EFFECT OF OFF-FARM INCOME ON AGRICULTURAL TECHNOLOGY ADOPTION AMONG MAIZE FARMING HOUSEHOLDS IN KOGI STATE, NIGERIA

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ABSTRACT
The study examined the effect of off-farm income on agricultural technology adoption among maize farming households in Kogi State, Nigeria. The study was carried out in 2018/2019 farming year. Primary data was utilized in the study. The data was collected using questionnaire. A total number of One hundred and twenty (120) maize farming households were randomly selected for the study. Data obtained were analyzed using descriptive tools, poisson regression and likert rating scale. The results of the study revealed that majority (71.7%) of the farming households were male-headed with a mean age of 36 years. Also, majority (75.8%) of the respondents were married. Neighbours and friends (71.7%), cooperatives (62.5%) and esusu/ajo (63.3%) were the major off-farm income sources available to the farmers in the study area. The regression results revealed that age, farm size, education, and off-farm income were the major factors influencing adoption of agricultural technology in the study area. The study concluded that off-farm income have positive relationship with agricultural technology adoption in Kogi State, Nigeria. The study therefore recommended that attention be given to how to help maize farmers in the study area generate more off-farm income so as to enhance the adoption of agricultural technology among maize farmers.
Keywords: Off-farm income, Agricultural Technology, Kogi State, Nigeria,Adoption

INTRODUCTION

Agriculture plays an important role in economic growth, enhancing food security, poverty reduction and rural development. It is the main source of income for around 2.5 billion people in the developing world. The sector is dominated by smallholder farmers, who serve as a vital development tool for achieving poverty and hunger reduction (Mwangi and Kariuki,2015). The sector plays an important role in the economic development of Nigeria economy and is mainly practiced under rain fed condition. (Manza and Atala, 2014**).** Though majority of smallholder farmers relies on traditional methods of production and this has lowered the level of productivity. Despite this 70% of the maize production in the majority of developing countries is from smallholders who use traditional methods of production (Muzari *et al.,* 2012). These farmers generally obtain very low crop yields because the local varieties used by the farmers have low potential yield. Most of the maize grown under rain-fed conditions and irrigation is used only in limited areas, little or no fertilizers are used and pest control is not adequate (Muzari *et al*., 2012).

Consequently, the rural economy is characterized by two major activities: farm and non-farm economic activities. Nonetheless, one of the most established characteristics of rural households in developing countries is that they can obtain their incomes from different sources Odoh and Nwibo, 2017). Farming household income diversification is the norm in rural societies and owing to the risks and uncertainties that characterize agriculture, attention of most farming households in developing countries is gradually shifting to non-farm activities (Odoh and Nwibo, 2017). Off-farm activities have become an important component of livelihood strategies among farm households in most developing countries. Studies have reported a substantial and increasing share of off-farm income in total household income (Haggblade, Hazell, and Reardon,2007). Off-farm income activities include activities like processing, marketing, manufacturing, wage and casual local employment in the rural villages.

Furthermore, Omotayo (2016)reported that the livelihoods of rural households are more often characterized by complex strategies that involve multiple income-generating activities by one or more household members, as non-farm income sources assume an increasingly important role over time.In addition, there is no reason to assume that the impact of nonfarm income on agricultural outcomes would be homogenous either across types of farm households or across space (Omotayo, 2016).It has however been reported that off-farm income is a substitute for borrowed capital in rural economies where credit

markets are either missing or dysfunctional (Ellis and Freeman, 2004). In addition, off-farm work may serve as collateral to facilitate access to credit by small-scale farmers. In summary, off-farm income is expected to provide farmers with liquid capital for purchasing productivity enhancing inputs such as improved seed and fertilizers (Diiro,*2013).* On the other hand, pursuit of off-farm income by farmers may undermine their adoption of modern technologies (especially labor intensive technologies) by reducing the amount of household labor allocated to farming enterprises (Diiro,*2013;*Goodwin and Mishra, 2004).

