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Research Application Summary

Farmers awareness, participation and participation intensity of organic tomato production in south-West Nigeria: A Triple Hurdle Model estimation

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Abstract

Agriculture is usually categorised into organic agriculture and non-organic agriculture. Organic agriculture is still at the initial development stage in Nigeria. Hence, its awareness and participation in it is still low. Therefore, this study determined the effects of factors affecting the awareness, adoption and quantity of organic tomato production in South-West Nigeria. Specifically, the study examined the factors influencing famers' awareness about organic farming practices, determined the factors influencing farmers' decision to participate in organic tomato production and determined the factors affecting the intensity of participation in organic tomato farming. A total of 384 vegetable farmers were sampled using structured questionnaire instrument. However, only 155 farmers produced tomatoes. Therefore, data analysis was based on the 155 tomato farmers. Data was analysed using the Triple Hurdle Model. The first and second stage of the hurdle for awareness and adoption respectively, were estimated using the Probit model. The third stage for the intensity of participation was estimated using a Lognormal multiple regression model. Results showed that the probability of awareness and adoption increased for farmers that were single, member of cooperatives/association and received extension services. However, the quantity of organic tomato produced increased for male household. Therefore, we conclude that the use of extension agents, associations and information media were pivotal to engineer the development of organic farming in Nigeria. Thus, continuous sensitization of farmers and provision of organic news on radios and other information media should be enhanced for increased awareness and possible adoption of organic farming.

Keywords: Organic agriculture, tomato production, Nigeria, Triple Hurdle Model

Résumé

L'agriculture est généralement classée en deux catégories : l'agriculture bio et l'agriculture non bio. L'agriculture bio est encore au stade initial de développement au Nigeria. Par conséquent, la sensibilisation et la participation à cette activité sont encore faibles. Ainsi donc, cette étude a déterminé les effets des facteurs affectant la sensibilisation, l'adoption et la quantité de la production de tomates bio dans le sud-ouest du Nigeria. Plus précisément, l'étude a examiné les facteurs influençant la sensibilisation des agriculteurs aux pratiques de l'agriculture bio, déterminé les facteurs influençant la décision des agriculteurs de participer à la production de tomates bio et ainsi que les facteurs influençant l'intensité de la participation à la culture de tomates bio. Au total, 384 producteurs de légumes ont été interviewés à l'aide d'un questionnaire structuré. Cependant,

seuls 155 agriculteurs étaient producteurs des tomates. Par conséquent, l'analyse des données a été basée sur les 155 producteurs de tomates. Les données ont été analysées à l'aide du modèle Triple-Hurdle. La première et la deuxième étape de l'obstacle pour la sensibilisation et l'adoption respectivement, ont été estimées en utilisant le modèle Probit. La troisième étape pour l'intensité de la participation a été estimée à l'aide d'un modèle de régression multiple Lognormal. Les résultats ont montré que la probabilité de sensibilisation et d'adoption augmente pour les agriculteurs célibataires, membres de coopératives/associations et bénéficiant de services de vulgarisation. Cependant, la quantité de tomates bio produites elle, a augmenté pour les ménages dirigés par un homme. Par conséquent, l'étude conclut que l'utilisation d'agents de vulgarisation, d'associations et de médias d'information a joué un rôle essentiel dans le développement de l'agriculture bio au Nigeria. Ainsi, la sensibilisation continue des agriculteurs et la diffusion d'informations sur l'agriculture bio sur les radios et autres médias d'information devraient être renforcées pour accroître la sensibilisation et l'adoption éventuelle de l'agriculture bio.

Mots-clés : Agriculture bio, production de tomates, Nigéria, modèle Triple-Hurdle

Introduction

Agriculture is the backbone of the Nigerian economy (Atoma *et al*., 2019). The contribution of agriculture to employment generation and Gross Domestic Product (GDP) of the country are about 34.66% and 24%, respectively (Statista, 2021; WorldBank, 2021). Agriculture is usually grouped as organic and inorganic agriculture. The International Federation of Organic Agriculture Movements (IFOAM) (2008) definies organic agriculture as "a production system that sustains the health of soils, ecosystems and people, relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects and combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved". Organic farming technique includes the use of crop rotation, crop residues, green maunres, cover cropping, application of compost, organic fertilizers, mixed cropping, use of 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). This study defines organic farmers as farmers with the certification from an organic certification body to produce organic products using organic prinicples.

