people of the state are predominantly rural dwellers whose poverty is a result of inability to generate enough income from their agricultural and non-agricultural activities. Ekiti state is an agrarian economy with the production of food crops providing employment and income for more than 75% of the population (Oluwatayo, 2004). The people are mainly farmers while women engage in food processing, trading, in addition to farming activities. The climate favours the state in the cultivation of crops like maize, yam, cassava, millet, rice, plantains, cocoa, palm produce, cashew, etc.

Sampling Techniques

A multi-stage sampling procedure was used in selecting the respondents for this study. The first stage involved a purposive sampling of rice producing communities in Ekiti-state (the study area). The second stage involved a random selection of twenty-three (23) rice producing communities from the rice producing communities in the study area. At the third stage, the number of rice farmers selected from each of the selected rice producing communities is proportionate to the total number of registered rice farmers in all the selected rice producing communities. This proportionate selection was done by firstly determining the sample size for the study following Yamene (1967) sample size determination formula that is stated as follows:

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

Where, N (1556) is the population size (number of registered rice farmers) and e is the level of precision (4%), n is the sample size. Subsequently, a proportionality factor adapted from Amao and Ayantoye (2015) was used in selecting the number of rice farmers (sample) from each of the selected rice producing communities to ensure fair representation. The proportionality factor is stated as follows:

$$x_i = \frac{n}{N} * Number\ of\ registered\ rice\ farmers\ in\ i-th\ community \quad (2)$$

Where, x_i = sample selected from ith community, n = total sample estimate obtained from Yamene (1967) formula and N= population of registered rice farmers in the study area. This led to a simple random selection of 446 rice farmers in the study area. However, out of the 446 questionnaires administered on the selected rice farmers, 420 were those with complete information used for the data analysis.

Method of Data Analysis

Data collected were analysed using descriptive statistics, food insecurity threshold measure, value at risk analysis, and endogenous switching regression.

Descriptive statistics

Descriptive statistics such as frequencies, tables, percentages, averages, etc., were used to analyse and describe respondents' socioeconomic variables.

Analysis of Household Food Insecurity Status

To establish the household food insecurity status, firstly, quantities of the commonly consumed food items at the household level in the study area were calculated and converted to calories based on their composition (Oguntona & Akinyele, 1985; Stefan & Pramila, 1998). The resulting calorie values were divided by the respective adult equivalent values of the households to obtain numbers that are comparable across households of different sizes. The World Health Organization (WHO) considers 2850kilocalories as the required daily intake for a moderately active adult equivalent (FAO-WHO-UNN, 1985). Food secure households are those whose daily per capita calorie consumed per Adult Equivalent (AE) is greater than or equal to the minimum recommended daily calorie requirement of 2850kcal/day/AE, otherwise the household was considered food insecure for this study. Therefore, household food security status assumed a binary choice of 1 for food insecured household, 0 otherwise.

Determination of Vulnerability to Food Insecurity Using Value at Risk (VaR) Analysis

To achieve the objective which aims at assessing the probability of household's being vulnerable to food insecurity, VaR analysis was employed. The VaR methodology analysed the probability that the outcome of a risky event might fall below a critical threshold, based on the statistical distribution of all possible outcomes. Feasible Generalized Least Square (FGLS) analytical technique was used to determine VaR as follows:

Let C stand for the food security indicator, which provides an overview of a household's food security situation. The expected welfare loss associated with an inadequate value of the food security indicator can then be used to define the household vulnerability to food insecurity. This definition is dependent on several factors, including the characteristics of the household, the strategies they employ, the risk management policies put in place by public institutions, and external factors like negative shocks that affect the entire community. An appropriate econometric

formulation of the vulnerability process is as follows: let C_h be the kilocalorie intake of the family and let X_h be a vector of variables, such as household size, location, etc. The number of calories consumed by each family is stated as:

$$C_h = X_h'\beta - \beta_1 x_{h1} + \cdots + \beta_2 x_{h2} + \cdots + \beta_3 x_{h3} \quad (3)$$

In each case, β represents a vector of constant parameters. To estimate the multivariate equation and provide estimates of the parameters that account for both the residual component and calorie consumption, one must first follow the 3 Feasible Generalised Least Squares (FGLS) process.