Agricultural technologies play immense role in increasing food productivity. As a result, it is useful to examine the adoption of technologies among farmers(Udimal *et al.*,2017). Agricultural technologies are said to include all kinds of improved techniques and practices which influence the growth of agricultural output (Udimal *et al.*,2017).New agricultural technology enhances sustainable production of food and fiber is therefore critical for sustainable food security and economic development. This has made the dynamics of technical change in agriculture to be an area of intense research since the early part of twentieth century (Mwangi and Kariuki,2015). According to Loevinsohn *et al*. (2013) the most common areas of technology development and promotion for crops include new varieties and management regimes; soil as well as soil fertility management; weed and pest management; irrigation and water management. Conversely, by virtue of improved input/output relationships, new technology tends to raise output and reduces average cost of production which in turn results in substantial gains in farm income (Challa, 2013).

Given the importance of off-farm work to farm households, off-farm income has been recently added to the analysis of technology adoption (Gedikoglu and Parcell,2013).Adoption of improved technologies is believed to be a major factor in the success of the green revolution experienced by Asian countries (Udimal *et al.*,2017). According to Mwangi and Kariuki (2015), the rate of adoption of these technologies has remained low in most of the developing countries. Most smallholder farmers rely on traditional methods of production and this has lowered the level of productivity. Several empirical studies have been carried out to investigate the factors that determine agricultural technology adoption (Akudugu *et al.,* 2012; Loevinsohn *et al.,* 2012). Most adoption studies have attempted to measure socio-demographic factors, through the farmer's education, age, experience and household size (Fernandez-Cornejo *et al.*, 2007; Keelan *et al.,* 2009; Mignouna *et al.,* 2011). While the finding of low levels of technology adoption is well accepted, few studies attempt to explain the effect of off-farm income on the adoption of agricultural technology in among maize farmers in Kogi State, Nigeria. This constitutes a gap literature that this study seeks to help fill. This is considered to be very critical given the role played by maize in human and animal diets as well as its role as raw material in industry. The present study analyzes the effect of off-farm income on smallholder maize farmer's agricultural technology adoption. The study utilized maize production as its case study. The study hypothesized that off-farm income should enhance agricultural technology adoption among smallholder farmers in Kogi State, Nigeria. The outcome of the study will be of great benefits to farming community, agricultural policy makers and other relevant stakeholders and by extension the country at large as a result of its likely effect on increase productivity of the farmers. The major objective of paper is to examine the effect of off-farm income on agricultural technology adoption among rural farming households in Kogi State, Nigeria. The specific objectives of the study are to;

i. identify the socio-economic characteristics of maize farming households in Kogi state, Nigeria;
ii. identify the different agricultural technologies adopted by the respondents;
iii. examine the different sources of off-farm income available to the maize farming households;
iv. assess the relationship between off-farm income of the respondents and agricultural technologies adopted by the farmers in the study area;
v. identify the challenges limiting the adoption of agricultural technologies among maize farming households.

RESEARCH METHODOLOGY

STUDY AREA

Dekina and Ofu local government areas in Kogi State have their administrative headquarters in the town of Dekina and Ugwolawo respectively. located in the eastern senatorial district of Kogi State otherwise known as Kogi East Senatorial Zone alongside Ankpa, Bassa, Ibaji, Idah, Igalamela-Odolu, Olamaboro and Omala local government area. Dekina forms a Federal constituency alongside Bassa local government area while Ofu forms a federal constituency alongside Idah, Igalamela and Ibaji local government areas. Dekina local government area covers an area of 2,461 km². With a population of 260,968 as at the 2006 national population census, Dekina is the largest local government area by population in Kogi State, after Okene local government area. Dekina local government area is bounded in the east by Ankpa local government area, in the west by Ajaokuta, Omala and Ankpa local government areas, in the north by Bassa local government area and in the south by Ofu local government area, all in the same Kogi State.

SOURCES AND TYPES OF DATA

The use of primary data was employed for the study. The data were collected through the use of questionnaire.

