Org. Agr. (2023) 13:351–366
https://doi.org/10.1007/s13165-023-00431-8

A triple hurdle model of organic vegetable awareness, adoption, and production among smallholder farmers in Ekiti and Oyo states of Nigeria

L. C. Familusi · A. Edriss · M. A. R. Phiri · J. Kazembe · A. O. Onoja

Received: 18 February 2022 / Accepted: 31 March 2023 / Published online: 1 May 2023

Abstract Organicagriculture is still in its early development stage in Nigeria. As a result, its awareness and participation are still in development. Hence, the study identified factors influencing awareness, adoption, and quantity produced of organic green leafy vegetables, tomatoes, and peppers in Ekiti and Oyo states of Nigeria. A multistage sampling technique was employed to sample 384 vegetable farmers. Primary data was collected using a structured survey questionnaire instrument. The data was analysed using the triple hurdle model, which consists of three stages of decision-making. Probit was used to model the first and second stages of the triple hurdle for awareness and adoption, respectively. The third stage for adoption intensity was modelled using log–log multiple regression. According to the findings, farmers who were members of cooperatives and received extension services were more likely to be aware of and adopt organic vegetables. However, the use of radio was lowly used to promote organic agricultural awareness. On the other hand, the amount of labour used, and total revenue increased the quantity of organic vegetables produced. As a result, we conclude that the use of extension agents was pivotal in engineering the development of organic farming in Nigeria. Therefore, establishing an organic information hub would be an appropriate strategy for increasing awareness, adoption, and intensity in organic green leafy vegetable, tomato, and pepper production. This would help foster extension activities, and information transfer, as well as connect producers with buyers.

Keywords Adoption · Organic agriculture · Triple hurdle model · Vegetable production

L. C. Familusi (✉) · A. Edriss · M. A. R. Phiri · J. Kazembe
Lilongwe University of Agriculture and Natural Resources, Bunda College Campus, P.O. Box 219, Lilongwe, Malawi
e-mail: linda.familusi@uniport.edu.ng

A. O. Onoja
University of South Africa, Science Campus, Corner of Christiaan de Wet Road & Pioneer Avenue, Florida, 1709 Johannesburg, South Africa

Introduction

Agriculture contributes around 24% of Nigeria's gross domestic product (GDP) in 2021, with crop production accounting for the majority (91%) (National Bureau of Statistics (NBS) 2022). Nigeria is a significant vegetable-growing country in Africa and globally (Willer and Lernoud 2019; Plaisier et al. 2019), ranking second in African tomato production and fourteenth in the world (Onabu 2022). Vegetable crops are a good source of essential and micronutrients for human body building and tissue repairs (Oluwasusi 2014; Ibeawuchi et al. 2015a) and include a wide range of crops comprising tomato (*Solanum lycopersicum*), pepper (*Capsicum annuum*), pumpkin (Telfariria *occidentalis*), *Amaranthus* spp., okra

(*Abelmoschus escuentus*), and jute (*Corchorus olitorius*). According to Ibeawuchi et al. (2015a), the value of vegetable production is high and can thus be used as a strategy to alleviate poverty and improve food security among farmers. This implies that vegetable farming is an income-generating activity that can be carried out on a small, medium, or large scale. Small-scale vegetable farmers in Nigeria are those who grow their crops on less than or slightly more than 1 hectare of land and mostly practice conventional farming (Aderemi 2017). However, these vegetable producers are frequently confronted with the issue of low production technology (Oluwasusi 2014; Ibeawuchi et al. 2015a). Because of this, there is a need to look into alternative ways to farm, such as organic agriculture.

However, organic agriculture in Nigeria is still in its early stages of development (Mgbenka et al. 2015). As a result, farmers' awareness and participation in organic vegetable farming are low when compared to their conventional[1] agricultural counterpart, which is well established and widely practiced by farmers (Atoma et al. 2019). Organic agriculture is a method of farming that fosters soil health and maintains the ecosystem, biological processes, and biodiversity (International Federation of Organic Agriculture Movements (IFOAM) (2007)). In other words, organic farming relies on natural processes, biodiversity, and biological cycles, thereby ensuring sustainability in the whole system (Ibeawuchi et al. 2015b; Oyedele et al. 2018). It also implies the application of both traditional and scientific knowledge in farming in a way that creates a balance between nature and farming activities (International Federation of Organic Agriculture Movements (IFOAM) 2007; Alawode and Abegunde 2015). Hence, organic farming includes the following practices: crop rotation, mixed cropping, cover cropping, the use of green manures, compost, organic fertilizers, natural pesticides (e.g. soybean oil, neem), wood ash, peat moss, seaweed, and the presence of natural enemies for pest control (Mgbenka et al. 2015).

Organic farming provides multifunctional benefits as it plays a vital role in economic, environmental, and social functions (Atoma et al. 2019). These functions include the use of organic farming as a source of livelihood for farmers, combating climate change, environmental and health improvement, marketing opportunity creation, and numerous benefits (IFOAM 2007). Despite the numerous importance of organic farming, its land area remains small and comprises around 1.4% of the world's agricultural land (Willer et al. 2019) even though it experienced about 1.6% growth globally (Willer et al. 2021). Specifically, the total agricultural land area in Nigeria is approximately 71 million hectares (Food and Agriculture Organization of the United Nations (FAO) (2022)). However, only about 0.075% is used for organic crop farming and about 0.00020% for organic vegetable production (Willer and Lernoud 2019). This implies that the adoption of organic vegetable farming (OVF) in Nigeria is low.

Given the limited studies on the factors that affect farmers' decisions to adopt OVF and on the quantity of organic vegetables to produce, the study thus identified the factors influencing farmers' awareness of organic farming and their decision to adopt OVF, as well as their decision on the intensity (quantity) of organic green leafy vegetable (GLV), tomato, and pepper to grow. Therefore, the study adds to existing knowledge and literature on the factors that could improve farmers' awareness of organic farming as well as motivate conventional farmers (CFs) to adopt OVF while intensifying its production. In addition, the adoption of organic vegetable farming is critical to achieving the African Union's Malabo June 2014 declaration on improving food security, ending hunger, halving poverty, and enhancing resilience in African production systems by 2025 (Sez 2017). This study is also important for achieving the United Nations' Sustainable Development Goals (SDGs) 2 and 12, which stand for zero hunger and responsible consumption and production, respectively (Willer and Lernoud 2019).

Methodology

Nigeria is located in West Africa (9° 4′N 7° 29′E) having borders with Benin, Chad, Cameroon, and Niger. Nigeria is made up of 36 states and a Federal Capital Territory — Abuja. Nigeria is also divided

[1] Conventional farming (CF) involves the use of inorganic fertilizers and agrochemicals like pesticides, artificial hormones, nematicides, herbicides, antibiotics, fungicides, insecticides, vaccines, and genetically modified organisms for crop production (Dipeolu et al. 2009; Kutama et al. 2013).

into six geopolitical zones according to their cultural similarities, shared history, close territories, and agricultural background (Abdallah et al. 2017). Based on this, Ekiti and Oyo states were chosen purposively for the study area because of their concentration of organic vegetable farmers and organic vegetable farmer associations. The two states are both located in the South-West geopolitical region of Nigeria. The map of Ekiti and Oyo states showing the local government areas (LGAs) sampled are shown in Fig. 1.