U = $[U_1, U_2, \ldots, U_n]$:

$$C = X\beta + u \quad (4)$$

Since the anticipated residuals from (4) are heteroskedastic and correlated, the study evaluates their dependency on the same explanatory factors using a set of parameters γ in a subsequent step. It calculates the following equation:

$$U = X\gamma + \varepsilon \quad (5)$$

Where ε is the residuals' vector from this second estimation, displaying all the desired residual characteristics that u lacks. Compute a consistent estimate of the household variation of food consumption using the deterministic portion of equation (5) and repeat the correction for heteroskedasticity. The variance is used to calculate the likelihood of food insecurity for each family. The study assesses the likelihood that a family would experience food insecurity in the upcoming period given X, or the vulnerability estimates, assuming log normality of the calorie consumption distribution. These estimates are as follows:

$$V_h = pr(lnch < \ln(Z\backslash X) = \theta\left[\frac{lnZ}{\sqrt{varln(Ci\backslash x)}} - \frac{E(ln\ Ci\backslash x)}{\sqrt{varln(Ci\backslash x)}}\right] = \theta\left[\frac{lnZ - \alpha X}{\sqrt{\dot{\eta} Xi}}\right] \quad (6)$$

Where ln is the natural logarithm of kilocalories consumed by the households, θ is the operator for standard normal cumulative distribution, ά and ή were estimated vector of parameters and X was vector of covariates. The ultimate outcome of the calculations is a set of estimates (one for every household h) of the probability that each household faces by falling below the minimum energy requirement in the future. The obtained estimate i.e. V_h was now compared with a vulnerability threshold of 0.5. A household is vulnerable if V_h is higher than 0.5, otherwise, not vulnerable. The choice of vulnerability threshold of 0.5 is arbitrary (Chaudhuri, *et al*, 2002), however this study used the 0.5 as done by Azam and Imai, (2012). A household requires minimum of 2850kcal per day per AE to be food secured. Based on Chaudhuri *et al.,* (2003), a household's vulnerability to food insecurity can be expressed as a probability that household fails to attain the minimum level of calorie intake in the future.

Effect of Agricultural Commercialization on Vulnerability to Food Insecurity

Endogenous Switching Regression Model

Endogenous switching regression model that accounts for both endogeneity and sample selection was used to determine the effect of agricultural commercialization on vulnerability to food insecurity following Maddala and Nelson (1975) and Di Falco *et al.* (2011). The model uses a probit model in the first stage to determine the relationship between agricultural commercialization and several household and farm characteristics. In the second stage, separate regression equations were used to model household vulnerability to food insecurity conditional on a specified criterion function. To clarify the method, consider a situation where a farmer could

commercialize or not. Let P_i^* be a latent variable capturing the expected net benefits from agricultural commercialization. The study specifies the probit model of agricultural commercialization as:

$$P_i^* = \propto' Z_i + u_i \; with \; P_i^* = \begin{cases} 1 & if \;\; P > 0 \\ 0 & otherwise \end{cases} \quad (7)$$

Where P_i^* is the unobservable or latent variable for agricultural commercialization; P_i is its observable counterpart (i.e. the dependent variable agricultural commercialization equals l, if the farmer has sold any quantity of rice produced in the market, and zero otherwise); Z_i is a vector of observed farm and non-farm characteristics determining agricultural commercialization; α is the coefficient estimates and is random disturbances associated with the agricultural commercialization. The two welfare regression equations where farmers face the regimes of commercialization or non-commercialization are defined as follows:

Regime 1: $V_{1i} = \beta_1 X_{1i} + \varepsilon_{1i} \;\; if \; P_i = 1$ (8)

Regime 2: $V_{2i} = \beta_2 X_{2i} + \varepsilon_{2i} \;\; if \; P_i = 0$ (9)

Where, V_i is household vulnerability to food insecurity in regimes 1 and 2, X_i is a vector of exogenous variables of household *i*, expected to influence vulnerability to food insecurity; β is the coefficient vector; P is dummy for agricultural commercialization, and ε_i the residuals.

The error terms are assumed to have a trivariate normal distribution with zero mean and non-singular covariance matrix specified as

$$cov(\varepsilon_{1i}, \varepsilon_{2i}, u_i) = \begin{bmatrix} \sigma_{\varepsilon 2}^2 & . & \sigma_{\varepsilon 2u} \\ . & \sigma_{\varepsilon 1}^2 & \sigma_{\varepsilon 1u} \\ . & . & \sigma_u^2 \end{bmatrix} \quad (10)$$

where, σ_u^2 is the variance of the error term in the selection equation; $\sigma_{\varepsilon 1}^2$ and $\sigma_{\varepsilon 2}^2$ are the variances of the error terms in the welfare outcome functions; $\sigma_{\varepsilon 1u}$ is the covariance of u_i and ε_{1i}; and $\sigma_{\varepsilon 2u}$ is the covariance of u_i and ε_{2i}. Since V_{1i} and V_{2i} are not observed simultaneously, the covariance between ε_{1i} and $\varepsilon_{2i}$is not defined (Maddala, 1983). An implication of the error structure is that because the error term of the selection equation u_i is correlated with the error terms of the welfare outcome functions, ε_{1i} and ε_{2i}, the expected values of ε_{1i} and ε_{2i} conditional on the sample selection are non-zero and are defined as:

$E[\varepsilon_{1i} / P_i = 1] = \sigma_{\varepsilon 1u} \frac{\emptyset(\alpha Z_i)}{(\alpha Z_i)} = \sigma_{\varepsilon 1u} \lambda_{1i} and \; E[\varepsilon_{2i} / P_i = 0] = -\sigma_{\varepsilon 2u} \frac{\emptyset(\alpha Z_i)}{1-\Phi(\alpha Z_i)} = \sigma_{\varepsilon 2u} \lambda_{2i}$

Where Ø (.) is the standard normal probability density function, Φ(.) the standard normal cumulative density function, and $\lambda_{1i} = \frac{\emptyset(\alpha Z_i)}{\Phi(\alpha Z_i)}$ and, $\lambda_{2i} = \frac{\emptyset(\alpha Z_i)}{1-\Phi(\alpha Z_i)}$.

If the estimated covariances $\sigma_{\varepsilon iu}$ and $\sigma_{\varepsilon 2u}$ are statistically significant, then the decision to commercialize and the welfare outcome variables are correlated; that is, the study will find evidence of endogenous switching and reject the null hypothesis of absence of sample selectivity bias (Lokshin and Sajaia, 2004).

A more efficient method of estimating endogenous switching regression models is full information maximum likelihood (FIML) method. The FIML method simultaneously estimates the probit criterion or selection equation and the regression equations to yield consistent standard errors.

Given the assumption of trivariate normal distribution for the error terms, the logarithmic likelihood function for the system of equations (8) and (9) can be given as:

$$lnL_i = \sum_{i-1}^{N} P_i \left[ln\emptyset\left\{\frac{\varepsilon_{1i}}{\sigma_{\varepsilon 1}}\right\} - ln\sigma_{\varepsilon 1} + ln\emptyset(\emptyset_{1i})\right] + (1 - P_i)\left[ln\emptyset\left\{\frac{\varepsilon_{2i}}{\sigma_{\varepsilon 2}}\right\} - ln\sigma_{\varepsilon 2} + \ln(1 - \emptyset(\emptyset_{2i}))\right] \quad (11)$$

Where $\emptyset_{ji} = \frac{(\alpha Z_i + \gamma_{ji}/\sigma_j)}{\sqrt{1-\gamma_j^2}}$, $j_i = 1{,}2$ with denoting the correlation coefficient between the error term $u_i$of the selection equation (10) and the error term ε_{ij} of outcome equation (11), respectively, The FIML estimates of the parameters of the endogenous switching regression model can be obtained using the movestay command in Stata (Lokshin and Sajaia, 2004).

Variable definition and measurement

Dependent variables

P = commercialization (1=commercialization decision, 0 otherwise)

V = vulnerability status (1= vulnerable, 0 otherwise)

Independent variables

$X_1 = Years\ of\ fromal\ education$ (Years)

$X_2 = Livestock\ value$ (Naira)

$X_3 =$ Credit value (Naira)

$X_4 = Contact\ with\ extension\ agents$ (Yes=1; 0 otherwise)

$X_5 = Trust\ trader$ (Yes=1; 0 otherwise)

$X_6 =$ Cost of transport per ton (Naira)

$X_7 =$ Ownership of means of transportation (Yes =1; 0 otherwise)

$X_8 =$ Remittance (Naira)

$X_9 = Savings$ (Naira)

$X_{10} = Sex$ (Male=1; 0 female)

$X_{11} = Age$ (Years)

$X_{12} = Adult\ equivalent$ (Number)

$X_{13} = Dependable\ relative$ (Number)

$X_{14} = Ownership\ of\ mobile\ phone$ (Yes=1; 0 otherwise)