SAMPLING PROCEDURE

Multi-stage sampling was used. In stage one, Five (5) wards were randomly selected in each of the Local Government Areas to be used. In stage two, One farming community were randomly selected from each of the five wards selected earlier, and then 12 respondents were randomly selected from each of the farming communities making a total number of one hundred and twenty (120) respondents in all. The 120 questionnaire were completed and returned for the study.

METHOD OF DATA COLLECTION

Model Specification

The Poisson Maximum Likelihood Estimator requires that the data be Poisson distributed with density function of Poisson regression model as given by (Gbenga *et al.*,2020):

Where;

$\lambda i = \exp(\alpha + X'\beta)$ and $yi = 0,1\ldots\ldots i$ is the number/count food eaten by the household X = a vector of predictor variables

Following (Animashaun, 2012) the expected number of the events, yi

$E(yi/xi) = var[yi/xi] = \lambda = \exp(\alpha + X'\beta)$ - 2

For i = 1, 2……m

Determinants of agricultural technology adoption

Based on the model above, the implicit functional form of the model estimated to examine the determinants of agricultural technology adoption is specified as:

$Y = a + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + e$ - -(3)

Where;

Y = Agricultural technology adoption (Numbers of technologies adopted),

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Sampling procedure was strictly followed in getting data since questionnaires were administered in other to collect information from respondents in the study area, the questionnaires were administered, ensured to be completed accurately and verified for consistency during pretesting.

ANALYTICAL TECHNIQUES

Descriptive and inferential statistics were used to analyze data collected from the field. Objective 1-3 was analyzed using descriptive statistics such as mean, frequency and percentage, Objective 4 was analyzed using poisson regression model and Objective 5 was analyzed using likert scale.

$$F(yi/xi) = \frac{e^{-\lambda(x)}\lambda i(x)^{(y)}}{\Gamma(1+yi)} \quad - \quad 1$$

X_1= Educational level (Numerical)

X_2=Household farm size (hectare),

X_3= Household annual off farm income (Naira),

X_4=Farming experience (Years of farming experience),

X_5= Access to extension (dummy: Yes =1 or No=0),

e = error term

a = constant

β=parameter coefficients to be estimated

RESULTS AND DISCUSSION

The socio-economic characteristics of the respondents are presented in Table 1. The socio-economic variables considered in this study include: sex, age, marital status, farming experience, household size, level of education, farm size, access to credit and cooperative society

Table 1. Socio-economic characteristics of Maize farming households

Variables	Frequency	Percentage	Mean
Sex			
Male	86	71.7	
Female	34	28.3	
Age (years)			
21-30	6	5.0	
31-40	38	31.7	36 years
41-50	45	37.5	
51 and above	31	25.8	
Marital status			
Married	91	75.8	
Unmarried	29	24.2	
Farming experience			
1-10	71	59.2	
11-20	33	27.5	11 years
21-30	16	13.3	
Household size			
1-5	32	26.7	

6-10	47	39.2	6 persons
10 and above	41	34.2	
Level of education			
Non-Formal Education	8	6.7	
Primary Education	11	9.2	
Secondary Education	30	25.0	
Tertiary Education	71	59.2	
Farm size (hectares)			
1.00 -2.00	44	36.7	
2.10-3.00	40	33.3	3.45
Greater than 3.00	36	30.0	
Access to credit			
Credit access	21	17.5	
No Credit access	99	82.5	
Cooperative society			
Member	70	58.3	
Non-member	50	41.7	
Total	**120**	**100.0**	

Source: Field Survey, 2019

The results in Table 1 shows that majority (71.7%) of the farmers were male while only 28.3% were females. This may be because men actually do most of the tedious work on the farm.Abiodun and Damilola (2018), show that sex was a positive and significant variable that influenced the adoption of maize technologies in their research. This implies that the adoption of improved maize production technologies was gender sensitive.

