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ECONOMICS OF INTEGRATED PEST MANAGEMENT AND PESTICIDES USE DECISION MAKING PROCESS AMONG COWPEA FARMERS, KADUNA STATE, NIGERIA.

ALABI,[1] Olugbenga Omotayo; DAVID[2] Hyelni Seth; SANUSI,[3] Saheed Olakunle;
MADAKI, [4]Musa Janga ; OMOLE, [5]Ebunlola Bosede ; OLOHUNGBEBE, [6]Sheu Ahmad;
OLADELE, [7]Ayoola Olugbenga; OLUMUYIWA, [8]Samson Abiade;
WAZIRI-UGWU[9], Phidelia Ramatu, and IBRAHIM[10], Azeez Olalekan

[1]Department of Agricultural-Economics, University of Abuja, PMB 117 Gwagwalada-Abuja, Nigeria.

[2]Department of Agricultural-Economics and Extension, Federal University Gashua, PMB 1005, Gashua, Yobe State, Nigeria.

[3]Department of Agricultural-Economics and Extension, Federal University Gashua, PMB 1005, Gashua, Yobe State, Nigeria.

[4]Department of Agricultural-Economics and Extension, Federal University Gashua, PMB 1005, Gashua, Yobe State, Nigeria.

[5]Basic Science Department, Federal College of Wildlife Management (FCWM), Forestry Research Institute of Nigeria (FRIN), PMB 268 New Bussa, Niger State, Nigeria.

[6]Department of Agricultural Economics and Extension, Faculty of Agriculture, Federal University Kashere Gombe, PMB 0182, Gombe State, Nigeria.

[7]Department of Agricultural Extension and Management, Federal College of Forestry Mechanization, Forestry Research Institute of Nigeria (FRIN), PMB 2273, Afaka, Kaduna, Nigeria.

[8]Department of Basic Sciences and General Studies, Federal College of Forestry Mechanization, Forestry Research Institute of Nigeria (FRIN) PMB 2273 Afaka, Kaduna, Kaduna State, Nigeria.

[9]Department of Agricultural-Economics and Extension, Federal University Gashua, PMB 1005, Gashua, Yobe State, Nigeria.

[10]Federal College of Wildlife Management (FCWM), Forestry Research Institute of Nigeria (FRIN), PMB 268 New Bussa, Niger State, Nigeria.

ABSTRACT

Agricultural sustainability can be achieved through Integrated Pest Management (IPM). Integrated Pest Management (IPM) incorporates economic sustainability with environmental and social concerns. The goal of integrated pest management is to optimize profits and achieve agricultural and natural resource sustainability over the long period. This study evaluated economics of integrated pest management and pesticides use decision making process among cowpea farmers, Kaduna State, Nigeria. The study was designed specifically to provide answers to the following objectives: determine the socio-economic profiles of cowpea farmers, analyze costs and returns of cowpea production, evaluate factors influencing cowpea farmers' decision of adopting integrated pest management and pesticides use, evaluate factors influencing output of cowpea production, and determine the constraints facing cowpea farmers. Data used were from primary sources. Multi-stage sampling technique was adopted. A total sample size of 100 cowpea farmers was selected. Data were analyzed using descriptive statistics, gross margin analysis, financial analysis, principal component analysis and Heckman two–stage model which involve Probit model analysis and Ordinary Least Squares Regression Model. The result shows that 84% of cowpea farmers were less than 50 years of age. The mean age was 40 years. Also, 61% of cowpea farmers had less than 11 people as members of households. Furthermore, 88% of cowpea farmers had formal education. The farmer had average experiences in cowpea farming of 9 years. The integrated pest management techniques and pesticides use adopted by cowpea farmers include crop rotations, use of quality improved seeds, early harvest, use of resistant varieties, use of insecticides, use of pesticides sprays among others. Cowpea production was profitable enterprise. The gross margin and net income of cowpea production were 911,990 Naira and 889,090 Naira respectively. The gross margin ratio was 0.92. In first stage of the Heckman two-stage model, the statistical and significant factors influencing adoption of integrated pest management and pesticides use include age $(P < 0.05)$,sex $(P < 0.10)$, educational level $(P < 0.01)$, household size $(P < 0.05)$, extension contact $(P < 0.05)$, and experiences in cowpea farming$(P < 0.10)$. In the second stage, factors significantly influencing output of cowpea production were age$(P < 0.10)$, sex$(P < 0.10)$, educational level$(P < 0.05)$, household size$(P < 0.10)$, farm size$(P < 0.05)$ and labour input$(P < 0.10)$. Lack of improved seeds, lack of extension agents, lack of storage facilities, lack of chemical inputs and bad roads infrastructures were constraints facing cowpea farmers. The retained constraints explained 71.42% of all components included in the principal component model. The study recommends that extension agents should be employed to train farmers on integrated pest management and pesticides use, improved quality cowpea seeds should be provided and feeder roads should constructed for easy evacuation of cowpea produce to market centres.