Organic agriculture occupies only 1.4 percent of the world's agricultural land (Willer *et al*., 2019). Nigeria has about 58,000 hectares of organic farm area (which is 2.8 percent of Africa's organic farm area and 0.01 percent of world's organic farm area) of which about 141 hectares is used for organic vegetable production (FiBL, 2019). The total land used for agricultural cultivation in Nigeria is about 61 million hectares (66% of total land in the country). However, only about 0.095% is used for organic farming and 0.00023% is used for organic vegetable production. Thus, the participation of farmers to organic agriculture is low (0.01 percent). This implies that organic agriculture is still at the initial development stage in Nigeria compared to its inorganic agricultural counterpart which is well established and practiced widely by farmers.

Non-organic farming involves the use of agrochemicals, inorganic fertilizers and genetically modified organisms for food production (Kutama *et al*., 2013). Organic farming is believed to be a better method of cultivating crops than the conventional methods in terms of productivity, profitability, environmental impact and nutrition. Organic farming entails using indigenous

knowledge, local and available resource, low and inexpensive input for agricultural production and generates high income from sales of organic products given its premium price. It is a sustainable farming method which is highly relevant in the achievement of the United Nation's Sustainable Development Goals (SDGs), with emphasis on the SDG 2 and SDG 12 which represent Zero hunger and Responsible consumption and production respectively. Yet, the awareness and adoption of organic farming methods is still low (Atoma *et al*., 2019). Therefore, this study determined the effects of factors affecting the awareness, adoption and quantity produced of organic tomato production in South-West Nigeria. Specifically, the study examined:

i. The factors influencing famers' awareness about organic farming practices
ii. The factors influencing farmers' decision to participate in organic tomato production
iii. The factors affecting the intensity of participation in organic tomato farming

Methodology

The study was conducted in Ekiti and Oyo State located in the south-west region of Nigeria. Registered and certified tomato farmers of the Association of Organic Agriculture Practitioners of Nigeria (NOAN), Justice Development and Peace Initiative (JDPI) Ekiti State, Agricultural Development Programme Ekiti State and Farmers Development Union (FADU) Ibadan were sampled. Non-random sampling technique was employed because the population size could not be ascertained for both groups. The sample size includes 72 organic tomato farmers and 83 non-organic tomato farmers making a total of 155 tomato farmers sampled. Primary data were collected through the use of a survey questionnaire.

Data were analysed using the Triple Hurdle Model. The triple hurdle model was the pioneer work of Burke, Myers, and Jayne (2015) and it is used in this study to model the factors influencing farmers' awareness, participation decision and the intensity of participation in organic tomato farming. Burke *et al*. (2015) modelled the above three hurdles in a single model thus the name 'triple hurdle model'. Conventionally, the decision to participate and the intensity of participation was modelled using the Double Hurdle Model (Cragg, 1971; Barrette, 2008). However, in recent times, researchers have extended the model to a triple hurdle model (Burke *et al*., 2015; Gebremedhin *et al*., 2017; Jiang and House, 2017; Tabe-Ojong *et al*., 2018; Kondo *et al.,* 2019). The model is thereby specified as:

(1) 1st stage: $y_i^{a*} = \propto_1 W_1 + \propto_2 W_2 + \cdots + \propto_{16} W_{16} + \varepsilon \; ; y_i^a = \begin{cases} 1 \; if \; y_i^{a*} > 0 \\ 0 \; otherwise \end{cases}$

(2) 2nd stage: $y_i^{p*} = \gamma_1 X_1 + \gamma_2 X_2 + \cdots + \gamma_{21} X_{21} + \epsilon \; ; y_i^p = \begin{cases} 1 \; if \; y_i^{p*} > 0 \\ 0 \; otherwise \end{cases}$