The result further shows that majority (37.5%) of the farmers were within the age range of 41-50 years of age with a mean of 36 years. This shows that the farmers are within their active economic years to carry out farming activities. This is line with Umar *et al.* (2014) who reported that majority of maize farmers (78.6%) were within the active age range of 25-54 years.Arif*et al.* (2018) alsoreported that, the coefficient of farmer's age had a positive relationship with the adoption of technology, and the estimated marginal effect indicates that the probability of adopting the technology increases by 0.3%. These results of the study are consistent with the results of Grazhdani (2013). Education plays an important role in judging the behaviours and attitude of the farmers (Aydogdu &Yenigün, 2016) and creates opportunities to improve the managerial ability of farmers (Nyuor *et al.*, 2016).

The result revealed that majority (75.8%) of the respondents was married while 24.3% were unmarried. Umar *et al.* (2014) indicates that most of the respondents were married with 58% being in monogamous marriages, 35.2 % in polygamous marriages and only a small proportion (5.7%) single. The high number of married respondents may lead to higher adoption of agricultural technologies.The resultalso shows that 59.2% of the farmers had farming experience ranged of 1-10 years while 13.3% had farming experience ranged of 21-30 years. The mean farming experience was 11 years. This implies that majority of the maize farmers had enough farming experience, this could influence the decision to adopt maize technology. This is in line with Abiodun and Damilola (2018) who reported that farming experience had a positive influence on the adoption of improved maize production technologies at the 5% level of significance. This implies that as maize farmers increased their adoption level they advanced in farming experience. A more experienced farmer may have a lower level of uncertainty about the innovation performance and also be able to evaluate the advantage of the technology being considered.

Distribution of respondent according to household size revealed that 39.2% of the respondents had household size ranged of 6-10 members while 34.2% had household size of above 10. The mean household size of maize farmers in the study area was 6 members. This implies that most of the farmers in the study area had large household size. This could be an added advantage to maize production as more hands will be available for various production practices.

The result revealed that a high proportion (59.2%) of the respondents had tertiary education, about 25% had secondary education, 9.2% had primary education while only 6.7% had no formal education. This implies that majority of farmers were literate. High level of literacy among the respondents may facilitate better adoption of improved technologies and better ability of impacting knowledge and skills for adoption of an innovation. This is in contrast with the results of Umar et al. (2014) who reported low level of education among maize farmers in the study area. Low level of formal education may limit adoption of improved technologies including the improved maize varieties.Abiodun and Damilola (2018) also show that 'Years of education' have a positive and significant influence on the adoption of maize technologies. This implies that the more educated a farmer was, the more likely to adopt any innovation. The education level of a farmer increased his/her ability to obtain, process and use the informationrelevant to the adoption of a

new technology (Mignouna *et al.,* 2011; Lavison,2013; Namara *et al.*, 2003).

The results showed that 36.7% of the farmers had farm size ranging from 1.00-2.00 hectares, 33.3% had farm size of between 2.10-3.00 hectares while 30% had farm size of more than 3.00 hectares. The mean farm size was 2.45hectares.

The results indicated that the majority about (82.5%) of the farmers had no access to credit to finance their maize production activities while 17.5% had access. Adequate funding is required by farmers to finance all crop production activities. This is also confirmed by Umar et al. (2014) who revealed that only 6.6% of the respondents had access to credit. This indicates that most of the farmers did not have access to credit and this may limit the adoption of improved technologies including the improved maize or may not increase area under cultivation. Access to credit is important in influencing the likelihood of adoption of improved maize seed among farmers. The importance of agricultural credit in production cannot be over emphasized Umar et al. (2014). Most farmers fear trying improved technologies because they do not have the necessary financial resources to adopt such technologies.

The results revealed that about 41.7% of farmers do not participate in any cooperative association. However, majority (58.3%) were members of cooperative societies. Bamire *et al.* (2010) found that interaction of farmers with other farmers is an avenue through which diffusion of innovation can occur.