Keywords: Economics, Integrated Pest Management, Pesticides Use, Heckman Two-Stage Model, Kaduna State, Nigeria

INTRODUCTION

Cowpea (*Vigna unguiculata L*) is a leguminous crop and it is a good and cheap source of plant protein. It can be used as animal feed when the demand for animal feed reach the peak during the dry season. Cowpea is very important for rural livelihoods of millions poor people in Nigeria. Nigeria is the largest consumer and producer of cowpea both in West Africa and the World (Coulibaly and Lowenberg-Deboer, 2000). Cowpea can reduce poverty and has potentials of serving as food security crop in Africa. Countries that principally produced cowpea are Nigeria, Ghana, Niger, Senegal, Burkina Faso and Mali (FAOSTAT, 2000). Niger is recorded to be the largest exporter of cowpea in West Africa and the World (Coulibaly and Lowenberg-Deboer, 2000). Niger export 215,000MT of cowpea annually to Nigeria. Nigeria and Niger produced 2,099,000 and 641,000 MT of cowpea annually (FAOSTAT, 2000). Considering the importance of cowpea in reducing poverty, and as food security crop, increasing the production, marketing and storage are faced with a lot of challenges and constraints that need attention of researchers, policy makers, development economics and stakeholders. In West Africa, cowpea is grown on a smallscale, subsistence in the Sahelian regions and savannah, dry and lowland (Coulibaly and Lowenberg-Deboer, 2000). Cowpea is grown as sole crop or in relay cropping with maize, millet and sorghum which are cereal crops (Adewuyi and Okunmadewa, 2005). The profitability of cowpea in all the farming system employed by farmers depend on the management and cropping practices employed such as the chemicals used, pesticides, fertilizers; also depend on the improved or local varieties planted; and access to output and input markets. Cowpea production can significantly be increased with adoption of pesticides that can be sprayed on the crop by farmers (Okike *et al*, 2007). Cowpea yields are generally low as a result of insect pest and diseases, weeds, drought and excessive mixtures with other crops (Gongula and Garjila, 2005). The major problem to cowpea yields is pest and diseases (Ibrahim and Tilson, 2007). There is an inadequate record of the economic benefit or profitability of pesticides applications to cowpea for farmers (Ibrahim and Tilson, 2007). The impact and intensity of insect pest infestation on cowpea in the absence of availability and affordability of pesticides has led the cowpea farmers abandoning the crop.

Integrated Pest Management tries to create an environment sustainability which it is difficult for pest to appear or thrive, and discourage the use of pesticides. Researchers have suggested Integrated Pest Management (IPM) as a solution to problem of pest and pesticides misuse among cowpea farmers. Integrated pest control can be defined as an ecological approach to management of pest which combines non-chemical and chemical control methods that minimize risk to people and also the environment. Integrated pest management reduces the use of chemicals by farmers, also reduces the impacts on environment, people and saves money. Integrated pest management is a comprehensive approach and also an ecosystem approach of crop protection and production that combine different management practices of reducing the pest status to tolerable levels and maintaining the quality of environment. Integrated pest management integrates multiple pest management such as biological, chemical, mechanical and cultural methods. It is a decision making process whereby inspections, observations and monitoring were used to make decisions on pest control methods based on the pre-determined management objectives. Records keeping to documents procedures and results together with evaluation are crucial in integrated pest management. The overall goal of integrated pest management is to reduce health and environmental risks of pesticides within economic and social constraints. Integrated pest management has been accepted worldwide for managing pest. The adoption of integrated pest management is very slow when compared to pesticide intensive pest management. Integrated Pest

Management is an environmental sustainable and economically practical method of controlling pest based on belief that most diseases, weeds, insect and other pests can be controlled by employing good management practices and maximizes many controls already existing in nature. Integrated pest management is cost effective, it meets sustainable developments requirements, allows cowpea farmers to manage pest in sound environment and can be adopted under local conditions. After cowpea farmers make decision to implement integrated pest management controls, farmers must carefully select various control options based on the effectiveness, environment and human safety. When using chemical control method, the least toxic chemical method should be selected. Integrated pest management approach laid emphasis on making decisions on pest control together with increased information and the integration of cultural, biological and chemical methods of control. It utilizes all available techniques of controlling pest and maintains the pest population at levels below economic injury level.

