GENDER DIMENSION IN THE ADOPTION OF IMPROVED SESAME PRODUCTION VARIETIES AMONG SESAME FARMERS IN KOGI STATE, NIGERIA

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ABSTRACT
This study analyzed the gender dimension in the adoption of improved sesame production varieties among sesame farmers in Kogi State, Nigeria. *Multistage sampling technique was adopted for selecting sample of 240 respondents. Primary data used were collected using a structured questionnaire. Data were analysed using Descriptive statistics, z-test and Double Hurdle Regression Model. The analyses results showed that 79.40% of the respondents were male. The mean age of the respondents was 49.24 years. 85.41% of the respondents were married .Farming (66.95%) was the major occupation among the respondents. The mean farming experience was 33 years. Average farm size was 2.8 hectares. Average annual income was ₦392, 060.09.The result of the double hurdle analysis showed that; awareness (0.488), education(0.158), farming experience (0.052) and farm size (0.143) were the key factors the influenced adoption of sesame farming technologies by male farmers while education (0.161) was the only factor which influenced adoption of sesame farming technologies among female farmers. Also, results showed that male adopters of improved sesame varieties (*50.98) *recorded higher output than non-adopters (41.46). Also, male adopters of improved sesame varieties under pooled (*46.22) *recorded higher output than non-adopters (34.92). Government and relevant stakeholders should provide relevant awareness and trainings to sesame farmers on the various recommended sesame production technologies in order to boost productivities.*

Keywords: Gender, Adoption, Sesame, Dimension, Production.

INTRODUCTION

Sesame (*Sesamum indicum L*.) otherwise known as sesamum or benniseed, a member of the family padaliaceae, is one of the ancient oil seeds known to mankind(Tunde-Akintunde*et al.* 2020).It ranks second to cocoa in terms of export volume in Nigeria and is fast becoming prominent among non-oil exports because it is one of the few cash crops that earn Nigeria foreign exchange (FAO, 2018). Although it is quite extensively cultivated, it is mainly a small-holder crop, often intercropped with others crops (Abu *et al.* 2011). Available records show that Nigeria exported 140,800 tonnes of sesame seed worth $139 million in 2018; it was also recorded that Nigeria earned ₦21 billion from the export of sesame seed products in the first half of 2019 (Ciuci, 2019).

Market opportunities exist in Korea, India, and the Middle East and Mediterranean countries where sesame seed oil is in very high demand (Ciuci, 2019).In Nigeria, small-holder farmers constitute about 80% of the farming population (Food and Agriculture Organization, FAO, 2018). Both the white and brown types are commonly grown by smallholder farmers in Adamawa, FCT Abuja, Benue, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Kogi, Nasarawa, Plateau, Taraba and Yobe State (USAID, 2009; Ezeano*et al.*, 2018). While both male and female farmers are involved in sesame production in Nigeria and Kogi State in particular, little is known about gender differences in the adoption of technologies which improve sesame productivity.Statistics revealed a huge demand – supply gap in Nigeria's sesame production. Studies on sesame indicated a wide gap between potential and actual yields obtained (Kanton*et al.*, 2013; Olowe, 2017; NAERLS, 2020). According to NAERLS (2020), actual sesame yield of 300kg/ha against potential yield of between 700-1,000 kg/ha is below the world average yield of 4,900kg/ha and four times lower than the average yield of other oil seed crops like groundnut and soybean. Sani*et al.* (2014) reported actual sesame yield of 0.55 tonnes/ha against a potential yield of 2 tonnes/ha with a yield gap of 264% for North-Central Nigeria. This shows sesame yield is low and unstable due to technical and socioeconomic constraints like weed competition, low soil fertility, rust, inappropriate use of improved varieties, high prices of fertilizer and herbicides, and inadequate funds or credit to purchase inputs, among others. The low productivity of sesame is still a challenge, which is attributed to the limited adoption of improved varieties and other recommended production practices, especially by female farmers (Ume *et al*, 2016). Based on the above background, this study was designed to assess gender dimension in the adoption of improved sesame production technologies among farmers in Kogi State, Nigeria. The specific objectives were to:

(i) describe the socioeconomic characteristics of sesame farmers in the study area

(ii) determine the factors that influence adoption decision of improved sesame production seed variety and intensity of adoption by gender

(iii) determine the effect of adoption of improved sesame varieties on farmers' outputs

METHODOLOGY

This study was conducted in Kogi State, Nigeria. Kogi State is located between latitude 6°30'N and 8°48N, and Longitude $5°23^1$E and 7°48'E, sharing boundaries with Kwara, Ondo, Ekiti, Niger, Benue. Nasarawa, Anambra, Enugu, Edo States as well as the Federal Capital Territory. It has a land area of 283,135,359km, (National Population Commission, NPC, 2006).There are three major ethnic groups in Kogi namely Okun, Ebira, and Igala. It has an estimated population of about 3,278,487 people. Kogi state has four agricultural zones as delineated by the Kogi State Agricultural Development Project (Kogi ADP).These zones are: Zone A which comprises of Ijumu, Kabba/Bunu, Mopamuro, Yagba-East, Yagba-West Local Government Areas with headquarters in Aiyetoro-gbede. Zone B, comprises of Dekina, Bassa, Ankpa, and Omala Local Government Areas, with zonal headquarters in Anyigba. Zone C, comprises of Adavi, Ajaokuta, Koton-Karfe, Kogi, Okene and Okehi Local Government Areas with zonal headquarters in Koton-Karfe. Zone D, comprises of Idah, Ofu, Ibaji, Olamaboro, and Igala-Mela Local Government Areas with zonal headquarters at Aloma. Major crops produced include cassava, rice, cowpea, cashew, sesame, millet, and maize, among others. Multistage sampling technique was adopted for selecting sesame farmers for the study. In stage one, three (3) agricultural zones, namely: zones B, C and D were purposely selected from the four (4) zones based on the intensity of sesame production. In the second stage, two (2) extension blocks were purposively selected giving a total of six (6) extension blocks. In the third stage, two (2) extension cells were randomly selected from each block to give twelve (12) extension cells. Finally, twenty (20) sesame farmers were randomly selected from each cell, making a sample size of 240 respondents. Primary data were used for the study. The primary data were collected with the aid of a structured questionnaire administered to the respondents. Data were collected by the researcher and trained enumerators from the selected agricultural blocks. Data were analyzed using descriptive and inferential statistics. Specific objective 1 was analyzed using descriptive statistics, specific objective2 was analyzed using z-test while specific objective 3 was analyzed using Cragg's Double-Hurdle (DH) Regression Model.

Model specifications

Z-test:

$$Z = \frac{(\bar{X} - \mu)}{\sqrt{\frac{S^2}{N}}}$$

Where:

$\bar{X}$ = Sample mean

μ = Population mean

S^2 = Sample variance

N = Sample size

Double Hurdle Model:

Following the double-hurdle model as originally formulated by Cragg (1971), sesame farmers make two decisions with regard to adoption of improved sesame seed variety, which is determined by a different set of explanatory variables. In order to observe a positive level of adoption, two separate hurdles must be passed. A different latent variable is used to model each decision process, with a probit model to determine participation (Blundell and Meghir, 1987).

The model specifically allows the factors that determine the adoption decision and intensity of adoption to be differ in independently (Temitayo and Kabir, 2016).

First hurdle adoption equation:

$di^* = aixi + \mathcal{E}_i$ (1)

$$Di = \begin{cases} 1, if\ di * > 0 \\ 0, if\ di * \leq 0 \end{cases} (2)$$

Where; di^* is latent choice of the adoption by the ith sesame farmers, αi is vector of unknown parameters, xi is a vector of explanatory variables which affect adoption decision, $\mathcal{E}$i is normally distributed error term with zero mean and constant variance (σ2), i = 1, 2, … n (n is the number of observation) and represents observable farmers status to adopt improved sesame production technologies, 1 if adopt and 0, other-wise.