Agricultural technologies adopted by the maize farmers in the Study Area

Table 2: Agricultural technologies adopted

Technologies	Frequency (*)	Percentage
Fertilizer	106	88.3
Pesticides	92	76.7
Herbicides	76	63.3
Spacing	48	40.0
Change in planting date	59	49.2
Improved Seed	85	70.8
Pruning	76	63.3
Thinning	51	42.5
Fungicides	50	41.7

Source: Field Survey, 2019(*) = Multiple responses allowed

Results in Table 2 shows the various types of technology adopted for agricultural production by the respondents in the study area. This includes fertilizer 88.3%, pesticides 76.7%, Improved Seed 70.8%, Pruning 63.3% and Herbicides 63.3%. This showed that farmers were aware of the importance of using fertilizer in maize production. Only 41.7% applied fungicides, 49.2% adjust planting dates and thinning 42.5%. these findings is supported by Ugwumba and Okechukwu (2014) who indicated that, the use of hybrid maize seeds came first with80% adoption level, followed by use of fertilizer (45%), use of agro-chemicals (40%) and finally, use of organic manure (20%). This result implied that the levels of adoption of the improved maize production technologies (apart from use of hybrid maize seeds which is the cheapest in acquisition) attained by the farmers would have been higher if not the problem of high cost of the technologies. That is, the cheaper the technology, the higher the level of adoption. Abiodun and Damilola (2018) reported that the most common maize production technologies farmers adopted in the study area was: inorganic fertilisers, use of pesticide, and use of knapsack sprayer. The least adopted technologies were: seed planter, grain harvester, tractor and improved pest scaring devices.

Sources of off-farm income available to the rural farming households

Table 3: Sources of off-farm income available to the rural farming households

Sources	Frequency	Percent
Trading	75	62.50
Government employment	30	25.00
Artisans	6	5.00
Transport business	2	1.67
Remittance	7	5.83
Total	**120**	**100.00**

Source: Field survey, 2019

Result in Tables 3 shows that 62.50% of respondents engaged in trading as their source of off-farm income, 25.00% were employed by the government which pays them wages. It also shows that 5.00% of the respondents were artisans, 1.67% engaged in transport business and 5.83% of the respondents agreed to earning off-farm income from remittance which implies having access to income from friends, family and relatives. Onyebu (2015) indicated that, the majority of the women apart from farming, engage in Trading, processing of agro products, hair dressing, tailoring, food vending, weaving of clothes, mat making and black soap making. This implies that women sampled engaged in different activities so as to ensure household food security. Also a research by Nmeregini *et al.* (2019) revealed that about 55.0% of the respondents were involved in non-farm activities under service category, while 46.88% of the respondents were involved in trade and commerce. However, 41.88% of the respondents were involved in petty trading followed by transportation, tailoring and processing of produce (18.75%), (11.88%) and (7.50%) respectively. This result corroborates with Awoyemi, (2011) where 41.95% of the respondents were in service non-farm category and 15.34% in sales. The involvement of the rural household mostly in service non-farm category could be due to the fact that most of the non-farm activities under service non-farm category require little or no technical skill to undertake.

Relationship between off-farm income and agricultural technology adoption

Table 4: Regression results of the relationship between off-farm income and adoption of agricultural technology

Variables	Coefficient	Std error	p>|z|
Educational level	2.120	0.3681	0.000***
Farm size	0.0272	0.0383	0.653
Off farm income	3.62e-07	1.43e-07	0.016**
Farming experience	-0.0004	0.0014	0.866
Access to extension	0.1328	0.0580	0.865
constant	0.5931	0.2314	0.014
Log-likelihood	251.929		
Pseudo R^2	0.1423		
LR X^2	78.51		
prob.>X^2	0.0000		

Source: Field Survey, 2019 Note: *** and ** indicate significance level at 1%, 5%