Objectives of the Study

The objective broadly evaluated economics of integrated pest management and pesticides use decision making process among cowpea farmers in Kaduna State, Nigeria. Specifically, the objectives were designed to achieve the following;

(i) determine the socio-economic profiles of cowpea farmers,

(ii) analyze costs and returns of cowpea production,
(iii) evaluate factors influencing cowpea farmers' decision of adopting integrated pest management and pesticides usage,
(iv) evaluate factors influencing output of cowpea production, and
(v) determine the constraints facing cowpea farmers.

METHODOLOGY

The research study was conducted in Kaduna State, Nigeria. Kaduna State has a land mass of 46, 053 Km^2 with Latitudes 10^0 20^0 N and Longitudes 7^0 45^IE. Kaduna State has a population of 6, 113, 503 people (NPC, 2006). Majority of people are farmers and crop grown include maize, millet, groundnut, cowpea, rice, yam, cassava, and sorghum. The inhabitants also reared animals like goats, sheep, poultry birds, and cattle. Data were of primary sources. Data were collected with the use of questionnaire. The questionnaire was subjected to validity and reliability test. Multi-stage sampling method was adopted. In the first stage, Kaduna State was randomly selected using ballot-box raffle draw method. In the second, third and fourth stages, Igabi Local Government Area, 5 wards, and 5 villages were randomly selected respectively using ballot-box raffle draw method. In the fifth and final stage, proportional randomly sampling method using Yamane (1967) was adopted to select 100 cowpea farmers. Yamane (1967) formula for estimating sample size is stated as:

$$n = \frac{N}{(1+N(e)^2} = 100 \ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where,

n = Sample Size (Units).

N = Sample Frame (Units).

e = Level of Precision (5%).

Data obtained from the field were subjected to statistical and econometrics analysis.

Descriptive Statistics: This includes frequency distributions, mean, and percentages. This was used to have a summary statistics of data collected from cowpea farmers. This was used to achieve specific objective one.

Gross Margin Analysis: Profitability of cowpea production was evaluated using gross margin model:

$$GMA = \sum_{j=1}^{m} P_j\, Y_j - \sum_{j=1}^{n} P_i\, X_i \text{ ……………………………..(2)}$$

Where,

P_j = Unit Price of Cowpea Product (Output)

Y_j = Quantity of Output

P_i = Unit Price of Variable Inputs Used in Cowpea Production

X_i = Quantity of Variable Inputs i, j….n, m

$$\textit{Net Farm Profit (NFP)} = \left[\sum_{j=1}^{m} P_j\, Y_j - \sum_{j=1}^{n} P_i\, X_i\right] - K \text{ …….(3)}$$

Where,

K = Fixed Costs

This was used to achieve specific objective two

Financial Analysis: Gross Margin Ratio (GMR) following Ben-Chendo (2015) was used to determine the profitability of cowpea production.

$$Gross\ Margin\ Ratio = \frac{Gross\ Margin}{Total\ Revenue} \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

This was used to achieve specific objective two.

Heckman Two-Stage Model:

(a) Probit Model Analysis: The Probit Model is stated thus:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e_i \ldots\ldots..(5)$$

$$Y_i = b_0 + \sum_{i=1}^{6} b_iX_i + e_i \ldots\ldots\ldots\ldots(6)$$

Where,

Y_i =Dichotomous Adoption of Integrated Pest Management and Pesticide Usage (1, Adopt; 0, Otherwise)

X_1 = Age (Years)

X_2 = Sex Dummy (1, Male; 0, Female)

X_3 = Educational Level (1, Formal Education; 0, Otherwise)

X_4 = Household Size (Number of Persons)

X_5= Extension Contact (1, Contact; 0, Otherwise)

X_6 = Experiences in Cowpea Farming (Years)

b_0 = Constant Term

$b_1 - b_6$ = Regression Coefficients

e_i= Error Term

This was used to achieve specific objective three

(b) Ordinary Least Square Model (OLS): The Ordinary Least Square Regression model is stated thus:

$$Y = b_0 + \sum_{i=1}^{6} b_iX_i + e_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

The explicit function is stated:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e_i \ldots\ldots..(9)$$

Where,

Y_i = Output of Cowpea Products (Kg)

X_1 = Age (Years)

X_2 = Sex Dummy (1, Male; 0, Female)

X_3 = Educational Level (1, Formal Education; 0, Otherwise)

X_4 = Household Size (Number of Persons)

X_5= Farm Size (Hectares)

X_6 = Labour Input (Mandays)

b_0= Constant Term

$b_1 - b_6$ = Regression Coefficients

This was used to achieve specific objective four

Principal Component Analysis (PCA): The perceived constraints faced by cowpea farmers were analyzed using principal component analysis (PCA). This was used to achieve specific objective five.