Model specifications

Second Hurdle outcome model (intensity of adoption)

The second hurdle involves an outcome equation, which uses a truncated model to determine the level of adoption of improved sesame production technologies. This model excludes part of sampled observation based on the value of the dependent variable. That is, the truncated regression uses observations only from farming households who reported positive and greater than zero. The intensity of adoption is modeled as a regression truncated at zero that is lower limit zero, upper limit positive infinity (Yassin*et al*., 2016). A dependent variable that has a zero value for a significant fraction of the observation requires a truncated regression model because standard OLS results in a biased and inconsistent parameter estimates. The bias arises from the fact that if one considers only the observable observations and omits the others, there is no guarantee that the expected value of the error term would be zero (Tarefe and Ahmed, 2016).

Truncated model is expressed as follows:

$$Y^* = \beta X_i + \mu_i \quad (3)$$

$$Yi = \begin{cases} Y*, \ if\ Di = 1\ and\ Y* \geq \mu \\ 0, Di \leq 0\ and\ Y* < \mu \end{cases} \quad (4)$$

Where; Yi* is the latent variable which is the number of observation (i),β is a vector of parameters, Xi is a vector of explanatory variables hypothesized to affect intensity of technology adoption, μ representing threshold; minimum use of sesame production technologies in the study area whereas i implies number of observation. The decision of adoption of sesame production technologies and how much of it is used can be jointly modeled if they are made simultaneously by sesame farmers, independently modeled if they are made separately, or sequentially modeled if one is made first and affects the other one as in the dominance model (John, 2009). The independent double hurdle model assumes that the two error terms from the two hurdles are normally distributed and uncorrelated. This suggests that the two stage adoption decision and the intensity of adoption are done independently. Under the assumption of independency between the error terms $\mathcal{E}$**i** and μ**i** the model as originally proposed by Cragg (1997) is equivalent to a combination of a truncated regression model and a Univariate Probit model.

$$P = \sum_{j=1}^{n} b_j x_{ij} \quad (5)$$

The regression is implicitly specified as:

$$P = \beta qi + \mu i \quad (6)$$

$P_i^* = \beta_i \alpha + \mu_i$ *Decision to adopt (7)*

The first hurdle is represented by

$$P_i = 1 \; if \; P_1^* > 0 \quad (8)$$

$$P_i = 0 \; if \; P_1^* \leq 0 \quad (9)$$

The first hurdle is thus assumed to be defined by the latent variableP_i^*,

The second hurdle closely resembles the Probit model.

The second hurdle is represented by;

$$Pi = \partial i P_i^* \quad (10)$$

As the model name suggests, subjects must cross two hurdles to contribute. The first hurdle needs to be crossed to be a potential contributor. Given that the subject is a potential contributor, farmers' current circumstances and treatment in the experiment dictate whether the farmer contributes.

This is the second hurdle.

$$P_j = \sum_{j=1}^{n} b_j x_{ij} \quad (11)$$

Where,

Pi - 1 for Xi, Z; I - 1, 2…,n

qi = is a vector of explanatory variables and is the vector of the parameters.

µi = random error.

The dependent variable Pi is the intensity of adoption (number of times improved sesame seed variety was planted) among the male and female sesame farmers.

The explanatory variables are:

X_1 = awareness (dummy, yes = 1, no = 0)

X_2 = income (naira)

X_3 = education (years)

X_4 = household size (number)

X_5 = farming experience (in years)

X_6 = farm size (hectares)

X_7 = marital status (dummy; married = 1, otherwise = 0)

X_8 = credit access (dummy, yes = 1, no = 0)

X_9 = Age (years)

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Sesame Farmers

The result of the socioeconomic characteristics of sesame farmers described in this study is presented in Table 1. It shows that majority (79.40%) of the respondents were males implying that men took active part in the production of sesame, probably due to the physical energy required. The mean age of the respondents was 49.24 years. This implies that farmers were young and in their productive age. Also majority (85.41%) of the respondents were married. This finding agrees with Abbas and Yuansheng, (2018) who reported that majority (98.80 %) of farmers in Nigeria were married. The average household size of the respondents was 7 persons, which is similar to the national average reported by the National Bureau of Statistics, NBS (2020). This result is corroborated by Balogun and Nalini (2019) who reported a household size of between 5 to 7 members.