(3) 3rd stage: $Y_i^* = \beta_1 Z_1 + \beta_2 Z_2 + \cdots + \beta_{18} Z_{18} + \mu \; ; Y_i = \begin{cases} Y_i^* \; if \; Y_i^* > 0 \; and \; y_i^{p*} = 1 \\ 0 \qquad\qquad\qquad otherwise \end{cases}$

Where i =1,2,3,…,155 tomato farmers

Equation 1, 2, and 3 represent the awareness, participation 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 to organic tomato farming practices, participation in organic tomato farming and the quantity of organic tomato produced respectively. y_i^{a*} and y_i^{p*} are binary variables with values 1 for farmers that are aware and participate in organic tomato farming respectively and zero if otherwise. Y_i^* is a continuous variable which is conditioned on farmers having a positive production and also conditioned on farmers being a participant in the production of organic tomato. y_i^{a*}, y_i^{p*} and Y_i^* are only observed when these conditions are met. The W's, X's and the Z's represent the explanatory variables for each model while the $\propto'$ s, γ's and β's represent the parameters to be estimated. The error terms are represent by ε, ϵ and μ for each model, respectively.

Results and Discussion

The triple hurdle model for tomato farmers were estimated and results are shown in Tables 1, 2 and 3. Table 1 is the first stage of the triple hurdle model showing the factors influencing farmers' awareness to organic farming methods. The second and third stages show the factors affecting the decision of farmers to participate in organic farming and on the quantity of organic tomato to produce respectively. The first two stages were estimated using the Probit model while the third stage was estimated using lognormal regression model. The Average Marginal Effect (AME) estimation for the first stage triple hurdle model is presented in Table 1.

Table 1 shows that the probability of farmers' awareness about organic farming practices increases with farmers being single, being a member of a cooperatives and receiving extension services. However, household who had a radio set reduced the probability of gaining awareness to organic farming. To elaborate, being single increased the probability of awareness to organic tomato farming practices by 38% on average at 1% significant level. This suggests that farmers who are not married are better informed on the best agronomic practices and farm management techniques

Table 1. First stage of the Triple Hurdle Model – Probit Model

Awareness n=149	AME	Standard Error	z value
Male	0.013	0.085	0.150
Age	0.010	0.020	0.510
Age Square	0.000	0.000	-0.290
Being single	0.382	0.089	4.310***
Household size	0.017	0.016	1.060
Years of education	0.007	0.008	0.880
Association (1=yes; 0=no)	0.117	0.097	1.210
Cooperative (1=yes; 0=no)	0.317	0.082	3.840***
Number of Extension visit	0.057	0.023	2.500**
Asset to radio (1=yes; 0=no)	-0.269	0.099	-2.720***
Asset to Phone (1=yes; 0=no)	-0.109	0.125	-0.870
Asset to TV (1=yes; 0=no)	-0.076	0.105	-0.730
Years of farming experience	0.000	0.004	-0.110
Price per kg	0.000	0.000	0.460
Uses public transport(1=yes; 0=no)	-0.042	0.091	-0.460
Have electricity (1=yes; 0=no)	0.075	0.099	0.760

Source: Field survey, 2021 *** represents 1%, ** represents 5%, and * represents 10%

than their married counterparts.

Result also showed that being a member of a cooperative was statistical significant at 1% significant level and increased the probability of farmers' awareness to organic farming practices by 32% on average. This implies that farmers who are members of cooperatives are better informed on agronomic practices and farming innovations. Number of extension visits also increased the probability of farmers' awareness to organic farming by 6% on average at 5% significant level. The results imply that the single farmers were more involved with cooperative societies and received more services from extension agents thus the awareness of organic farming.

However, farmers possessing a radio-set decreased the probability of awareness to organic farming practices by 27% on average at 1% significant level. This implies that information on organic farming methods were not adequately convened on radio stations and thus the decrease in the probability of awareness. This is in-line with Oyewole *et al*. (2014) and Mgbenka *et al.* (2015). Oyewole *et al*. (2014) indicated that there was low coverage of organic agriculturral news in Nigeria while Mgbenka *et al*. (2015) suggested that the awareness of organic farming could increase if the information on organic farming activities were made available.