RESULTS AND DISCUSSION

Socio-Economic Profiles of Cowpea Farmers

Table 1 presented the socio-economic profiles of cowpea farmers. About 84% of cowpea farmers were less than 50 years of age. The average age of cowpea farmers was 40 years. The cowpea farmers were active, resourceful, energetic and young. This means they will easily adopt innovations, research findings, and technologies. Also, 67% of cowpea farmers were male. The household sizes were large with an average of 9 people per farming households. About 61% of cowpea farmers had less than 11 people as members of households. The mean value of experiences in cowpea farming was 9 years. Furthermore, 88% of cowpea farmers had formal education and were literate. This result is in line with findings of Alabi, Banta and Manza (2016), Ibrahim and Tilson (2007).

Table 1: Socio-Economic Profiles of Cowpea Farmers

Socio-Economic Profiles	Frequency	Percentage	Mean
Age (Years)			
< 31	21	21.00	**40.20**
31 – 40	31	31.00	
41 – 50	32	32.00	
51 – 60	12	12.00	
> 60	04	04.00	
Sex			
Male	67	67.00	
Female	33	33.00	
Household Size (Units)			
1 – 5	29	29.00	**9.45**
6 – 10	32	32.00	
11 – 15	20	20.00	
16 – 20	19	19.00	
Educational Status			
Non-Formal	11	11.00	
Primary	33	33.00	
Secondary	45	45.00	
Tertiary	11	11.00	
Experiences in Farming(Years)			
1 – 5	27	27.00	**9.10**
6 – 10	39	39.00	
11 – 15	19	19.00	
16 – 20	15	15.00	
Total	**100.00**	**100.00**	

Source: Field Survey (2019), Computed using STATA 14

Integrated Pest Management Practices Adopted by Cowpea Farmers

Farmers adopt technologies that are sustainable when their expected utility from the new technology exceed that of the current technology. Table 2 presented the techniques of integrated pest management adopted by cowpea farmers. The management techniques were integrated; cowpea farmers combined crop management practices. Crop rotations happens to be the most adopted integrated pest management technique with 12.11%, appropriate weeding, the use of improved cowpea seeds and use of insecticides spray according to recommended practices had 09.70%, 09.44% and 09.31% were ranked 3rd , 4th and 5th respectively. Other integrated pest management techniques adopted by cowpea farmers were early harvest of cowpea product (07.88%), use of resistant varieties to diseases and pests (06.58%), use of traps for pests (06.25%), and appropriate spacing (08.98%).This result is in line with findings of Mauceri, Alwang, Norton and Barrera (2005).

Table 2: Integrated Pest Management Technique Adopted by Cowpea Farmers

Integrated Pest Management Technique	*Frequency	Percentage
Crop Rotations	183	12.11
Use Quality Improved Seeds	145	09.44
Early Harvest of Cowpea	121	07.88
Disinfect Seeds with Insecticides	134	08.72
Use Resistant Varieties	101	06.58
Use Insecticides Spray according to Recommendations	143	09.31
Use Traps	96	06.25
Use Recommended Storage	87	05.66
Use Pesticides Sprays to Recommendations	110	07.16
Appropriate Weeding’s	149	09.70
Dispose of Residues on the Field	129	08.39
Appropriate Spacing	138	08.98
Total	***1536**	**100.00**

Source: Field Survey (2019), Computed using STATA 14 *Multiple Choices

Profitability Analysis of Cowpea Production

The analysis of costs and returns of cowpea production was presented in Table 3. The estimated values were based on the prevailing market price of cowpea products at the time of this research study. The total variable cost constitutes 84.97% of total cost of cowpea production. The total variable cost comprises of cost of seeds (13.99%), cost of weeding (08.74%), cost of chemical (10.14%), labour cost (13.99%), cost of threshing and winnowing (06.88%), cost of bagging (06.18%), cost of storage (05.48%), labour input (10.49%), and harvesting cost (09.09%). The fixed cost constitutes 15.03% of total cost of cowpea production. The fixed cost comprises of taxes, expenses, interest, and depreciation. Cowpea production was profitable with gross margin and net income of 911,990 Naira and 899, 090 Naira respectively. The gross margin ratio was 0.92 which implies that for every one Naira invested in cowpea business 92 Kobo covered profit, taxes, interest, expenses and depreciation. This result is in line with findings of Lawal, Alabi and Oladele (2016), Ibrahim and Tilson (2007), Alabi, Banta and Manza (2016), Alabi, Lawal, Awoyinka and Coker (2014), Alabi, Lawal and Oladele (2016).