Conditional Expectations, Treatment and Heterogeneity Effects

Following Di Falco *et al*., (2011), the endogenous switching regression model can be used to compare the expected vulnerability outcome of households that commercialized (a) with respect to households that arenon-commercialized (b), and to investigate the expected vulnerability outcome in the counterfactual hypothetical cases (c) that the commercialized households did not commercialize, and (d) that the non-commercialized households commercialized. The conditional expectations for outcome variables in the four cases are defined as follows:

$$\mathrm{E}(V_{1i}/P_i = 1) = \beta_1 X_{1i} + \sigma_{\varepsilon 1u}\lambda_{1i} \quad (12)$$

$$\mathrm{E}(V_{2i}/P_i = 0) = \beta_2 X_{2i} + \sigma_{\varepsilon 2u}\lambda_{2i} \quad (13)$$

$$\mathrm{E}(V_{2i}/P_i = 1) = \beta_2 X_{1i} + \sigma_{\varepsilon 2u}\lambda_{1i} \quad (14)$$

$$\mathrm{E}(V_{1i}/P_i = 0) = \beta_1 X_{2i} + \sigma_{\varepsilon 1u}\lambda_{2i} \quad (15)$$

Cases (a) and (b) along the diagonal of Table 1 represent the actual expectations observed in the sample. Cases (c) and (d) represent the counterfactual expected outcomes. In addition, following Heckman *et al*., (2001), the effect of agricultural commercialization on vulnerability outcome of the households that actually commercialized is calculated as the difference between (a) and(c).

$$\mathrm{TT} = \mathrm{E}(V_{1i}/P_i = 1) - \mathrm{E}(V_{2i}/P_i = 1) = X_{1i}(\beta_1 - \beta_2) + \lambda_{1i}(\sigma_{\varepsilon 1u} - \sigma_{\varepsilon 2u} \quad (16)$$

Similarly, the effect of the treatment on the untreated (T U) for households that actually did not commercialize is calculated as the difference between (d) and (b),

$$TU = E(V_{1i}/P_i = 0) - E(V_{2i}/P_i = 0) = X_{2i}(\beta_1 - \beta_2) + \lambda_{1i}(\sigma_{\varepsilon 1u} - \sigma_{\varepsilon 2u}) \quad (17)$$

The effect of "base heterogeneity" for the group of farm households that decided to commercialize is defined as the difference between (a) and (d),

$$BH_1 = E(V_{1i}/P_i = 1) - E(Y_{1i}/P_i = 0) = \beta_{1i}(X_{1I} - X_{2I}) + \sigma_{\varepsilon 1u}(\lambda_{1i} - \lambda_{2i}) \quad (18)$$

Similarly, for the group of farm households that decided to be non-commercialized, the effect of "base heterogeneity" is the difference between (c) and (b)

$$BH_2 = E(V_{2i}/P_i = 1) - E(Y_{2i}/P_i = 0) = \beta_{2i}(X_{1I} - X_{2I}) + \sigma_{\varepsilon 2u}(\lambda_{1i} - \lambda_{2i}) \quad (19)$$

Finally, the difference between TT and TU can be estimated. This effect called "transitional heterogeneity" (T H), estimates whether the effect of agricultural commercialization is larger or smaller for households that commercialized or for the household that were non-commercialized in the counterfactual case that they did commercialize.

Table 1: Conditional expectations, treatment, and heterogeneity effects

Sub-samples	Decision stage		Treatment
Households that commercialize	(a)$E(V_{1i}/P_i = 1)$	(c) $E(V_{2i}/P_i = 1)$	TT
Households that were non-commercialized	(d) $E(V_{1i}/P_i = 0)$	(b) $E(V_{2i}/P_i = 0)$	TU
Heterogeneity effects	BH_1	BH_2	TH

Source: Author's computation from field survey 2018

Notes: (a) and (b) represent observed expected food security outcome; (c) and (d) represent counterfactual expected food security outcome.

P_1 = 1 if household commercializes in the market; P_1 = 0 if farm household did not - commercialize
V_{1i} = food security outcome if household commercializes
V_{2i} = food security outcome if household did not commercialize
TT = the effect of the treatment (i.e. commercialization) on the treated (i.e. household that commercializes)
TU = the effect of treatment (i.e. commercialization) on the untreated (i.e. household that does not commercialize)
BH = the effect of Base heterogeneity for household that commercializes (*i= 1*), and does not commercialize (*i=2)*
TH = *(TT, TU),* i.e. transitional heterogeneity.