Farming (66.95%) was the major occupation of the farmers and this underscores the role of the agricultural sector in livelihood development. This agrees with Adebiyi and Okunlola, (2013) who found similar percentage among households in Kogi State. The literacy level of sesame farmers in the study area could increase adoption of improved sesame production technologies. This agrees with Ume et al (2016), who observed that higher educational attainment could facilitate the adoption of newer technologies among Nigerian farmers. Table 1 further shows the mean farming experience of 33 years, meaning that sesame farmers were vast and have the necessary experience to enable them make adoption decision in sesame production. This is in tandem with Ainembabazi (2015) who reported that 84% of rural farmers in Niger State had up to 30 years farming experience.

Average farm size of the respondents was 2.8 hectares implying that sesame farmers in the study area operate at the subsistence level. Table 1 shows that 52.79% of the respondents inherited their farmlands, 37.34% purchased the farmland, while 9.87% of the sesame farmers leased farmland. Table 1 shows that majority (81.12%) of the respondents had access to extension services. This implies a positive influence on the adoption of improved sesame production technologies. Farmers who have access to extension services are quick to welcome innovations. Also, 48.07% of the respondents were members of farmers association while 51.93% do not belong to any farmer association. The average annual income from sesame production among the respondents was ₦392, 060.09.

Table 1: Socioeconomic Characteristics of the Respondents

Socioeconomic Characteristics	Frequency	Percentage	Mean
Sex			
Male	185	79.40	
Female	48	20.60	
Age (years)			
20-40	45	19.31	49 years
41-60	166	71.24	
61-80	22	9.44	
Marital Status			
Married	199	85.41	
Unmarried	34	14.59	
Family Size (number)			
1-4	79	33.91	7 members
5-8	76	32.62	
9-12	78	33.48	
Major Occupation			
Farming	156	66.95	
Civil Service	21	9.01	
Trading	56	24.03	
Educational Qualification			
Primary education	173	74.25	7 years
Secondary education	24	10.30	
Tertiary education	33	14.16	
Informal education	03	1.29	
Farming Experience (years)			
1-10	34	14.59	33 years
11-20	23	9.87	
21-30	109	46.78	
31-40	67	28.76	
Farm size (hectares)			
0.1-2.0	96	41.20	
2.1-4.0	115	49.36	2.8 hectares
Above 4.0	22	9.44	
Method of Land Ownership			
Inheritance	123	52.79	
Purchase	87	37.34	
Lease	23	9.87	
Extension Access			
Access	189	81.12	
No access	44	18.88	
Membership of Farmers Association			
Member	112	48.07	
Not a Member	121	51.93	
Farm Income from Sesame Production (₦)			
Below 200,000	68	29.18	
200,000 – 400,000	112	48.07	₦392,060.09
Above 400,000	53	22.75	

Source: Field Survey, 2022

Factors influencing adoption decision of improved sesame seed variety and intensity of adoption by gender

Table 2 shows the results of the double hurdle regression model on factors that influence adoption decision and the intensity of adoption of improved sesame seed technology by male and female sesame farmers. In both hurdles, the pooled and separate (male and female farmers) samples were estimated. In the first hurdle, the factors that influenced sesame farmers' adoption decision of improved sesame production technology were estimated, while the second hurdle considered the intensity of adoption of technologies. The pooled result shows that, out of nine variables included in the model, six of them significantly influenced the probability of adopting improved sesame production technologies while three variables determined the intensity of adoption. Result of the male sesame farmers' model as shown in Table 2 reveals that four out of the nine included variables in the model significantly influenced male farmers' likelihood of adopting improved sesame seed technology, while the intensity of adoption is determined by three of the variables. On the female sesame farmers' model, the result shows that the probability of female farmers' adopting improved sesame technology is influenced by only one factor out of the nine explanatory variables in the model, while intensity of adoption among the female sesame farmers is determined by two of the variables. The models' result in Table 2 shows that the LR chi square statistics for the three models was significant at 1% level of probability. This indicates the joint significance of the explanatory variables that were used in the models.