Vegetable farmers registered and certified under the Agricultural Development Programme, Ekiti State; Justice Development and Peace Initiative (JDPI), Ekiti State; Farmers Development Union (FADU), Ibadan; and Association of Organic Agriculture Practitioners of Nigeria (NOAN) comprised the sample. The study adopted the multi-stage sampling technique by stratifying based on the LGA. Farmers in each LGA were classified as organic or conventional vegetable farmer. Vegetable farmers were chosen at random from each group and a total of 384 farmers were sampled according to Cochran's sample size calculator for unknown population (Edriss 2019). Therefore, the sample size n_0 is:

$$n_0 = \frac{Z^2 p(1-p)}{e^2} = \frac{(1.92)^2(0.5)(1-0.5)}{(0.05)^2} = 384.16$$

where z is the z-value with respect to the desired degree of confidence (95%), p is the population proportion estimate (0.5), and e is the margin (0.05) of error in estimating p. As a result, the sample size is made up of 165 (43%) small-scale organic vegetable farmers and 219 (57%) small-scale conventional vegetable farmers. The sample size is made up of 231 (60%) farmers from Ekiti state and 153 (40%) farmers from Oyo state. Furthermore, the primary data collection instrument was a survey questionnaire. The data collected was estimated using the triple hurdle model as proposed by Burke et al. (2015) in order to understand some of the socioeconomic and institutional factors that could influence farmers' decision to participate in organic GLV, tomato, and pepper farming.

Triple hurdle model

To determine the respondents' decision-making levels, hurdle models are used. The most common of these hurdle models is the double hurdle model as proposed by Cragg (1971) and Heckman (1979). The triple hurdle model expands on the double hurdle model by including a third decision-making stage. The triple hurdle model is a pioneer work of Burke et al. (2015) and was used to determine the factors that influenced dairy farmers' production decisions, participation decisions, and the intensity of participation in the dairy market. Burke et al. (2015) incorporated the aforementioned hurdles into a single model, hence the name triple hurdle model. Traditionally, the double hurdle model was used to model both the decision to participate and the intensity of participation (Cragg 1971; Barrett 2008). However, researchers have recently expanded the model to a triple hurdle model (Burke et al. 2015; Jiang and House 2017; Gebremedhin et al. 2017; Tabe-Ojong et al. 2018; Kondo et al. 2019).

The first and second stages of the triple hurdle model analysed probabilities whereas the third stage analysed actual values. The first and second stages were modelled using the Probit model as adopted by Burke et al. (2015), Gebremedhin et al. (2017), and Tabe-Ojong et al. (2018), while the third stage was modelled using log–log multiple regression. The Probit model is a binary outcome model with dichotomous dependent variables. The errors are normally distributed with a zero mean and constant variance (Eq. 1).

$$Y^* = X\beta + \varepsilon, \varepsilon \sim N\left(0, \sigma^2\right) \tag{1}$$

where X represents the explanatory variables, β represents the parameter estimates, and ε is the error term. Y^* is the dependent variable. Y^* is observed only when Y_i takes the value of either 0 or 1 : $Y_i = \begin{cases} 0 \; if \; Y_i^* \leq 0 \\ 1 \; if \; Y_i^* > 0 \end{cases}$

Such that when Y_i takes the value of 1, the equation is estimated as $Y_i' > 0 \Rightarrow \beta' X_i + \varepsilon_i > 0 \Rightarrow \varepsilon_i > -\beta' X_i$. Hence, its probability is $Pr\left(Y_i^* > 0|X_i|\right) = Pr\left(Y_i = 1|X_i|\right) = Pr\left(\varepsilon_i > -\beta' X_i\right) = Pr\left(\frac{\varepsilon_i}{\sigma} > \frac{-\beta' X_i}{\sigma}\right) = \varphi\left(\frac{-\beta' X_i}{\sigma}\right)$.

Similarly, the probability of Y_i when it takes the value 0 is $\Pr\left(Y_i = 0|X_i|\right) = 1 - \varphi\left(\frac{-\beta' X_i}{\sigma}\right)$.

In the present study, the triple hurdle model was used to determine the factors influencing vegetable farmers' awareness of organic farming; their decision to participate in organic GLV, tomato, and pepper production; and the quantity of organic GLV, tomato, and pepper produced. As specified in Eqs. 2, 3, and 4, this is modelled in three stages:

$$1^{st}\text{ stage (Awareness)}: y_i^{a*} = \propto_1 W_1 + \propto_2 W_2 + \cdots + \propto_{13} W_{13} + \varepsilon \quad (2)$$

The awareness variable y_i^{a*} is only observed when y_i^a takes the value 1: $y_i^a = \begin{cases} 1 \; if \; y_i^{a*} > 0 \\ 0 \; otherwise \end{cases}$

$$2^{nd}\text{ stage (Adoption)}: y_i^{p*} = \gamma_1 X_1 + \gamma_2 X_2 + \cdots + \gamma_{14} X_{14} + \in \quad (3)$$

The adoption variable y_i^{p*} is only observed when y_i^p takes the value 1: $y_i^p = \begin{cases} 1 \; if \; y_i^{p*} > 0 \; and \; y_i^{a*} = 1 \\ 0 \quad otherwise \end{cases}$

$$3^{rd}\text{ stage (Production)}: y_i^{*} = \beta_1 Z_1 + \beta_2 Z_2 + \cdots + \beta_6 Z_6 + \mu \quad (4)$$

The production output variable Y_i^* is only observed for positive Y_i values: $Y_i = \begin{cases} Y_i^* \; if \; Y_i^* > 0 \; and \; y_i^{p*} = 1 \\ 0 \quad otherwise \end{cases}$ where $i = 1, 2, 3, \ldots, 384$ vegetable farmers

Equations 2, 3, and 4 represent the farmers' awareness to organic farming methods, participation in organic farming, and the intensity of participation models respectively. y_i^{a*}, y_i^{p*}, and Y_i^* are latent variables which represent the probability of farmers awareness, participation, and the intensity of participation in organic farming respectively.y_i^{a*} and y_i^{p*} are binary variables with values 1 for farmers who are aware of organic farming and adopt OVF, respectively, and zero if otherwise. Y_i^* is a continuous variable, which is conditioned on farmers having positive sales and also conditioned on farmers being an adopter. y_i^{a*}, y_i^{p*} and Y_i^* are only observed when these conditions are met. The Ws, Xs, and the Zs represent the explanatory variables for each model. The choice of explanatory variables used for each stage was based on theory and literature reviewed as shown in Table 5. The $\propto' s$, $\gamma' s$, and$\beta' s$ represent the parameters to be estimated. The error terms are represented by ε, ϵ, and μ for each model respectively.

The error terms (ε, ϵ, and μ) are assumed to be uncorrelated (Burke et al. 2015). Hence, the null hypothesis that the inverse Mills ratio (IMR) is not different from zero is tested. This is tested to ensure that the parameter estimates are unbiased. The IMR is predicted from the first equation and included in the second equation. If the IMR coefficient is not significant, the IMR variable is excluded from the second model and the second model re-estimated without the IMR variable. This implies that the error terms are uncorrelated (i.e. we fail to reject the null hypothesis) and thus the model coefficients are unbiased and efficient. However, if the error terms on both equations are correlated (i.e. reject the null hypothesis), robust standard error is used to correct for the significant inverse Mills ratio coefficients and the IMR is included in the model. A similar test is done for the third stage as IMR is predicted from the second stage and included in the third equation. The IMR is tested for significance and correction is applied if required.