Table 2: Distribution of Respondents by Commercialization Status

Commercialization Status	Frequency	Percentage
Commercialized Respondent	269	64.0
Non-Commercialized Respondent	151	36.0

Total	420	100

Source: Author's computation from field survey 2018

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Respondents

Table 3 presents the distribution of households by age. The result showed that for both commercialised and non-commercialised respondents, the age of most of them is less than or equal to 60 years. Furthermore, the average age of the sampled respondents regardless of their commercialization status was 47 years. This implies that the sampled respondents were in their active and productive age. It is expected that being in their active and productive age would enable them to engage in income-generating activities such as agricultural commercialization that has potential to reduce being vulnerable to food insecurity. The table also showed the distribution of households by sex. The distribution shows that 68.4% of the households that commercialized were male while the remaining commercialized households were female. However, for non-commercialized households, 67.5% were male while the rest were female. This implies there were more male rice farmers than female rice farmers in the sampled households. This finding could be associated with the possibility that rice farming is a labour and resource-intensive enterprise (requires much productive resources that men are usually more endowed with than women especially in an African setting). The usual practice in farming enterprise is that women tend to support their husbands in the harvesting and processing aspect of rice production activities. Table 3 also presents the distribution of respondents by acquisition of formal education. The result showed that all the commercialized respondents acquired formal education, but the result reflected varying levels of acquisition or completion. In the case of non-commercialised respondents, 8.6% of them did not have formal education while the rest showed varying levels of acquisition of formal education like their commercialised counterparts. The average number of years that commercialized and non-commercialized respondents spent to acquire formal education were about 10.5 and 9.3 years respectively. This implies that commercialized respondents were more educated than their non-commercialized counterparts. The level of education acquired by respondents could determine the range of opportunities available to improve livelihood strategies, access to market and enhance food security (Ukpe, 2016). Table 3 further presents the distribution of respondents by household size. The results showed that most of the sampled respondents were 4-6 and 7-9 members. For commercialized households, 45.7% and 27.5% has 4-6 and 7-9 members respectively. However, for the non-commercialized respondents, 43.7% and 27.8% has 4-6 and 7-9 members respectively. The average household size of the sampled respondents regardless of commercialization status was about 7 members. Household comprising of 7 members is a fairly – large one which may reduce or threaten household's vulnerability to food insecurity. On one hand, large household size may serve as source of labour supply on the household's farm. This may enable household to produce more output for consumption or sale to earn income. On the other hand, large-sized household has the potential of exerting pressure on household available resources such that affected household can experiences reduction in its per capita food consumption or entertain anxiety of food shortage. Again, Table 3 presents the distribution of households by farm size. The distribution indicated that sampled respondents cultivated varying sizes of rice farm. For commercialized respondents, about 68% cultivated rice farm ranging from one hectare to three hectares while their non-commercialized counterpart cultivated less than one hectare of rice farm. The average rice farm size cultivated by commercialized and non-commercialized respondents were 2 hectares and 0.12 hectare respectively. The finding implies that sampled respondents were

predominantly smallholder rice farmers since their farm holdings were less than 10 hectares (Oluwatayo, 2019).

Table 3: Socioeconomic Characteristics of Respondents

Socio-Economics Characteristics	Commercialized respondents		Non-commercialized respondents	
Age	**Frequency**	**Percentage**	**Frequency**	**Percentage**
≤30	27	10.0	15	9.9
31-40	47	17.5	27	
40-50	85	31.6	48	31.8
51-60	72	26.8	43	31
>60	38	14.1	18	11.9
Total	269	100.0	151	100.0
Mean	47.2		47.2	
SEX				
Male	184	68.4	102	67.5
Female	85	31.6	49	32.5
Total	296	100.0	151	100.0
Years of formal education				
0	-	-	13	8.6
1-6	24	8.9	72	47.0
7-12	167	62.1	45	30.5
> 12	78	29.0	21	13.9
Total	269	100.0	151	100.0
Farm size(Hectare)				
<1	43	16.0	151	100.0
1-3	185	68.8	-	-
>3	41	15.2	-	-
Total	269	100.0	100.0	100.0
Mean	2.0		012	
Household size				
1-3	16	5.9	11	7.3
4-6	123	45.7	66	43.7
7-9	74	27.5	42	27.8
10-12	44	16.4	24	15.9
13-15	12	4.5	8	5.3
Total	269	100.0	151	100.0
Mean	7		7	