The coefficients of awareness and education were positively signed and significant in influencing the decision to adopt improved sesame seed technology among the male and entire sesame farmers. Though positively signed as in other models, the coefficient of awareness was not statistically significant in the female sesame farmers' model. This implies that, educated sesame farmers who are aware of improved sesame seed technology are able to acquire and use relevant information on improved sesame production technologies to enable them make the best decision given more diverse option.

Table 2: Estimates of the double hurdle model

Hurdle 1: Probability of Adoption Decision - Probit Regression			
Variables	**Pooled**	**Male Farmers**	**Female Farmers**
Awareness	0.519 (3.55)**	0.488 (2.14)**	0.633 (1.39)NS
Income	7.34e-06 (1.72)*	7.55e-06 (1.54)NS	6.75e-06 (0.78)NS
Education	0.159 (6.83)***	0.158 (6.03)***	0.161 (3.19)***
Household size	0.107 (1.30)NS	0.104 (1.12)NS	0.119 (0.69)NS
Farming exp	-0.050 (-1.81)*	-0.052 (-1.69)*	-0.039 (-0.61)NS
Farm size	0.129 (1.87)*	0.143 (1.83)*	0.083 (0.55)NS
Marital status	0.105 (0.49)NS	0.091 (0.38)NS	0.192 (0.41)NS
Credit access	0.242 (1.00)NS	0.198 (0.73)NS	0.426 (0.78)NS
Age	-0.028 (-1.60)NS	-0.029 (-1.47)NS	-0.022 (-0.59)
Constant	-0.724 (-0.55)NS	-0.657 (-0.45)NS	-1.182 (-0.41)NS
LR Chi^2	92.01***	72.68***	19.82
Pseudo R^2	0.287	0.286	0.301
Hurdle 2: Intensity of adoption of improved sesame seed technology – Truncated regression			
Awareness	4.01 (4.34)***	3.909 (3.79)***	4.406 (2.12)**
Income	-3.26e-06 (-0.24)NS	-4.65e-06 (-0.31)NS	3.50e-06 (0.12)NS
Education	0.725 (6.69)***	0.722 (5.92)***	0.738 (3.08)***
Household size	0.396 (1.02)NS	0.391 (0.86)NS	0.457 (0.57)NS
Farming exp	-0.313 (-2.63)***	-0.325 (-2.46)**	-0.246 (-0.89)NS
Farm size	0.311 (1.01)NS	0.354 (1.03)NS	0.199 (0.29)NS
Marital status	0.914 (0.95)NS	0.961 (0.9)NS	1.32 (0.61)NS
Credit access	1.03 (0.92)NS	0.729 (0.59)NS	2.29 (0.90)NS
Age	-0.092 (-1.26)NS	-0.097 (-1.19)NS	-0.061 (-0.38)NS
Constant	-0.074 (-1.01)NS	0.578 (0.09)NS	-3.819 (-0.30)NS
LR Chi^2	94.97***	74.29***	20.71**
Pseudo R^2	0.108	0.106	0.116
Number of obs.	233	185	48

Source: Field Survey Data, 2022 *, **, * → level of significant at 1%, 5% and 10%, respectively. NS =Not Significant. t-values are given in parentheses.**

The result on education agrees with Muriithi *et al*. (2018) who found a direct relationship between education and the adoption of agricultural technologies in Kenya.

The coefficient of farm income was positively signed in the pooled and statistically significant at 10 percent. It was positively signed among the male and female farmers, but however not statistically significant.

This implies that an increase in income of sesame farmers will increase the probability of adopting improved sesame seed technology. The positive sign could mean that as farmers earn more money, they tend to invest more in farming activities by increasing their scale of production through land expansion. Increased income can influence (positively) the decision to adopt improved agricultural production technologies. This disagrees with Gebre *et al*. (2019) who found a negative relationship between income and the adoption of improved maize production technologies among farmers in Ethiopia.