Furthermore, given that the Probit model is nonlinear and the coefficient estimates are not slopes, average marginal effect (AME) was therefore estimated. AME measures the effect a unit change in the explanatory variables (Ws and Xs) would have on the dependent variables (y_i^{a*} and y_i^{p*}) of the Probit models (stages 1 and 2). The AMEs for stages 1 and 2 are shown in Eqs. 5 and 6, respectively, according to Edriss (2019):

$$\text{AME} = \frac{1}{n}\sum_{i=1}^{n} \propto_i \frac{W_i}{\widehat{y_i^{a*}}} = \frac{1}{n}\sum_{i=1}^{n} \propto_i \left(\frac{W_i}{\propto_1 W_1 + \propto_2 W_2 + \cdots + \propto_{13} W_{13}} \right) \quad (5)$$

$$\text{AME} = \frac{1}{n}\sum_{i=1}^{n} \gamma_i \frac{X_i}{\widehat{y_i^{p*}}} = \frac{1}{n}\sum_{i=1}^{n} \gamma_i \left(\frac{X_i}{\gamma_1 X_1 + \gamma_2 X_2 + \cdots + \gamma_{14} X_{14}} \right) \quad (6)$$

The Probit models were estimated using the maximum likelihood (ML) method while the log–log regression was estimated using the ordinary least square (OLS) method.

Results and discussions

The results for the test for the difference in the socioeconomic characteristics of organic and conventional farmers are shown in Table 1. The socioeconomic characteristics of the sampled organic and conventional vegetable farmers show that they were mostly male (64.38%) and married (92.33%) and were members (37.33%) of a cooperative society (Table 1).

They also possessed an average of 10 years of schooling and 12 years of vegetable farming experience on less than 1 hectare of land (Table 1). In addition, the difference in age (3 years) between OFs (49 years) and CFs (46 years) was statistically significant ($p = 0.0225 < 0.05$), implying that OFs are older than their conventional counterparts (Table 1). As a result, these older OFs may require a more sustainable farming method, such as organic farming. This was consistent with the findings of Sodjinou et al. (2015) and Meemken et al. (2017).

Furthermore, the CF group had larger household size (7) relatively ($p = 0.0213 < 0.05$) to OFs (6) as shown in Table 1. This could imply that households with smaller family sizes enjoy better wellbeing[2] than households with larger family sizes, *ceteris paribus*. This agreed with the findings of Ayuya et al. (2015), who reported that households with larger family members were relatively poorer. The findings also showed that vegetable farmers received extension services (80%), were members of farmer associations (79%), and had access to farm credit (9%). However, access to farm credit was generally very low, despite a relatively higher percentage for OFs (8%). This was similar to the findings of Adesope et al. (2012), who identified limited access to credit as a constraining factor to farmer's adoption decision.

Table 1 also indicates that the household head made the majority of the farm decisions (56.1%) for both organic (24%) and conventional farmers (32%). This proportion was, however, statistically higher for CFs ($p = 0.044 < 0.05$). This was in line with the findings of Adebiyi et al. (2020), who found that household heads were regarded as the household's decision-making authority. As a result, the study concluded that the decision-making factor of the household head was crucial to the adoption of organic farming. All organic farmers (43%) were aware of organic farming practices. However, only about 18% of conventional farmers were familiar with organic farming methods. This implies low awareness as information on organic farming practices was not properly disseminated to the majority of the farmers in the study area. This was in concordance with the findings of Atoma et al. (2019) who reported a low level of awareness about organic farming techniques.

Furthermore, the average amount of green leafy vegetables produced by farmers was 1661 kg. However, the average production level of conventional tomatoes (2663 kg) and peppers (2586 kg) was higher than that of organic tomato (1150 kg) and pepper (1309 kg). This implies that the conventional farming method produced more than the organic farming method. This was in agreement with the findings of Durham and Mizik (2021) and Ogunmola et al. (2021), who reported that organic agriculture produces less than conventional agriculture. The use of inorganic fertilisers, pesticides, growth enhancers, and other agrochemicals by CFs results in a difference in production. These, however, have environmental, health, and economic consequences. In addition, the average price for 1 kg of organic GLV (USD0.75),[3] tomatoes (USD1.37), and pepper (USD1.38) was significantly higher than their CF counterparts (USD0.48, USD0.84, and USD0.68, respectively). This implies that OFs received a premium price for their organic products. This was in conformity with the findings of Azam and Shaheen (2019) and Durham and Mizik (2021), who noted that farmers expect a higher price for their organic products. The outcome of this result was expected as the price advantage for organic products is supposed to offset the lower production quantities from organic farming.

The results show no significant difference between organic and conventional vegetable farmers with respect to their monthly consumption expenditures as well as their monthly off-farm income from other agricultural and non-agricultural activities. Therefore, there was no significant difference between the monthly consumption expenditures of conventional (USD363) and organic households (USD337). This was consistent with the findings of Uematsu and Mishra (2012). In addition, there was no significant difference between the monthly off-farm income of organic (USD466) and conventional households (USD453). This was in accordance with Kisaka-Lwayo and Obi's (2014) findings that off-farm

[2] Wellbeing is multidimensional in nature encompassing different aspects like economic, psychological, and social wellbeing among others (Anand, 2016). This study focused on economic wellbeing which has different determinants as household income, consumption expenditure, and wealth.

[3] Using NGN380 to USD1 as at October, 2020 (https://www.cbn.gov.ng/rates/exrate.asp?year=2020).

income contributes to farm wages and other payments. Lastly, approximately 83% of organic (33%) and conventional (50%) households own a radio while approximately 92% of organic (39%) and conventional (53%) households own a phone. The use of these multimedia and social media devices was paramount to the adoption process. As a result, the use of communication media may have a positive impact on farmers' decision to move to organic farming (Sudheer 2013).

Triple hurdle model estimation results

The results for the triple hurdle model are shown in Tables 2, 3, and 4. Table 2 is the first stage of the triple hurdle model showing the factors influencing farmers' awareness to organic farming methods. The second (Table 3) and third (Table 4) show the factors affecting the decision of farmers to participate in the production of organic vegetables and the quantity of organic vegetables produced, respectively. The results in Table 2 show that the probability of farmers' awareness of organic farming practices increased with farmers' being a member of a cooperative society and the number of extension visits. However, households who were married and possessed a radio set reduced the probability of gaining awareness of organic farming.

In addition, an increase in the age and farming experience of pepper and GLV farmers, respectively, by 1 year increased their probability of awareness by 0.6% each ($p < 0.10$) (Table 2). The implication is that as farmers advance in age and increase in experience, they acquire relevant knowledge and skills on farming methods which could improve their farm produce, efficiency and profitability. This was in agreement with the findings of Ado et al. (2018), who reported that farming experience increases farmers odds of awareness. Hence, age and farming experience play an important role to determine the level of exposure of farmers to innovations.

Further results show that being married negatively influenced the probability of GLV and tomato farmers' awareness of organic farming by 27.1% and 37.9% ($p = 0.000 < 0.01$) respectively. This suggests that married farmers were less knowledgeable about on the best agronomic practices and farm management techniques than their single counterparts. The results also indicated that an increase in household size and year of schooling of pepper farmers significantly influenced farmers' awareness of organic farming positively by 2.9% and 1.5% ($p = < 0.10$), respectively. The result was consistent with the findings of Ado et al. (2018) who also reported a positive relationship between household size and year of education for farmers' awareness.