Table 3: Costs and Returns Analysis of Cowpea Production

Variables	Value (Naira)	Percentage
(a) Variable Cost		
Cost of Seeds	12,000	13.99
Cost of Weeding	7,500	08.74
Cost of Chemical	8,700	10.14
Labour Input	12,000	13.99
Threshing and Winnowing	5,900	06.88
Bagging	5,300	06.18
Cost of Storage	4,700	05.48
Land Input	9,000	10.49
Harvesting Cost	7,800	09.09
(b) Total Variable Costs	**72,900**	**84.97**
Fixed Cost (Expenses, Taxes, Interest, Depreciation and Charges)	**12,900**	**15.03**
(c) Total Cost	**85,800**	**100.00**
Gross Revenue	**984,890**	
Gross Margin	**911,990**	
Net Income	**899,090**	
Gross Margin Ratio	**0.92**	

Source: Field Survey (2019), Computed using STATA 14

Factors Influencing Adoption of Integrated Pest Management and Pesticide Use among Cowpea Farmers

Adoption model is based on the theory that farmers make decision to maximize their expected utility or benefits. Benefits may include increased profitability, health, food security, lower risk, and environmental sustainability. The first stage of Heckman two-stage model involves the use of Probit model analysis. This was used to evaluate factors influencing adoption of integrated pest management and pesticide use among cowpea farmers as presented in Table 4.The statistical and significant predictor variables included in the Probit model were age $(P < 0.05)$,sex $(P < 0.10)$, educational level $(P < 0.01)$, household size $(P < 0.05)$, extension contact$(P < 0.05)$, and experiences in cowpea farming $(P < 0.10)$. The Pseudo R^2 was 0.7128 and the Log Likelihood value of -145.97 was significant at 1% probability level. The results of the marginal effects shows that as cowpea farmers acquired formal education the likelihood or probability of adoption of integrated pest management and pesticide use increases by 0.2343. Also, a 1% increase in years of experiences in cowpea farming will lead to the likelihood or probability of 11.04% increase in adoption of integrated pest management and pesticide use among cowpea farmers. Adoption of agricultural technologies increases with knowledge and human capital base of farmers and with participation in farmers' cooperative associations or groups (Adesina *et al*., 2000; Caviglia-Harris, 2003). Formal education enables farmers to respond to new technologies, new ideas and new innovations (Chaves and Riley, 2001). Farmers access to agricultural information enables farmers to optimize decision making process to adopt new agricultural technologies (Feder *et al*, 2003).Some research studies observed that farmers may prefer capital intensive more than labour intensive technologies (Orr, 2003). The characteristics of technology such as labour requirements and capital can influence the decision of farmers to adopt integrated pest management technologies. Age can influence adoption of agricultural technologies positively and negatively as the farmers grow older, the farmers will have an increase in risk aversion and the long term interest in investment on the farm will decrease. It is assumed that young farmers are less risk averse and they are willing to take and adopt new technologies (Alabi, Oladele and Oladele, 2020).

Household size is another factors that can influence adoption of new technologies. Larger households are observed to adopt new agricultural technologies more than smaller households. Household size is taken to be an indication of availability of farm family labour. Availability of family labour for farms is a significant factor for adoption of new technologies (Abatania, Gyasi, Coulibaly, Adeoti and Salifu, 2001).

Table 4: Heckman Two-Stage: Determinants of Cowpea Farmers Adoption of Integrated Pest Management Practices and Pesticides Usage

Variables	**Coefficients**	**Standard Error**	**Marginal Effects**
Age (X_1)	0.2920**	0.1168	0.2312
Sex (X_2)	1.3149*	0.6920	0.1125
Educational Level (X_3)	1.5401***	0.4400	0.2343
Household Size (X_4)	1.7602**	0.6770	0.0120
Extension Contact (X_5)	2.3011**	0.8522	0.2190
Experiences in Cowpea Farming (X_6)	2.0154*	0.9160	0.1104
Constant	1.0341	0.6894	
Diagnose Statistics			
$Wald\ \chi^2$	167.32		
Prob $>\ \chi^2$	0.0000		
Pseudo $>\ R^2$	0.7128		
Log Likelihood	-145.97		
Number of Observations	100		

Source: Field Survey (2019), Computed using STATA 14
, **, *-Significant at 10%, 5% and 1% Probability Levels*