The second stage of the Triple Hurdle Model for participation is presented in Table 2. The inverse mills ratio coefficient was not significant, so it was dropped and the model was run excluding it. The result showed that being a member of a farmer association increased the probability of famers participating in organic tomato farming by 14% on average at 10 % significant level. This implies that associations are key to improving the level of participation in organic agriculture as relevant information on farming methods and guidance are offered to farmers for optimum farm production.

Also, farmers being single increased the probability of participating in organic tomato farming by 30% on average at 5 % significant level. This could imply that single individuals (not married) are more active in associations with the objectives of having a sustainable farming methods. This was in-line with Adesope *et al*. (2012) where being married had an inverse relationship with adoption which suggested the importance of marital status in the adoption of organic agriculture.

The household decision making process of the farmer's family was considered for this model because it is important to determine who makes farming decisions. Hence, households making joint farming decision increased the probabilty for the adoption of organic tomato farming by 15% on average at 5% significant level. The result suggests the importance of regrading family members opinion (especially spouses) on issues for the improvement of the general wellbeing of households.

The increase in the number of extension visits by 1 visit would increase the probability of farmers participating in organic farming by 5.7% on average at 1 percent significant level as shown in Table 2. This implies that extension services rendered to farmers is vital to the increased participation in organic farming in the study area. This is inline with Sodjinou *et al* (2015) who indicated that organic farmers need a constant interactions with extension agents given that organic farming is a knowledge intensive venture.

Table 2. Second stage of the Triple Hurdle Model – Probit Model

Participation n=142	AME	Standard Error	z value
Male	0.064	0.083	0.770
Age	0.001	0.003	0.440
Household size	0.010	0.013	0.710
Years of education	-0.007	0.008	-0.880
Association (1=yes,0=no)	0.141	0.081	1.730*
Being single	0.298	0.142	2.100**
Cooperative (1=yes,0=no)	0.095	0.085	1.120
Joint farm decision making	0.150	0.076	1.980**
Number of extension visits	0.057	0.018	3.240***
Cost of labour	0.000	0.000	-1.130
Price per kg	0.000	0.000	0.820
Benefit Cost Ratio	0.000	0.006	-0.080
ln Total consumption expenditure	-0.093	0.056	-1.660*
Number of Meal per day	0.039	0.121	0.320
Formal job (1=yes,0=no)	0.119	0.105	1.130
Organic certification cost	0.168	0.063	2.660***
Asset to radio (1=yes,0=no)	-0.147	0.112	-1.310
Asset to phone (1=yes,0=no)	-0.127	0.135	-0.940
Sandy floor type	-0.061	0.093	-0.660
Tiled floor type	0.190	0.130	1.460
Total Land size	0.007	0.006	1.040

Source: Field survey, 2021 *** represents 1%, ** represents 5%, and * represents 10%

One-unit increase in the household's total food and non-food consumption expenditure decreased the probability of participation in organic tomato farming by 0.093 percent on average at 10% significant level. This implies that household with larger monthly expenditure are less likely to adopt organic farming. This suggests that organic farming is yet to attain the potential level of providing farmers with higher incomes compared to conventional farming.

Contrary to a priori expectation, organic certification cost increased the probability of participating in organic farming by 17% on average at 1 percent significant level. The explanation to this phenomenon lies on the type of certification the studied organic farmers obtained. The organic farmers mostly obtained the Participatory Guarantee System (PGS) certification which involved farmers pooling resources to obtain certification as a group. This implies that the certification cost is split among group members. This makes it easier for farmers to participate in organic farming given that the cost of certification is brought to its minimum. The result was contrary to the findings of Mgbenka *et al*. (2015) where the cost of certification was high and hence limited farmers from participating in organic agriculture given that they have little resources.