Subsequently, the higher the number of extension visits to farmers, the more aware farmers were of organic farming methods (Table 2). This was in agreement with Adebiyi et al. (2020) who also reported that the use of extension services promotes the awareness of organic farming. This implies that the role of extension agents was indispensable to the development and increased awareness of organic farming among small-scale farmers. The results (Table 2) also show that farmers' awareness of organic farming increased for those that belong to a cooperative society and association ($p = 0.000 < 0.01$). This suggests that farmers who belong to a cooperatives and associations were more informed about current agronomic practices and farming innovations. This was in line with the findings of Jatto (2019) who reported a positive relationship between membership of a cooperative and awareness and thus implied that cooperatives provided farmers with practical activities to improve their awareness and decision-making process.

However, the probability of awareness of organic farming decreased for farmers that own a radio and a phone. This implies that information on organic farming and its methods was not adequately communicated on radio channels and social media. This was similar to the findings of Oyewole et al. (2014) and Mgbenka et al. (2015). According to Oyewole et al. (2014), the coverage of organic agricultural news was low, while Mgbenka et al. (2015) suggested that the awareness of organic farming could increase if information on organic farming activities were made available.

The results for the factors affecting farmers' decision to participate in organic vegetable farming are shown in Table 3. The results show the AME estimation for the second stage triple hurdle model estimated using Probit. From the results, a negative relationship between household size and organic GLV and tomato farming participation was noted (Table 3). Hence, household size decreased the probability of farmers adopting in organic GLV and tomato farming by 4.8% ($p < 0.01$) and 2.6% ($p < 0.10$) respectively.

This implies that households with large family size were less probable to adopt organic vegetable farming. This could be because organic vegetable farming produces less than their conventional counterparts (Table 1), so they would not be enough to meet with family demand for food and for commercial purpose. In addition, an increase in the years of educational attainment decreased the probability of small-scale farmers participating in organic tomato farming by 2.3% ($p<0.01$) as shown in Table 3. The implication of this is that less educated small-scale farmers are more probable to adopt organic tomato farming than more educated farmers. This result was contrary to a priori expectation and is similar to the findings of Sodjinou et al. (2015). Therefore, strategies to improve the participation of small-scale farmers in organic tomato farming should target this group of farmers.

The result further shows that membership in a cooperative society increased the probability of farmers participating in organic GLV farming (Table 3). This suggests that cooperative societies play a role in the dissemination of information on better farming methods as well as the provision of shared resources and support to farmers. This was similar to the findings of Ayuya et al. (2015), who reported in their study that the increment in farmers' means of receiving information is important in order to influence their knowledge, thinking process, and attitude. The household decision-making process for the farmers' family was considered for this model because it was important to determine who makes most of farming decisions. Hence, joint farming decisions increased the probability for the adoption of organic GLV and pepper farming by 11.9% ($p<0.10$) and 13.8% ($p<0.10$) respectively (Table 3). This implies that households where members other than the household head solely made farming decisions are likely to adopt organic farming.

Furthermore, extension visits were shown to increase the probability of participating in organic GLV, tomato, and pepper farming (Table 3). The implication of this result is that extension services to farmers were vital to raise the engagement of small-scale farmers in organic farming in the study area. This concurred with the findings of Sodjinou et al. (2015) and Adebiyi et al. (2020). They indicated that organic farmers need constant interactions with extension agents given that organic farming is a knowledge-intensive venture (Sodjinou et al. 2015). Increased access to extension services is also argued to have resulted in increased adoption of organic farming in Nigeria (Adebiyi et al. 2020).

In addition, results in Table 3 also indicate that households with formal jobs increased the probability of growing organic tomato and pepper by 18.7% ($p=0.000<0.01$) and 19.0% ($p=0.000<0.01$) respectively and agreed with the findings of Adebiyi et al. (2020). This indicates that income from such jobs could be used to sustain farmers especially during the initial stage of converting farmlands to organic farms. With respect to total land size, 1-hectare increase in the farmers' land area increased the probability of growing organic tomato on average by 3.1% ($p<0.10$) (Table 3) and was similar with the findings of Wu et al. (2010) and Wordofa et al. (2021). This suggests that farmers with bigger land size would probably be more willing to engage in transitional production.

The result for factors influencing organic vegetable output is shown in Table 4. The outcome from the diagnostic tests showed no evidence of multicollinearity (mean variance inflation factor = 1.26, 1.19, and 1.38) and heteroskedasticity (Prob > $chi^2=0.1901$, 0.5648, and 0.3639) for GLV, tomato, and pepper models, respectively. In addition, the inverse Mills ratio predicted from the second equation of the triple hurdle model was not significant for the GLV and tomato model, so it was excluded for data analysis. However, the robust standard error was estimated and used to correct for the significant inverse Mills ratio coefficient in the pepper model. Hence, the result indicates that the amount of land, labour, and seed used significantly increased vegetable production (Table 4). This means that 1% increase in the size of land used (in ha) would increase the quantities of organic GLV produced by 0.778%. This suggests that the responsiveness of vegetable output to a change in land size is high. Hence, an expansion of the land used for vegetable farming leads to a positive marginal effect. This was in line with the findings of Onoja (2010).

On the other hand, labour significantly increased the output of organic tomato and pepper. The practice of organic farming is labour-demanding and intensive (Mgbenka et al. 2015). As a result, 1% increase in the amount of labour per person-day would lead to 0.505 and 1.132% of organic tomato and pepper produced, respectively. This implies that the more the supply of family or/and hired labour, the better the execution of vegetable farming activities, thereby improving on farm output. The result was in agreement with the findings of Abele and Tefera (2015), which reported that farmers having available labour will be in the disposition to continue in the present profitable enterprise and would be able to adopt other profitable innovations.

Furthermore, increasing the amount of seeds used by 1 kg increased the organic GLV and pepper produced by 0.274 and 0.305%, respectively (Table 4). This implies that the quantity of seed used is crucial in the number of vegetables produced. This result was consistent with the findings of Abele and Tefera (2015) and Dhakal (2020). However, the result for the application of farm manure and organic fertilizers unexpectedly decreased the production of organic pepper and tomato by 1.640 and 0.413%, respectively. Likewise, organic vegetable output is positively influenced by the total revenue acquired from vegetable sales (Table 4). Therefore, 1% (one percent) increase in total revenue of GLV, tomato, and pepper farming increased production output by 0.542, 0.483, and 0.430% ($p < 0.01$), respectively. Therefore, the higher the total revenue realized, the greater the intensity of participation in organic vegetable production (Alawode and Abegunde 2015).