Factors Influencing Output of Cowpea Produced among Farmers

Increasing agricultural productivity using improved agricultural technology that enhances sustainable food and fibre production is critical for sustainable food security, growth and economic development. The second stage of Heckman two-stage model involves the use of Ordinary Least Squares regression model to examine factors influencing output of cowpea produced (Table 5). The statistical and significant regressor variables included in the model were age($P < 0.10$), sex($P < 0.10$) , educational level($P < 0.05$), household size($P < 0.10$), farm size($P < 0.05$), and labour input($P < 0.10$) . All regression coefficients of exogenous variables included in the model were positive. The coefficient of multiple determinations (R^2) value of 0.7102 revealed that 71.02% of variations in the dependent variable were explained by the exogenous variables included in the model. The F-value of 89.32 was significant at 1% probability level. This implies that all exogenous variables included in the model were responsible in the variations in dependent variable. As cowpea farmers acquire formal education will lead to 0.0842 increases in likelihood or probability of output for cowpea farmers. Farm size and labour inputs have positive coefficients and significantly influence productivity of cowpea farmers. This implies than an increase of 1% in these inputs resulted in an increase in output by 43.07% and 32.29% respectively. This aligns with the outcomes of studies conducted by Coker, Ibrahim and Ibeziako (2018); Nyagaka *et al* (2010); Agwu (2004).

Table 5: Heckman Two-Stage: Factors Influencing of Output of Cowpea Farmers

Variables	Coefficients	Standard Error
Age (X_1)	0.2207*	0.1104
Sex (X_2)	0.3702*	0.1763
Educational Level (X_3)	0.2104**	0.0842
Household Size (X_4)	0.3406*	0.1703
Farm Size (X_5)	0.4307**	0.1723
Labour Input (X_6)	0.3229*	0.1538
Inverse Mill Ratio	0.2317*	0.1219
R^2	0.7102	
Adjusted R^2	0.7001	
Prob $>$ F	0.0000	
F-Value	89.32	
Number of Observations	100	

Source: Field Survey (2019), Computed using STATA 14

*, **, ***-*Significant at 10%, 5% and 1% Probability Levels*

Constraints Facing Cowpea Farmers

The constraints facing cowpea farmers were subjected to principal component analysis. The results of the principal component analysis was presented in Table 6.Principal component analysis reduces many interrelated variables into few non-correlated variables. The variables that were retained by the model had Eigen values greater than one. Lack of improved seeds with Eigen value of 2.2479 was ranked 1st based on the perceptions of cowpea farmers. Lack of extension agents with Eigen value of 1.9732 was ranked 2nd based on the perceptions of cowpea farmers. Lack of storage facilities and lack of chemical input with Eigen values of 1.8027 and 1.7701 were ranked 3rd and 4th respectively based on the perceptions of cowpea farmers. The retained constraints explained 71.42% of all predictor variables included in the model. The Chi-square value of 3992.13 was significant at 1 % probability level.

Table 6: Constraints Facing Cowpea Farmers

Constraints	Eigen-Value	Difference	Proportion	Cumulative
Lack of Improved Seeds	2.2479	0.3309	0.2909	0.2909
Lack of Extension Agents	1.9732	0.3207	0.2203	0.5112
Lack of Storage Facilities	1.8027	0.3002	0.2001	0.7113
Lack of Chemical Input	1.7701	0.2607	0.0017	0.7130
Bad Road Infrastructures	1.4001	0.2443	0.0012	0.7142
Bartlett Test of Sphericity				
KMO	0.6604			
Chi-Square	3992.139***			
Rho	1.0000			

Source: Field Survey (2019), Computed using STATA 14

****-Significant at 1% Probability Level*

CONCLUSION

Integrated Pest Management (IPM) is sustainable interventions technology without damage to the environment, reduce environmental contaminations and cost. Integrated Pest Management minimizes pest resistance problems and reduces residues of pesticides on food products. Cowpea production in the area is a profitable enterprise. The cowpea farmers were active, young, energetic and resourceful with mean age of 40 years. The average household size of cowpea farmers was 9 people per farming household. The farmers had considerable experiences with average of 9 years in cowpea farming. The integrated pest management techniques and pesticides use adopted includes; crop rotations, use of quality improved seeds, early harvest, disinfecting seeds with insecticides, use of resistant varieties, use of insecticides sprays to recommendations, use of traps, use appropriate storage systems, use of pesticides sprays, appropriate weeding, disposing crop residues on the field and appropriate spacing. The gross margin and net income from cowpea production were 911,990 Naira and 899,090 Naira respectively. The gross margin ratio was 0.92. In the first stage of Heckman two-stage model, the statistical and significant factors influencing adoption of integrated pest management and pesticide use include age, sex, educational level, household size, extension contact and experiences in cowpea farming. In the second stage of the Heckman two-stage model, the statistical and significant factors influencing output of cowpea production were age, sex, educational level, household size, farm size and labour input. The constrained facing cowpea farmers were lack of improved seeds, lack of extension agents, lack of storage facilities, lack of chemical input and bad road infrastructures. The retained component in the principal component analysis explained 71.42% of all predictor variables included in the model.