The third stage of the tomato triple hurdle model is shown in Table 3. Lognormal multiple regression was used to determine the factors influencing the quantity of organic tomatoes produced. Diagnostic tests were done and the results showed no evidence of Multicollinearity (Mean VIF = 1.74) and Heteroskedasticity (Breusch-Pagan / Cook-Weisberg test of Prob > chi2 = 0.9430). The inverse mills ratio coefficient was insignificant and so was excluded from the regression analysis. Result showed that a one percent increase in the number of farmers that are male would increase the quantity of tomatoes produced by 0.403kg at 5% significant level. This implies that gender plays a vital role in determining the intensity of organic tomato production by farmers. This is consistent with Oyesola and Ibikunle (2011) and Fasina (2016) as majority of the farmers response were male.

In the same way, a percentage increase in the total revenue from tomato production would lead to a 0.807% increase in the quantity of tomato produced at 1 percent significant level. This implies that the higher the total revenue realised from organic tomato farming, the more the intensity of participation in organic tomato production. This is accordance with Alawode and Abegunde (2015) study. They implied that farmers objective in farming is to provide food security for household. Therefore, increased revenue would aid in the achievement of such goal.

In Table 3, the price of the tomato output showed a negative relationship with the tomato output by 0.1% at one percent significant level. This implies that tomato farmers are not optimizing the premium price for their organic product. If this were so, the positive effect of a price increase would have been reflected in the model. This is against the a prior expectation as the increase in output price should motivate organic farmers to produce more. The result also showed that an increase in the number of extension visit did increase the probability of participating in organic tomato farming as shown in Table 2.

Table 3. Third stage of the tomato Triple Hurdle model – Lognormal Regression

lnProduction output n=53	Coefficient estimate	StandardError	t value
Male	0.403	0.194	2.080**
Age	0.009	0.007	1.280
Household size	-0.024	0.029	-0.830
Single	-0.159	0.274	-0.580
Use of farm Manure	-0.190	0.181	-1.050
Area Planted (ha)	0.030	0.255	0.120
lnTotal Variable Cost	0.059	0.041	1.430
Association (1=yes,0=no)	-0.010	0.277	-0.030
lnConsumption on food	0.000	0.031	0.000
lnOff farm income	0.008	0.020	0.380
Credit (1=yes,0=no)	-0.011	0.260	-0.040
Cost of public transport	0.000	0.000	0.430
Number of Extension visit	-0.085	0.045	-1.890*
Asset to Bike (1=yes,0=no)	-0.068	0.189	-0.360
Number of Meal per day	0.261	0.310	0.840
Price per kg	-0.001	0.000	-7.500***
lnTotal Revenue	0.807	0.086	9.330***
Problem of low Patronage (1=yes,0=no)	-0.031	0.215	-0.150
_cons	-4.470	1.377	-3.250
R-squared	0.862		
Prob>F 0.000			

Source: Field survey, 2021 *** represents 1%, ** represents 5%, and * represents 10%

However, a percentage increase in the number of extension visit decreased the quantity of tomato produced by 0.085kg at 10% significant level. This could imply that a regular monitoring of farmers' production processes and final yield were not fully observed by extension agents.

Conclusion

Information dissemination to farmers is necessary to improve the awareness and participation of organic farming in South-West Nigeria. This was evident from the result of this study as farmers' being a member of an associations, cooperatives and extension visits increased the probability of farmers' awareness and participation in organic tomato farming. Therefore, the use of extension agents, associations, cooperatives and information media are pivotal to promote the development of organic farming in Nigeria. Although access to a radio-set did influence negatively on awareness., continuous sensitization of farmers and provision of organic news on radios and other information media could enhance the awareness and possible adoption of organic farming.

Marital status also played a role in the awareness and participation of organic farming as singles (including the divorced and widowed) were more keen to adopting more sustainable farming methods. Therefore, married folks are encouraged to participate in associations and cooperatives as information for better farming techniques and innovations are usually communicated in such unions. Male farmers were observed to produce more given total revenue and could therefore afford certification cost. Therefore, female farmers are encouraged to also engage in organic farming for better wellbeing and improved income.

Attention is drawn on the fact that the higher the revenue from organic farming the more farmers will participate in organic farming. However, a major challenge occurs when farmers do not enjoy premium prices from the production of their organic products. Therefore, it is recommended that the price for organic products should be regularised so that the economic benefit from farming organically can be optimized.

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