The coefficient of farming experience was negatively signed in influencing adoption decision among the male and female sesame farmers and significant at 10 percent in the pooled and male sesame farmers' models. This implies that, older sesame farmers with more years of sesame farming experience are likely to continue in their 'old' method of cultivating without recourse to modern farming techniques. This is similar to the findings of Ndiritu *et al*. (2014) who worked on the adoption of sustainable agricultural intensification practices among farmers in Kenya.

The coefficient of farm size is positively signed and significant at 10 percent (pooled and male sesame farmers) in influencing the decision to adopt improved sesame seed technology. This implies that, sesame farmers with large hectares of land are more likely to adopt improved sesame seed than farmers with smaller hectares. Consequently, it may not be economically efficient for smallholder sesame farmers to adopt improved sesame production technologies because the associated costs may be high. The result further shows access to credit was positively signed in influencing the adoption of improved sesame seed technology across the three models. The positive sign implies that, sesame farmers who had access to credit were more likely to adopt improved sesame seed than farmers who had not. This is consistent with Balogun and Nalini (2019) who found that access to credit directly influenced the decision to adopt improved agricultural production technologies.

Intensity of adoption

The results of the intensity of improved sesame seed production technology using a truncated regression model (second hurdle) is also presented in Table 2. The estimated models also shows that the LR chi square statistics for the three models was significant at 5% level of probability. This indicates the joint significance of the explanatory variables included in the models. The positive relationship between awareness, education and intensity of adoption implies that, an increase in the number of years spent schooling and awareness on improved sesame seed technology will increase the intensity of its adoption. This agrees with Asfaw *et al*. (2012) who found similar relationship.

Effects of Adoption of Improved Sesame Production Varieties on Output

Outcome of the z-statistics on the effects of adoption of improved sesame production varieties on the output of male and female farmers is presented in Table 3. It shows that the male adopters of improved sesame production technologies had higher output compared to the male non-adopters. The result also show that female non-adopters of improved sesame production technologies had a slightly higher output than the female adopters. Also, from the findings, Adopters of improved sesame production technologies recorded a higher output than the non-adopters under the pooled. The increased output observed among the adopters confirmed the importance of improved technologies which is primarily aimed at increasing farmers' productivity. Expectedly, farmers adopt innovations when yield increase in guaranteed. This finding is consistent with Kalinda *et al*. (2014) who found that adoption decision is determined by expectations about yield and output price. The result is further consistent with the findings of Bezu *et al*. (2014) who reported that farm output and income of farmers in Malawi increased with improved maize varieties.

Table 3: Effects of adoption of improved sesame production varieties

Items	**Male farmers**		**Female Farmers**		**Pooled**	
	Adopters	Non-Adopters	Adopters	Non-Adopters	Adopters	Non-Adopters
Obs.	101	84	36	12	173	60
Mean (bags of 50kg)	50.98	41.46	43.31	43.75	46.22	34.92
Std. Error	2.24	1.83	3.16	6.66	1.42	2.46
Z-value	3.20^{***}		0.07^{NS}		4.02^{***}	

Source: Field Survey Data, 2022 *** = 1% level of significance

CONCLUSION AND RECOMMENDATIONS

Conclusively, the study assessed gender dimension in the adoption of improved sesame production technologies among farmers in Kogi State, Nigeria. Most of the sesame farmers in the study area were male farmers who were still young. They had large households and were educated. They also a long time of farming experience and had small farm sizes. Male farmers' decision to adopt improved sesame seed technology was influenced by awareness, education, farming experience, and farm size; while education influenced female farmers' decision to adopt. The intensity of adoption by both the male and female farmers was determined by awareness, education, and farming experience. Also, the adopters of improved sesame production varieties recorded higher output than the non-adopters.

RECOMMENDATIONS

Based on findings of this study the following policy recommendations were made:

(v) Awareness play significant role in influencing sesame farmers' decision to adopt improved production technologies and the intensity of adoption. Government and relevant stakeholders should provide relevant awareness and trainings to sesame farmers in the study area on the various recommended sesame production technologies.

(vi) The small farm size which could be attributable to inadequate inputs, emanating from lack of credit facilities can be improved upon through the provision of micro-credit facilities (loans) to the farmers by the government.

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