Conclusion

The study determined the factors that influenced farmers' awareness, adoption, and production of organic leafy vegetables, tomatoes, and peppers. The study concludes that the awareness of organic vegetable farming is low in Ekiti and Oyo states. However, extension agents are critical in increasing farmers' awareness as well as their engagement in organic GLV, tomato, and pepper farming. These agents provide farmers with pertinent information on organic farming practices and principles, as well as support and advisory services for optimum farm productivity. In addition, single farmers are more aware of organic farming practices and are better prepared with knowledge and information on organic vegetable farming as a result of their membership in cooperative societies. Regarding how information about organic farming was disseminated, multimedia channels (such as radio stations) were underutilized, thus resulting in low awareness of organic farming techniques. The study also concludes that labour is an important factor in organic vegetable farming, which should be considered in the decision to adopt and expand organic vegetable production. In addition, higher returns generated from organic vegetable farming intensify its participation. Thus, an appropriate strategy to raise awareness, adoption, and intensity in organic vegetable production in the research area would be to augment extension services through a series of awareness programs and training activities aimed at small-scale vegetable producers.

As a result, some beneficial recommendations would be to strengthen the knowledge of and participation in organic vegetable cultivation. The dissemination of information, news, and advertisements about organic farming should be accelerated via multimedia channels. Organic farming cooperatives and extension agents can assist in improving the flow of information to vegetable producers, particularly among married farmers. Additionally, the government should create an enabling environment for organic agriculture in the country by establishing an organic information hub. The information centre can assist in increasing public awareness, interest, and adoption of organic farming as well as linking producers to buyers. If this is accomplished, it will be easier to establish a suitable and standardized price for organic products. Lastly, small-scale farmers should be encouraged to engage in organic farming, as organic vegetable produce can command a premium price, compensating for reduced production volumes and hence higher earnings. A more practical action would be for small-scale vegetable farmers to incorporate organic farming through the participatory guarantee systems (PGS) (also known as second party certification[4]), which would ensure that all organic standards and principles are enforced. The study's findings were based on aggregated data from smallholder vegetable farmers in Ekiti and Oyo states. Further research can concentrate on disaggregating the data on each state and comparing them further to ascertain their similarities and differences.

[4] The second-party certification or PGS is the certification of small-scale farmers usually grouped together to ensure that members comply with all organic farming principles.

Appendix

Table 1 Distribution of organic and conventional farmers by socioeconomic characteristics

Variables	CFs	OFs	***P*-value**
Sex: Female (%) Male (%)	20.84 36.68	14.78 27.70	0.770
Marital status: Married (%) Single (%)	54.50 3.17	37.83 4.50	0.126
Age (mean)	46.43	49.41	0.0225**
Household size (mean)	6.53	5.86	0.0213**
Years of education (mean)	9.85	9.49	0.4903
Vegetable farming experience (mean)	11.58	12.62	0.3237
Vegetable farm size (mean)	0.90	0.79	0.5437
Received extension visit (%):	43.23	36.72	0.019**
Membership to an association (%)	40.89	38.54	0.000***
Membership to cooperative society (%)	19.78	17.55	0.224
Access to credit (%)	1.88	7.50	0.000***
Household farm decision marker: Household head (%) Joint (%)	32.12 24.80	24.02 19.06	0.044**
Farmers awareness of organic farming (%)	19.79	42.97	0.000***
Mean quantity produced for GLV (kg)	1614.81	1727.53	0.9188
Mean quantity produced for tomato (kg)	2663.37	1149.93	0.0053***
Mean quantity produced for pepper (kg)	2585.78	1309.25	0.0792*
Mean price for GLV (USD/kg)	0.48	0.75	0.0220**
Mean price for tomato (USD/kg)	0.84	1.37	0.0553*
Mean price for pepper (USD/kg)	0.68	1.38	0.1028*
Mean monthly consumption expenditures (USD)	362.49	337.43	0.3909
Mean monthly off-farm income (USD)	453.42	466.13	0.9148
Asset owned: radio set (%)	50	33	0.001***
Asset owned: phone (%)	53	39	0.641

Source: field survey, 2021. *** represents 1%, ** represents 5%, * represents 10%

Table 2 Factors influencing farmers awareness of organic vegetable farming

Dependent variable = awareness	GLV		Tomatoes		Pepper	
	AME	*P*-value	AME	*P*-value	AME	*P*-value
Male	0.072	0.238	0.010	0.909	0.104	0.256
Age	0.003	0.353	0.004	0.260	0.006*	0.060
Married	−0.271***	0.000	−0.379***	0.000	−0.111	0.445
Household size	0.002	0.871	0.016	0.310	0.029*	0.069
Years of education	0.006	0.333	0.008	0.365	0.015*	0.092
Association membership	0.389***	0.000	0.097	0.302	−0.055	0.564
Cooperative membership	0.165***	0.006	0.319***	0.000	0.296***	0.001
Number of Extension visit	−0.009	0.367	0.058**	0.010	0.077***	0.004
Asset to radio	−0.223***	0.000	−0.274***	0.005	−0.342***	0.000
Asset to phone	−0.081	0.430	−0.127	0.281	−0.245**	0.029
Years of farming experience	0.006*	0.078	0.000	0.909	0.006	0.153
Price per kg	0.0004	0.544	0.0003	0.637	0.0002	0.629
Have electricity	0.077	0.250	0.045	0.625	−0.109	0.232
Likelihood ratio chi-square	61.11***	0.000	43.61***	0.000	47.43***	0.000
Log likelihood	−128.388		−80.500		−57.246	

Source: field survey, 2021. *** represents 1%, ** represents 5%, * represents 10%

Table 5 shows the reviewed literature in order to ascertain the relationship between the dependent and independent variables to aid model specification and data analysis. According to the literature, marital status had an effect on farmers' awareness of organic vegetable production, whereas household size has a substantial effect on participation decisions. Sex and age had both positive and negative implications on

Table 3 Factors affecting farmers participation in organic vegetable farming

Dependent variable = participation	GLV		Tomatoes		Pepper	
	AME	*P*-value	AME	*P*-value	AME	*P*-value
Male	0.023	0.740	−0.016	0.848	−0.068	0.438
Age	−0.004	0.172	−0.001	0.743	0.001	0.711
Household size	−0.048***	0.000	−0.026*	0.079	0.010	0.507
Years of education	−0.002	0.784	−0.023***	0.009	−0.002	0.816
Association (1 = yes, 0 = no)	−0.036	0.744	0.050	0.609	0.211	0.112
Married	−0.020	0.820	−0.098	0.257		
Cooperative (1 = yes, 0 = no)	0.163**	0.020	0.006	0.940	0.064	0.440
Joint farm decision-making	0.119*	0.058	0.033	0.688	0.138*	0.087
Number of extension visits	0.116***	0.000	0.087***	0.001	0.086**	0.014
Price per kg	0.000	0.286	0.000	0.704	0.000	0.490
Ln total consumption expenditure	−0.055	0.267	−0.035	0.562	0.028	0.596
Asset to radio (1 = yes, 0 = no)	−0.044	0.630	0.028	0.836	−0.097	0.235
Formal job (1 = yes, 0 = no)	0.065	0.357	0.187***	0.000	0.190***	0.000
Total land size	0.001	0.866	0.031*	0.078	−0.005**	0.032
Likelihood ratio chi-square	68.52***	0.000	44.72***	0.000	31.79***	0.003
Log likelihood	−68.719		−18.328		−17.494	

Source: field survey, 2021. *** represents 1%, ** represents 5%, * represents 10%