RECOMMENDATIONS

The following policy implications were recommended based on the findings of this research study:

(i)Extension agents should be employed to disseminate innovations, sustainable agriculture, research findings, new improved method of cowpea farming, integrated pest management techniques and pesticide use to farmers.

(ii) Improved seeds should be made available to cowpea farmers at appropriate time as this can increase production.

(iii) Feeder roads should be constructed to evacuate cowpea produce from farms to market centres.

(iv) Storage facilities should be made available to cowpea farmers to store produce after harvest.

(v) Training and capacity buildings should be organize for cowpea farmers on environmental, sustainable integrated pest management techniques and pesticide use

REFERENCES

Abatania, L., Gyasi, O., Coulibaly, O., Adeoti, R and Salifu, A.B (2001). Socio-Economic Studies of PRONAF Project: Adoption and Impact of Improved Cowpea Technologies in Ghana. Technical Report Submitted to the PRONAF Project/IITA Benin Station

Adewuyi, S.A and Okunmadewa, F.Y (2005). Economic Efficiency of Cowpea Farming in Kwara State, Nigeria. *Nigerian Agricultural Development Studies* 1

Adesina, A., Mbila, D.,Nkamleu, G.B., and Endamana, D. (2000).Econometric Analysis of the Determinants of Adoption of Alley Farming by Farmers in the Forest Zone of SouthWest Cameroon. *Agriculture, Ecosystem and Environment* 80: 255-265

Agwu, A.E (2004). Factors Influencing Adoption of Improved Cowpea Production Technologies in Nigeria. *Journal of International Agricultural Extension Education* 11 (1): 81 – 88

Alabi,O.O, Oladele, A.O, ,and Oladele,N.O (2020).Socio-Economic Factors Influencing Perceptions and Adaptation of Rural Rice Farmers to Climate Change, Abuja, Nigeria: Applications of Heckman Two-Stage Model. *Russian Journal of Agricultural and Socio-Economic Sciences (RJOAS)* 8 (104): 45 – 56

Alabi,O.O; Lawal,A.F; Awoyinka,Y.A and Coker, A.A (2014).Probit Model Analysis of Smallholder Farmers Decision to Use Agrochemicals Inputs in Federal Capital Territory Abuja, Nigeria, *Turkey International Journal of Food and Agricultural -Economics (IJFAEC), 2(1): 85-93, Nigde University Turkey,*

Alabi,O.O; Lawal, A.F and Oladele,A.O (2016). Factors Influencing the Use of Productivity Enhancing Technologies among Crop Farmers in Abuja, Nigeria. *Journal of Sustainable Development in Africa (JSD-Africa) Clarion University of Pennsylvania USA 18(1): 40 –52.*

Alabi,O.O. and Banta, A.L, Manza E.A.G (2016). *Food Security: An Application of Structure, Conduct and Performance of Cowpea (Vigna unguiculata L) Marketing in Abuja, Nigeria.* In : (Alexander Kure; Z.K.A. Bonat; Gaius Jatau (eds) Chapter 10, Pg 199-216. *Interdisciplinary Studies and Perspectives on Society and Development in Nigeria. Volume 1: Environment, Agriculture and Health. Festschrift in Honour of Professor W.B.Quirix.*

Ben-Chendo, G.N, N. Lawal, M.N. Osuji, I.I. Osugiri, and B.O. Ibeagwa, (2015). Cost and Returns of Paddy Rice Production in Kaduna State of Nigeria. *International Journal of Agricultural Marketing* 2(5):084-089.

Caviglia-Harris, J.L (2003). Sustainable Agricultural Practices in Rondonia, Brazil: Do Local Farmer Organizations Affect Adoption Rates? *Economic Development and Cultural Change* 52 : 23 – 49.

Chaves, B and Riley, J (2001). Determination of Factors Influencing Integrated Pest Management Adoption in Coffee Berry Borer in Colombian Farms. *Agriculture, Ecosystems and Environment* 87: 159 – 177

Coker, A.A.A., Ibrahim, F.D and Ibeziako, U.N (2018). Effects of Household Demographics on the Technical Efficiency of Cowpea Farmers: Evidence of Stochastic Function Analysis in Nigeria. Russian Journal of Agricultural and Socio-Economic Sciences1 (73): 179 – 186.