The table above presents the result of poisson regression model analysis on the factors influencing agricultural technology adoption in rural farming households of Dekina and Ofu local government areas of Kogi State, Nigeria. The result showed that the probability of maize farming households adopting agricultural technology is influenced by educational level and off-farm income. The coefficient of educational level was found to be positive and significant at 1% implying that adoption of agricultural technology increases with higher level of education, the positive and significant effect of higher educational level of rural households is that increased educational level leads to increase in their adoption of agricultural technology. The result of the study is consistent with Zavale *et al.,* (2005) who studied the adoption of improved seed by smallholder farmers and found a positive and significant effect of education on the probability of adoption of improved maize seeds. This is also supported by Ugwumba and Okechukwu (2014) who reported that educational level had positive and statistically significant influence on level of adoption of the technologies at 5% probability level. This implied that educated maize farmers in the area were more likely to adopt the improved maize production technologies, improve their productivity and earn higher income. The coefficient of off-farm income was also found to be positive and significant at 5% implying that agricultural technology adoption among maize farmers' increases with increase in off-farm income. The positive effect of off-farm income suggests that off-farm earnings may enhance agricultural technology adoption by supplying maize farmers with money needed for buying maize technologies when required. The finding of the study is consistent with Diiro (2013), who reported similar result that off-farm income is positively associated with modern technology adoption among maize farmers. The result of the study suggests promoting off-farm income generating activities could be an important policy approach that can be used to enhance increased adoption of technologies.

Factors limiting agricultural technology adoption among maize farming households

Table 4: Factors limiting agricultural technology adoption among the farming households

Problems	VGE	GE	TSE	LE	NE	Mean score
Inadequate access to extension services	61	34	11	13	1	4.18
Lack of information on rainfall	34	38	41	7	0	3.83
Inadequate financial resources	42	63	12	0	3	4.18
High illiteracy level among farmers	41	26	32	8	13	3.62
High cost of improved crop varieties	33	52	23	3	9	3.81
High cost of irrigation facilities	41	48	23	4	4	3.98
Inadequate land	31	45	29	14	1	3.76
High cost of chemical input	49	34	18	5	14	3.83
Poor weather and climatic condition	40	49	19	5	7	3.92

Source: Field Survey, 2019

VGE = Very Great Extent, GE = Great Extent, TSE = To Some Extent, LE = Little Extent, NE = No Extent

Results in Table 4 shows that inadequate financial resources and Inadequate access to extension services with a mean score of 4.18 were rated as very strong factors limiting the adoption of agricultural technology to a great extent by the farmers in the study area. Poor weather and climatic condition with a mean score of 3.92 was also one of the factors limiting the adoption of agricultural technology adoption in the study area. High cost of irrigation facilities with a mean score of 3.98 was also a limiting factor. High cost of improved crop varieties with mean score of 3.81 and high cost of chemical input with a mean score of 3.83 were also mentioned as factors limiting agricultural technology adoption. Inadequate land with a mean score of 3.76 was a problem that affects adoption of agricultural technology to some extent. Umar *et al.* (2014) showed that inadequacy of seed was the major constraint; followed by inadequacy of fertilizer, cost of seed being the third constraint faced by farmers in the study. Thus the unavailability of seed and fertilizer were major constraints to adoption as all of the varieties promoted needed fertilizer for maximum output to be realized. Also Yitbarek (2017) also reported that the factors affecting adoption of technologies are accessibility to market, wealth status of farmers, access to credit, technology access, size of cultivars etc. These show that adoption of technologies in Agriculture is still faced with a lot of challenges.

CONCLUSION

The study analyzed the effect of off-farm income on agricultural technology adoption among maize farming households in Kogi State, Nigeria. The study was carried out in the year 2018/2019 farming season. The analytical results demonstrated that off-farm income is very important for the adoption of agricultural technology among smallholder maize farmers in the study area. The results revealed that farmers' off-farm income and educational qualification both were positive and significant based on the results of the study.Based on the findings of the study, the study concluded that Off-farm income and educational qualification of maize farmers significantly influenced the adoption of agricultural technology in the study area. The study therefore recommended that income diversification should be encouraged as a means of improving farm household income since it has direct implication on the adoption of agricultural technology. The study also recommended that farmer's education be pursued as a means of enhancing agricultural technology adoption.

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