Table 4 Factors affecting organic vegetable production quantities

Dependent variable = Ln Organic Production output (kg)	GLV		Tomatoes		Pepper	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Ln land size	0.778**	0.014	0.503	0.218	−0.062	0.908
Ln labour	0.281	0.162	0.505*	0.080	1.132***	0.006
Ln seed quantity	0.274**	0.041	−0.127	0.956	0.305*	0.064
Ln manure quantity	0.117	0.254	−0.040	0.789	−1.640***	0.000
Ln organic fertilizer	−0.128	0.386	−0.413**	0.046		
Ln total revenue	0.542***	0.000	0.483***	0.000	0.430***	0.001
Inverse Mills ratio					0.777**	0.013
Constant	−1.534	0.016	−1.014	0.347	−2.483***	0.008
***R*-squared**	0.701		0.559		0.705	
Adjusted ***R*-squared**	0.683		0.514			
***P*-value**	0.000			0.000		0.000

Source: field survey, 2021. *** represents 1%, ** represents 5%, * represents 10%

farmers' organic farming adoption decisions. In addition, education, extension visits, and the size of the farm all have a significant effect on farmer awareness, adoption, and production. Cooperatives and association membership considerably enhance the awareness of farmers. Extension visits, on the other hand, positively influenced awareness and participation, whereas ownership of an asset decreased awareness levels but increased farmer participation characteristics. Furthermore, farmers' experience has a positive effect on the awareness and participation variables, while formal employment and access to credit have a significant effect on the participation variable. Literature shows that output price and access to credit had an effect on a farmer's decision to adopt. Input quantities such as land, labour, seeds, fertilizers, pesticides, and manure were all determinants of production, according to production theory and literature.

Table 6 indicates that organic vegetable farmers in Ekiti state (53 years) were older than farmers in Oyo state (44 years) on the average ($p = 0.0000 < 0.01$). The result suggests that the mean household size and years in education of organic vegetable farmers in Ekiti and Oyo states were 6 and 10 years, respectively ($p > 0.10$). The results in Table 6 also show that Oyo state organic farmers produced (2060 kg) higher quantities of GLV than that of Ekiti state (1284 kg) organic GLV farmers. However, the production level of Ekiti state organic tomato (1204 kg) and pepper (1394 kg) farmers was higher than that of Oyo organic tomato (436 kg) and pepper (120 kg) farmers. Although, the differences in the production outputs between the two states were not statistically significant ($p > 0.10$).

In addition, Table 6 indicates that the difference in the price per kilogram of organic tomato (USD1.37) and pepper (USD1.38) in Ekiti and Oyo states was not statistically significant. However, the price per kilogram of green leafy vegetables (USD1.18) was higher in Ekiti state as compared to Oyo (USD0.44) state ($p = 0.0018 < 0.01$). With respect to organic households' monthly income, the results show that Ekiti state organic farmers have higher income (USD156) relative to Oyo state (USD100) organic farmers ($p < 0.05$). This could imply that Ekiti state organic farming households have better wellbeing than that of Oyo state organic farming households with respect to their income. It is important to note that the study's findings were based on aggregated data from smallholder vegetable farmers in Ekiti and Oyo states. Further research can concentrate on disaggregating the data on each state and comparing them further to ascertain their similarities and differences.

Figure 1 shows the map of Ekiti and Oyo states.

Table 5 Explanatory variable selection according to literature

Explanatory variables	Awareness	Adoption	Production
Sex		Ayuya, et al. (2015) (−); Sodjinou, et al. (2015) (−); Wordofa et al. 2021 (+)	
Age		Ayuya, et al. (2015) (−); Sodjinou, et al. (2015) (+); Wordofa et al. 2021 (+)	
Marital status	Ado et al. (2018) (−)		
Household size		Sodjinou, et al. (2015) (+);Wordofa et al. 2021 (−)	
Education	Ado et al. (2018) (+)	Ayuya, et al. (2015) (+); Sodjinou, et al. (2015) (−); Wordofa et al. 2021 (+)	
Cooperative/association membership	Jatto (2019) (+)		
Extension visit	Adebiyi, et al. (2020) (+)	Ayuya, et al. (2015) (+); Sodjinou, et al. (2015) (+); Adebiyi, et al. (2020) (+)	
Assets like communication assets (radio, phone) and physical asset	Oyewole et al. (2014) (−) Mgbenka et al. (2015) (−)	Ayuya, et al. (2015) (+)	
Farm experience	Ado et al. (2018) (+)	Sodjinou, et al. (2015) (−)	
Price		Tabe-Ojong et al. (2018) (+)	
Formal job		Ayuya, et al. (2015) (+)	
Farm size	Ado et al. (2018) (+)	Ayuya, et al. (2015) (−); Sodjinou, et al. (2015) (−); Wordofa et al. 2021 (+)	Onoja (2010) (+); Ogunmola et al. (2021) (+), Kondo et al. 2019 (+); Gebremedhin et al. 2017 (−); Tabe-Ojong et al. (2018) (+);
Credit		Sodjinou, et al. (2015) (−); Wordofa et al. 2021 (+)	
Labour and seed			Onoja (2010) (+); Dhakal 2020 (+) Ogunmola et al. (2021) (+)
Fertilizer and manure			Onoja (2010) (+); Ogunmola et al. (2021) (+); Dhakal 2020 (+);

Source: literature reviewed

Table 6 Comparing some selected variables of organic vegetable farmers by state — Ekiti state and Oyo state

Variables	Ekiti Mean (standard deviation)	Oyo Mean (standard deviation)	Combined Mean (standard deviation)	Mean difference	***t***-value	***P***-value
Age (years)	53 (13)	44 (13)	49 (14)	9	4.2004	0.0000***
Household size	6 (3)	6 (2)	6 (3)	0.09	0.2063	0.8368
Years of education (years)	9 (5)	10 (6)	10 (5)	−0.72	−0.8978	0.3707
Quantity produced of organic green leafy vegetable (kg)	1284 (2166)	2060 (10,497)	1728 (8042)	−776	−0.5035	0.6156
Quantity produced of organic tomatoes (kg)	1204 (2032)	436 (601)	1150 (1973)	768	0.8375	0.4052
Quantity produced of organic pepper (kg)	1394 (4055)	120 (91)	1309(3929)	1274	0.6234	0.5354
Price per kg of organic green leafy vegetable (USD)	1.18 (1.83)	0.44 (0.24)	0.75 (1.25)	0.74	3.1979	0.0018***
Price per kg of organic tomatoes (USD)	1.40 (2)	0.87 (0.70)	1.37 (1.95)	0.53	0.5877	0.5586
Price per kg of organic pepper (USD)	1.43 (3.3)	0.69 (0.50)	1.38 (3.22)	0.74	0.4414	0.6606
Monthly income (USD)	156 (189)	100 (48)	134 (152)	56	2.3479	0.0201**