Source: Author's computation from field survey 2018

Distribution of respondents by calories consumed during the two survey periods

Table 4 presents the respondents' distribution by the number of calories consumed during the two survey periods. The study used calorie threshold of daily intake of 2850kilocalories for moderately active adult equivalent as set by World Health Organisation (FAO-WHO-UNU, 1985) and used by Azeem (2016) to categorise respondents' calorie consumption. The distribution

showed that more non-commercialized respondents (49%) consumed less than the calorie threshold value compared with commercialized respondents (27.5%) in the first period of the survey. However, more commercialized respondents (72.5%) consumed calorie above the threshold compared with non-commercialized respondent (51%) also in the first period of the survey. Again, in the second period of the survey similar results were observed as in the first period. More non-commercialized respondents (57%) consumed calorie below the threshold value compared with commercialized respondents (36.1%). However, in the same survey period more commercialized respondents consumed calorie above the threshold value compared with non-commercialized respondents (43%). This implies that in the survey periods commercialized respondents were more food secure compared with non-commercialized respondents. The average calorie consumed per adult equivalent by commercialized and non-commercialized respondents were 3274.2 and 3033.0kilocalories respectively in the first survey period. Also, the average calorie consumed per adult equivalent by commercialized and non-commercialized respondents were 3144.1 and 2816.0kilocalories respectively in the second survey period. This finding could be linked to seasonal effect orvariation in food availability and prices. This result connotes instability of access to food among the sampled respondents.

Table 1: Distribution of Respondents by Calories Consumed During the Two Survey Periods.

Calorie consumed	Commercialized				Non-commercialized			
	$Freq_1$	**$Freq_2$**	**$\%_1$**	**$\%_2$**	**$Freq_1$**	**$Freq_2$**	**$\%_1$**	**$\%_2$**
1850 – 2849	74	97	27.5	36.1	74	86	49.0	57.0
> 2849	195	172	72.5	63.9	77	65	51.0	43.0
Total	269	269	100.0	100.0	151	151	100.0	100.0
Mean	3274.2	3144.4			3033.0	2816.0		

Source: Author's computation from field survey 2018

Note: $Freq_1$ = Frequency of respondents in period one of the survey

$Freq_2$ = Frequency of respondents in period two of the survey

$\%_1$ = Percentage of respondents in period one of the survey

$\%_2$ = Percentage of respondents in period two of the survey

Households' Vulnerability Status

Table 5 showed the household distribution by vulnerability status. This study used a vulnerability threshold of 0.5 as done by Azeem (2016) to categorise households into non-vulnerable and vulnerable groups. Household whose vulnerability index is equal to or below 0.5 is considered non-vulnerable while household whose vulnerability index is above 0.5 is considered vulnerable. On this basis 59.5% and 31.8% of commercialized and non-commercialized households respectively were non-vulnerable. However, in terms of household being vulnerable 40.5% and 68.2% of commercialized and non-commercialized households respectively were vulnerable. This means that commercialized households were less vulnerable compared with non-commercialized households. Household that can produce higher marketable surplus and possesses insurance mechanisms tend to be less vulnerable to food insecurity.

Table 5: Distribution of Respondents by Vulnerability Status

Vulnerability Status	Commercialized		Non-commercialized	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Non-Vulnerable(≤ 0.5)	160	59.5	48	31.8
Vulnerable (> 0.5)	109	40.5	103	68.2
Total	269	100.0	151	100.0

Mean	0.46	0.65

Source: Author's computation from field survey 2018

Effect of Agricultural Commercialization on Vulnerability to Food Insecurity

The econometric results of the determinants of households' vulnerability to food insecurity probability obtained from the endogenous switching regression (ESR) model is presented in table 6. The results showed that some of the independent variables significantly influenced households' probability of being vulnerable to food insecurity. Age significantly and positively affected probability of being vulnerable to food insecurity regardless of the households' commercialization status. The levels of significance for households that commercialized and non-commercialized were 5% and 10% respectively. This result means that the older the household, the higher the vulnerability probability and vice versa. This finding could be associated with the possibility that at old age, human beings become less active and productive and tend to experience old age associated illnesses. Consequently, the need to receive medical treatment creates competition between medication and food consumption for the resources (time and money) of the elderly thereby threatening the stability of the older peoples' food security. This situation becomes worse if the aged people's economic base is constrained to offer help. This result is consistent with Echevin (2013) who found that adult equivalent obtained from household size significantly and positively influenced households' vulnerability to food insecurity at 1% level of significance regardless of the households' commercialization status. This finding implies that large-sized adult equivalent households are more likely to be vulnerable to food insecurity than small-sized adult equivalent households. This finding could be related to the possibility that large-sized households exert more pressure on available households' resources such that households always run out of food or become agitated because of the constant need to refill or restock households' food store. The anxiety becomes more pronounced if households' resources are limited. Moreover, the result showed that contact with extension workers significantly and negatively affected households' vulnerability to food insecurity at 1% level of significance irrespective of the households' commercialization status. This implies that households that had contact with extension workers are less likely to be vulnerable to food insecurity than households that had no contact with extension workers. This finding underscores the importance of extension information in enabling farming households to choose the most profitable technology of production on their farm. Savings significantly and negatively affected households' vulnerability to food insecurity not minding households' commercialization status. Also, savings influenced vulnerability of commercialized and non-commercialized households at 5% and 10% levels of significance respectively. This result implies that households that had savings were less likely to be vulnerable than households without savings. Specifically, commercialized households compared to non-commercialized households were less likely to be vulnerable to food insecurity. This result could be linked to the possibility that savings can be used as an insurance mechanism to smoothen food consumption on a "rainy" day. Again, sex significantly and negatively affected household's vulnerability to food insecurity regardless of households' commercialization status at 1%. This finding implies that male-headed households were less likely to be vulnerable to food insecurity than female-headed households. This finding could be attributed to the possibility that male-headed households were more likely to possess more productive resources which they can use to produce for marketable surplus and or own-consumption. Also, value of livestock possessed significantly and negatively influenced non-