Coulibaly, O and Lowenberg-Deboer, J (2000). *The Economics of Cowpea in West Africa.* In: *Challenges and Opportunity for Enhancing Sustainable Cowpea Production*. Proceedings of the World Cowpea Conference III held at the International Institute of Tropical Agriculture (IITA), I badan, Nigeria, 4 – 8 September 2000

FAOSTAT (2000). Food and Agriculture Organization, http// www.fao.org/statistics

Feder, G., Murgai, R and Quizon, J.B (2003). The Impact of Farmers Field Schools in Indonesia. World Bank Policy Research Working Paper 3022.

Gongula, D.I and Garjila, Y (2005). The Effects of Phosphorous on Growth and Yield of Cowpea in Yola. *Journal of Sustainable Development Agricultural Environment* 1: 96 – 101

Ibrahim, B.I and Tilson, T.K (2007). The Economic Effect of Spray Pesticides on Cowpea (Vigna unguiculata L Walp) Production in Adamawa State, Nigeria. *International Journal of Agricultural Research* 2 (7): 647 – 650.

Lawal, A.F; Alabi,O.O and Oladele, A.O (2016). Comparative Economic and Entrepreneurship Analysis of Pesticides Treated and Non-Treated Cowpea (*Vigna unguiculata L Walp*) Farms in Abuja, Nigeria. *Journal of Sustainable Development in Africa (JSD-Africa) Clarion University of Pennsylvania USA 18(1):1-13*

Mauceri, M., Alwang, J.M., Norton, G., and Barrera, V (2005). Adoption of Integrated Pest Management Technologies: A Case Study of Potato Farmers in Carchi, Ecuador. Paper Presented at American Agricultural Economics Annual Meeting, Providence, Rhode Island July 24 -27 2005

Nyagata, D.O., Obare, G.A., Omiti, J. M and Wilson, N (2010). Technical Efficiency in Resource Use: Evidence from Smallholder Irish Potato Farmers in Nyandarua North District, Kenya. *African Journal of Agricultural Research* 5 (11): 1179 – 1186.

Okike, I., Kristjamson, S.A and Singh, B.B (2007). Potentials Adoption and Diffusion of Improved Duel Purpose Cowpea in the Dry Savannah of Nigeria: An Evaluation Using Combination of Participatory and Structured Approaches.

Orr, A (2003). Integrated Pest Management for Resource-Poor African Farmers: Is the Emperor Naked? *World Development* 31 : 831 – 845

Yamane, T (1967). *Statistics: An Introductory Analysis.* 2nd Edition, New York, Harper and Row Publishers

ABOUT THE AUTHORS

S/N	First Name (Surname)	Last Name	Professional Rank	Institutional Affiliation
1	Alabi	Olugbenga Omotayo	Professor of Agricultural-Economics	Department of Agricultural-Economics, University of Abuja,Gwagwalada-Abuja, Nigeria.
2	David	Hyelni Seth	Assistant Lecturer	Department of Agricultural-Economics and Extension, Federal University Gashua, Gashua, Yobe State, Nigeria.
3	Sanusi	Saheed Olakunle	Lecturer One	Department of Agricultural-Economics and Extension, Federal University Gashua, Gashua, Yobe State, Nigeria.
4	Madaki	Musa Janga	Lecturer One	Department of Agricultural-Economics and Extension, Federal University Gashua, Gashua, Yobe State, Nigeria.
5	Omole	Ebunlola Bosede	Lecturer One	Basic Science Department, Federal College of Wildlife Management (FCWM), Forestry Research Institute of Nigeria (FRIN), New Bussa, Niger State, Nigeria.
6	Olohungbebe	Sheu Ahmad	Assistant Lecturer	Department of Agricultural-Economics and Extension, Faculty of Agriculture, Federal University Kashere Gombe, Gombe State, Nigeria.
7	Oladele	Ayoola Olugbenga	Senior Lecturer	Department of Agricultural Extension and Management, Federal College of Forestry Mechanization, Forestry Research Institute of Nigeria (FRIN), Afaka, Kaduna, Nigeria.
8	Olumuyiwa	Samson Abiade	Senior Lecturer	Department of Basic Sciences and General Studies, Federal College of Forestry Mechanization, Forestry Research Institute of Nigeria (FRIN), Afaka, Kaduna, Kaduna State, Nigeria.
9	Waziri-Ugwu	Phidelia Ramatu	Lecturer One	Department of Agricultural-Economics and Extension, Federal University Gashua, Gashua, Yobe State, Nigeria.
10	Ibrahim	Azeez Olalekan	Lecturer One	Federal College of Wildlife Management (FCWM), Forestry Research Institute of Nigeria (FRIN), PMB 268 New Bussa, Niger State, Nigeria.