Source: field survey, 2021. *** represents 1%, ** represents 5%

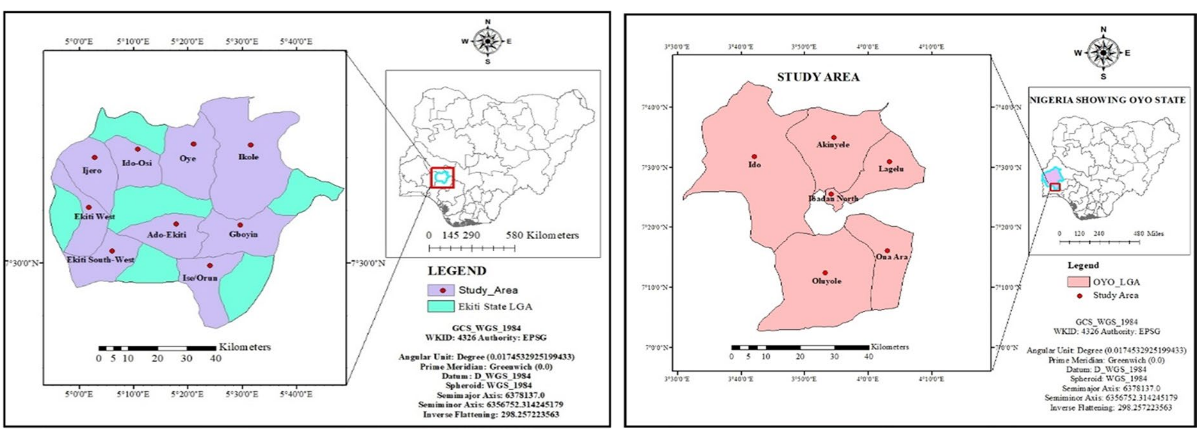

Fig. 1 Map of Ekiti and Oyo states showing the sampled LGAs in each state. Source: Map produced with Arc Geographic Information System (GIS) with data from https://data.humdata.org/m/dataset/nga-administrative-boundaries

Acknowledgements I thank the University of Port Harcourt (UNIPORT), World Bank Centre for Excellence UNIPORT, Lilongwe University of Agriculture and Natural Resources (LUANAR), and AQUAFISH LUANAR for their support during my PhD programme.

Funding This study was financially supported by the Carnegie Corporation of New York through the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM).

Data availability The datasets generated and analysed during the current study are available from the corresponding author on reasonable request

Declarations

Competing interests The authors declare no competing interests.

References

Abdallah NM, Jimoh A, Azu JC, Ibrahim YA, Oyew N (2017) Discordant tunes over 6 geo-political zones. Daily Trust. https://dailytrust.com/discordant-tunes-over-6-geopolitical-zones/. Accessed 24 April 2018

Abele W, Tefera T (2015) Factors affecting production and market supply of haricot bean in Southern Ethiopia. Journal of Economics and Sustainable Development 6(15):103-108. https://core.ac.uk/download/pdf/234647183.pdf. Accessed 26 June 2021

Adebiyi JA, Olabisi LS, Richardson R, Liverpool-Tasie LS, Delate K (2020) Drivers and constraints to the adoption of organic leafy vegetable production in Nigeria: a livelihood approach. Sustainability 12:1–21. https://doi.org/10.3390/su12010096

Aderemi K (2017) Agriculture: Southwest Nigeria & investment opportunities. AfroMidlands Trade Investment Summit & Exhibition. https://www.linkedin.com/pulse/agriculture-southwest-nigeriainvestment-kunle-aderemi/. Accessed 20 Jan 2022

Adesope OM, Matthews-Njoku EC, Oguzor NS, Ugwuja VC (2012) Effect of socio-economic characteristics of farmers on their adoption of organic farming practices. In: Peeyush S, Abrol PS (eds) Crop Production Technologies. Intech, London, pp 211–220. https://doi.org/10.5772/30712

Ado AM, Leshan J, Savadogo P et al (2018) Farmers' awareness and perception of climate change impacts: case study of Aguie district in Niger. Environ Dev Sustain. https://doi.org/10.1007/s10668-018-0173-4Accessed29November2021

Alawode OO, Abegunde VO (2015) Economic costs and returns from organic farming in Oyo state, Nigeria. J Org Syst 10:15–25

Anand P (2016) Happiness, well-being and human development: the case for subjective measures. Human Development Report background paper, 2016. United Nations Development Programme (UNDP), New York, https://core.ac.uk/download/pdf/84310326.pdf. Accessed 14 Sept 2020

Atoma CN, Adesope OM, Familusi LC (2019) Organic farming practices among livestock and fish farmers in Southern Nigeria. IntechOpen. Multifunctionality and impacts of organic agriculture IntechOpen, London, pp 1–12

Ayuya OI, Gido EO, Bett H, Lagat JK, Kahi AK, Bauer S (2015) Effect of certified organic production systems on poverty among smallholder farmers: empirical evidence from Kenya. World Dev 67:27–37. https://doi.org/10.1016/j.worlddev.2014.10.005

Azam MS, Shaheen M (2019) Decisional factors driving farmers to adopt organic farming in India: a cross-sectional study. Int J Soc Econ 46:562–580. https://doi.org/10.1108/IJSE-05-2018-0282

Barrett C (2008) Smallholder market participation: concepts and evidence from eastern and southern Africa. Food Policy 33:299–317

Burke WJ, Myers RJ, Jayne TS (2015) A triple-hurdle model of production and market participation in Kenya's dairy market. Am J Agr Econ 97:1227–1246. https://doi.org/10.1093/ajae/aav009

Cragg J (1971) Some statistical models for limited dependent variables with application to the demand for durable goods. Econometrica 39:829–844

Dhakal SC (2020) Productive efficiency of organic vegetable grown in kitchen garden of Chitwan, Nepal. J Agric For Univ 4:53–60

Dipeolu AO, Philip B, Aiyelaagbe IO, Akinbode S, Adedokun TA (2009) Consumer awareness and willingness to pay for organic vegetables in S.W. Nigeria. Asian Journal of Food and Agro-Industry 2(Special issue):57-65. https://www.ajofai.info/Abstract/Consumer%20awareness%20and%20willingness%20to%20pay%20for%20organic%20vegetables%20in%20south%20west%20nigeria.pdf. Accessed 8 Dec 2017

Durham TC, Mizik T (2021) Comparative economics of conventional, organic, and alternative agricultural production systems. Economies 9:1–22. https://doi.org/10.3390/economies9020064

Edriss A (2019) Distilled econometrics: using African data with stata. International i-Publishers, Beecsi series publications, Canada

Food and Agriculture Organization of the United Nations (FAO) (2022) Nigeria at a glance. FAO, Nigeria. https://www.fao.org/nigeria/faoin-nigeria/nigeria-at-a-glance/en/. Accessed 5 Sept 2022

Gebremedhin B, Shiferaw K, Tegene A, Hoekstra D (2017) A triple-hurdle model of small-ruminant production and marketing in the highlands of Ethiopia: implications for commercial transformation. Afr J Agric Resour Econ (AfJARE) 12:257–270

Heckman J (1979) Sample selection bias as a specification error. Econometrica 47:153–161

Ibeawuchi II, Obiefuna JC, Tom CT, Ihejirika GO, Omobvude SO (2015) Indigenous and current practices in organic agriculture in Nigeria: a review. Agric For Fish 4:257–262. https://doi.org/10.11648/j.aff.20150406.14

Ibeawuchi II, Okoli NA, Alagba RA, Ofor MO, Emma-Okafor LC, Peter-Onoh CA, Obiefuna JC (2015) Fruit and vegetable crop production in Nigeria: the gains, challenges and the way forward. J Biol Agric Healthc 5:194–208

International Federation of Organic Agriculture Movements (IFOAM) (2007) Organic agriculture—role in countering climate change. IFOAM, Germany

Jatto AN (2019) Assessment of farmer's awareness of agricultural insurance packages: evidence from "Farming is our pride" communities of Zamfara State, Nigeria. Agric Trop Subtrop 52:79–83. https://doi.org/10.2478/ats-2019-0009