commercialized households' vulnerability to food insecurity at 5% level of significance. This implies that non-commercialized households that possessed high value livestock were less likely to be vulnerable than similar households that possessed low-value livestock. This finding could be explained by the possibility that high-value livestock possessed by non-commercialized households could be sold off to buy food during lean period so that their flow of food is not disrupted. However, dependency ratio significantly and positively influenced commercialized households' vulnerability to food insecurity at 10% level of significance. This means that commercialized households that had high dependency ratio were more likely to be vulnerable than similar households with low dependency ratio. This result could be explained by the possibility of increased burden on the actively working household members to provide food for the non-working members of the household. This finding is consistent with Govereh and Jayne (2003). Furthermore, credit significantly and negative affected vulnerability of commercialized households to food insecurity at 5% level. This finding means that commercialized households that obtained credit were less likely to be vulnerable than similar households that did not obtain credit. This finding could be attributed to the important role played by credit in terms of food consumption smoothening during lean period. Moreover, trust in grain traders significantly and negatively influenced vulnerability of commercialized household at 10% level. This implies that commercialized households that trusted grain traders were less likely to be vulnerable than similar households that did not trust grain traders. This finding could be linked to the possibility that those households that trusted grain traders received better prices for the sale of their rice. Similarly, commercialized households could be obtaining fair prices for grains (food) during the lean season when they might need to buy food from the grain traders. They could even obtain credit from the traders to smoothen food consumption or use it to produce marketable surplus or food for home consumption. This trust is a two-way thing which builds over time after continual interactions with one another.

Table 6: Maximum Likelihood Estimates of Endogenous Switching Regression (ESR) for Examining Effect of

Variable	Participation in Agricultural Commercialization (1/0)		Commercialized respondents		Non-commercialized respondents	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
Years of Formal Education	0.312	0.236	0.005	0.009	0.004	0.005
Livestock Value	2.33e-05	1.63e-05	8.25e-07**	3.45e-07	401e-07	8.15e-07
Credit Value	6.25e-05*	3.57e-05	1.24e-06	8.72e-07	1.98e-06**	9.15e-07
Contact with Extension Agents	0.683	1.360	0.283***	0.073	0.510	0.068
Trust trade	0.569	1.085	0.059*	0.031	0.020	0.062
Cost of Transport per Tonne	-0.208**	0.009	-2.03e-04*	0.0001139	1.84e-05**	9.11e-06
Own Means of Transport	8.503*	4.433	0.125	0.087	0.050	0.042
Remittance	8.72e-05	6.92e-05	9.79e-07	2.10e-06	1.20e-05	1.16e-05
Savings	5.83e-05**	2.92e-05	6.37e-07*	3.48e-07	1.58e-06**	6.73e-07
Sex	5.220*	2.912	0.262***	0.037	0.144***	0.043
Age	0.041	0.047	0.005*	0.003	0.062**	0.002
Adult Equivalence	0.929**	0.464	0.032***	0.008	0.025***	0.008
Phone	2.723*	1.549	NA	NA	NA	NA
Constant	94.199**	41.436	1.081***	0.531	0.049**	0.016
σ_{ei^*}			0.080***	0.127	0.185***	0.492
φ_j			-0.215***	0.009	-0.181***	0.010

Agricultural Commercialization on Vulnerability to Food Insecurity

Conditional Expectation, Treatment Effect and Heterogeneity Effect of Households Participation in Agricultural Commercialization

Table 7 presents the effects of agricultural commercialisation under actual and counter-factual scenarios using the ESR method. The results shown in the last column indicate that agricultural commercialization has a positive effect in reducing households' vulnerability to food insecurity. More specifically, respondents who commercialised would have been 20.3% more vulnerable per adult equivalent per day had they not commercialised. This is the average treatment effect on the treated (ATT). Likewise, the average treatment effect on the untreated (ATU) is 0.167. This implies that respondents that were non-commercialised would have been about 26% less vulnerable had they commercialised. The transitional heterogeneity effect of vulnerability to food insecurity among the sampled respondents is positive implying that the effect is more for the rice farming respondents that commercialised compared to respondents that are non-commercialised.

Overall, this result indicate that agricultural commercialisation helps respondents in the study area to become more resilient to vulnerability to food insecurity. This may be due to the fact that improved income associated with agricultural commercialisation enables respondents' access to uninterrupted inflow of food which reduces their vulnerability.

Table 7: Average Expected Respondents' Vulnerability Outcome

Types of Respondent	Decision stage		Treatment Effect
	To Commercialize	Non-commercialized	
Commercialized (N=269)	0.386 (a)	0.484 (d)	TT = 0.098***
Non-commercialized (N=151)	0.475 (c)	0.642 (b)	TU = 0.167***
Heterogeneity effects	-0.089***	-0.158***	TH = 0.069***

Note: Significance level: *** at 1%

Source: Author's computation from field survey 2018

Conclusion

The objective of this study was to examine the effects of agricultural commercialization on rice farmers' vulnerability to food insecurity in Ekiti state, Nigeria. The samples for the study were segmented into commercialized sample (64%) and non-commercialized sample (36%).

From the study findings, 40.5% of the sample that commercialized were vulnerable to food insecurity while 68.2% of the sample that non-commercialize experienced vulnerability to food insecurity. The result of the vulnerability analysis further showed that commercialized and non-commercialized have vulnerability to food insecurity probabilities of 46% and 65% respectively.

According to the results of the ESR, factors such as the age of the respondents, adult equivalent, contact with extension workers, savings, and sex of the respondents were statistically significant in relation to vulnerability to food insecurity in the study area, regardless of the commercialization status of the respondents. Based on the significance and the direction (sign) of influence of the aforementioned factors, these results implied that aged/older and large-sized adult-equivalent respondents tends to be vulnerable to food insecurity. But in contrast, respondents who had contact with extension workers, had savings and who are males tended to be less vulnerable to food insecurity. Furthermore, the ESR analysis also showed the results that are status specific. For respondents that commercialized, factors such as dependency ratio, credit obtained by the respondents and trust in grain traders exclusively influenced their vulnerability to food insecurity. By implication, commercialized respondents who had more members of his/her households not working, tended to be more vulnerable. Nonetheless, commercialized respondents who obtained credit, and had trust in grain traders tended to be less vulnerable to food insecurity. But for non-commercialized respondents, the result implied that respondents whose livestock value is high in terms of monetary worth tended to be less vulnerable to food insecurity. The ESR results also showed that while respondents that commercialized would have been 20.3% more vulnerable to food insecurity had they not commercialized, the non-commercialized households would have been about 26% less vulnerable to food insecurity if they had commercialized.

Based on the results, respondents that commercialized were less vulnerable to food insecurity in the study area. This study revealed several factors that were either pro-vulnerability or anti-vulnerability to food insecurity. These factors should form the basis for initiating or strengthening (as the case may be) policies towards vulnerability reduction and right targeting of households for possible intervention. As the findings showed that older respondents were more vulnerable to food insecurity, this calls for the attention of the government to ensure that the senior citizens in agriculture and other activities should particularly be targeted in its cash transfer programme. In the case of the large-sized adult-equivalent (proxy for household size), government and non-governmental organizations have a role to play by intensifying campaigns on family planning and other family reproductive initiatives.

Moreso, the study suggests that government and other relevant stakeholders should strengthen the extension workers to be able to reach out to the farmers, especially those in remote farms scattered all over the study area. This will enable the farmers to benefit from packages such as trainings, improved production technologies and access to information in terms of both better input and output markets. Also, the significance of credit obtained as shown in the results of this study points to the need for government and non-governmental organizations to strengthen the existing credit policies or institutions to deliver by responding to the credit needs of the farmers promptly and appropriately so that they can take on agricultural commercialization and become less vulnerable to food insecurity.

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