Jiang Y, House LA (2017) A triple-hurdle count data model of market participation and consumption, 2017 Annual Meeting, July 30- August 1. Agricultural and Applied Economics Association, Chicago. https://doi.org/10.22004/ag.econ.258101

Kisaka-Lwayo M, Obi A (2014) Analysis of production and consumption of organic products in South Africa. In: Vytautas P (ed) Organic Agriculture Towards Sustainability. Intech, London, pp 26-50. https://doi.org/10.5772/58356

Kondo E, Sarpong DB, Egyir IS (2019) Production and market participation decisions of smallholder cowpea producers in the Northern Region of Ghana: a triple hurdle model approach. Invited paper presented at the 6th African Conference of Agricultural Economists, September 23–26, 2019. African Association of Agricultural Economists (AAAE), Abuja. https://doi.org/10.22004/ag.econ.295654

Kutama AS, Abdullahi MA, Umar S, Binta UB, Ahmad MK (2013) Organic farming in Nigeria: problems and future prospects. Glob Adv Res J Agric Sci 2(10):256–262

Meemken E, Spielman DJ, Qaim M (2017) Trading off nutrition and education? A panel data analysis of the dissimilar welfare effects of Organic and Fairtrade standards. Food Policy 71:74–85. https://doi.org/10.1016/j.foodpol.2017.07.010

Mgbenka RN, Onwubuya EA, Ezeano CI (2015) Organic farming in Nigeria: need for popularization and policy. World J Agric Sci 11:346–355

National Bureau of Statistics (NBS) (2022) Nigerian Gross Domestic Product Report Q4 2021. Abuja, Nigeria: NBS. https://nigerianstat.gov.ng/elibrary/read/1241137#:~:text=Overview,2020%20under%20the%20Covid%20pandemic. Accessed 28 June 2022

Ogunmola OO, Afolabi CO, Adesina CA, IleChukwu KA (2021) A comparative analysis of the profitability and technical efficiency of vegetable production under two farming systems in Nigeria. J Agric Sci (Belgrade) 66:87–104. https://doi.org/10.2298/JAS2101087O

Oluwasusi JO (2014) Vegetable farmers' attitude towards organic agriculture practices in selected states of South West Nigeria. J Agric Ext Rural Dev 6:223–230. https://doi.org/10.5897/JAERD2013.0572

Onabu OJ (2022) 'Nigeria's position as Africa's 3rd largest importer of tomato paste unacceptable'. Asaba, Nigeria. This Day. https://www.thisdaylive.com/index.php/2022/01/03/nigerias-position-as-africas-3rd-largest-importer-of-tomato-paste-unacceptable/#:~:text=%E2%80%9CNigeria%20is%20the%2014th%20largest,is%20produced%20in%20West%20Africa. Accessed 20 Aug 2022

Onoja AO (2010) Comparative analysis of technical efficiency in rice production under small-scale farmer managed irrigation systems and rain-fed system in Kogi State. Dissertation, University of Nigeria. http://www.dspace.unn.edu.ng/handle/123456789/1404. Accessed 27 July 2021

Oyedele GT, Wole-Alo FI, Owolabi KE, Okunlola JO (2018) Small–scale farmers perception on organic farming status in Ondo State, Nigeria. Am J Agric For 6:186–190. https://doi.org/10.11648/j.ajaf.20180606.15

Oyewole MF, Oloyede F, Meludu N (2014) Coverage of organic agricultural news in Nigerian Newspapers. In: Rahmann G, Aksoy U (eds), 4th ISOFAR Scientific Conference, October 13-15, 2014. Organic World Congress Istanbul, pp 863–866. https://orgprints.org/id/eprint/23608/1/23608_MM.pdf. Accessed 8 Dec 2017

Plaisier C, Dijkxhoorn Y, Rijn F, Bonnand J, Talabi O (2019) The vegetable and potato sector in Nigeria: An overview of the present status. Wageningen Economic Research Report No. 2019-119. Wageningen Economic Research. https://doi.org/10.18174/504921

Sez PS (2017) Overview on the CAADP, the 2003 Maputo and particularly 2014 Malabo Declarations. Embassy of Switzerland in Ethiopia: Federal Department of Foreign Affairs FDFA, Swiss Agency for Development and Cooperation SDC, Global Programme Food Security. https://www.shareweb.ch/site/Agriculture-and-Food-Security/news/Documents/2018_05_28_overview_caadp_malabo_declaration.pdf. Accessed 17 Oct 2019

Sodjinou E, Glin LC, Nicolay G, Tovignan S, Hinvi J (2015) Socioeconomic determinants of organic cotton adoption in Benin, West Africa. Agric Food Econ: SpringerOpen J 3:1–22. https://doi.org/10.1186/s40100-015-0030-9

Sudheer PS (2013) Economics of organic versus chemical farming for three crops in Andhra Pradesh, India. Journal of Organic Systems 8(2):36–49. https://orgprints.org/id/eprint/25532/1/25532.pdf. Accessed 27 July 2021

Tabe-Ojong M, Mausch K, Woldeyohanes TH (2018) A triple-hurdle model of the impacts of improved chickpea adoption on smallholder production and commercialization in Ethiopia. In: 30th International Conference of Agricultural Economists, July 28 - August 2 2018, IAAE, Vancouver, pp 1–28. https://doi.org/10.22004/ag.econ.273473

Uematsu H, Mishra AK (2012) Organic farmers or conventional farmers: where's the money? Ecol Econ 78:55–62. https://doi.org/10.1016/j.ecolecon.2012.03.013

Willer H, Lernoud J (eds) (2019) The world of organic agriculture: Statistics and emerging trends 2019. In: Research Institute of Organic Agriculture (FiBL), Frick, and IFOAM - Organics International, Bonn. https://ciaorganico.net/documypublic/486_2020-organic-world-2019.pdf. Accessed 24 April 2023

Willer H, Lernoud J, Kemper L (2019) The world of organic agriculture 2019: Summary. In: Willer H, Lernoud J. (eds) The world of organic agriculture: Statistics & Emerging Trends 2019. Research Institute of Organic Agriculture (FiBL), Frick, and IFOAM - Organics International, Bonn, pp 25–35. https://ciaorganico.net/documypublic/486_2020-organic-world-2019.pdf. Accessed 24 Apr 2023

Willer H, Meier C, Schlatter B, Dietemann L, Kemper L, Travnicek J (2021) The world of organic agriculture 2021: summary. In: Willer H, Travnicek J. Meier C, Schatter B (eds) The world of organic agriculture: Statistics and emerging trends 2021. Research Institute of Organic Agriculture FiBL, and IFOAM - Organic International, Bonn, pp 20–30. https://www.fibl.org/fileadmin/documents/shop/1150-organic-world-2021.pdf. Accessed 26 Feb 2022

Wordofa MG, Hassen JY, Endris GS, Aweke CS, Moges DK, Rorisa DT (2021) Adoption of improved agricultural technology and its impact on household income: a propensity score matching estimation in eastern Ethiopia. Agric Food Sec 10:1–12. https://doi.org/10.1186/s40066-020-00278-2

Wu H, Ding S, Pandey S, Tao D (2010) Assessing the impact of agricultural technology adoption on farmers' well-being using propensity-score matching analysis in rural China. Asian Econ J 24:141–160. https://doi.org/10.1111/j.1467-8381.2010.02033.x