Socio-Economic Determinants of Adoption of Improved Cowpea Varieties in Northern Nigeria

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Abstract.
Studies have been conducted on the factors influencing the adoption of cowpea in different locations in Nigeria. This study is specifically conducted to identify socio-economic factors influencing the adoption of improved cowpea varieties in some selected states of Northern Nigeria under the Community-Based Agriculture and Rural Development project. A four-stage sampling technique was employed to select farmers. In the first stage, five states with the highest poverty index were purposively selected in Northern Nigeria. Secondly, all the communities in each State were stratified into two groups; participating and non-participating communities. Using simple random sampling technique, 7 communities were selected in each group per State, and 5 farmers from each community. Primary data were collected from 144 respondents using structured questionnaire. The analytical techniques used were descriptive and inferential statistics. Determinants of adoption were identified using Logit regression model. The results showed that the most preferred cowpea variety in the study area was IT90K-277-2. The outstanding attribute indicated by most respondents was high yield. Factors influencing adoption decisions among the respondents include access to extension services ($\beta = 3.02$, $p \leq 0.01$), membership of farmers' association ($\beta = 1.04$, $p \leq 0.10$), livestock asset owned ($\beta =$ 1.89 E-06, $p \leq 0.05$) and farmers' access to credit facilities ($\beta = 1.63$, $p \leq 0.01$). These socio-economic factors were significantly different between adopters and non-adopters. The study concluded that improved varieties deployed to farmers were adopted across the five project implementing States.
Keywords: *Adoption, arable crops, improved varieties, logit, influence.*

Introduction

Over 5.4 million tons of dried cowpeas are produced in the world, of which Africa produces nearly 5.2 million; Nigeria doubles as the largest producer and consumer of cowpea accounting for 61% of Africa's production and 58% worldwide (IITA, 2015). Consequently, the importance of cowpea to Nigeria farmers can be seen from its adaptability to different types of soil as well as its ability to improve soil fertility. In addition, it serves as high protein content giving food to farmers and its stems and leaves as animal feed during the dry season. Over the years, International Institute of Tropical Agriculture (IITA) scientists have developed varieties that are high yielding, disease resistant, early maturing and varieties with consumer-preferred traits. These cowpea varieties have been deployed to about 68 countries after ensuring its adaptability to sole or intercropping production systems. Of importance, is the deployment of five (5) cowpea varieties to Northern Nigeria in 2011 under the poverty alleviating program known as Community-Based Agriculture and Rural Development (CBARD) project sponsored by Africa Development Bank. Numerous studies have been conducted on the factors driving the adoption of agricultural innovations in developing countries (Asfaw and Admassie, 2004; Idrisa, Ogunbameru, and Shehu, 2012) except CBARD project. Thus, the extent of technology diffusion and factors influencing adoption of improved cowpea varieties in the study area forms the basis of this study. Therefore, this study aims at identifying factors influencing the adoption of improved cowpea varieties in Northern Nigeria.

Methodology

The Study Area

The study was carried out in five States where the IITA/AfDB-CBARD project was implemented. The states are Adamawa, Bauchi, Gombe, Kaduna and Kwara. The project area covered about 200,000 km^2 or 22 per cent of Nigeria which their population was estimated at 18 million in 2001 (NBS, 2005). The five states are located in woodland and tall grass Savannah vegetation zone of Nigeria having two distinct climates, the dry season (November – March) and the rainy

season (April – October). Adamawa, Bauchi and Gombe falls in Dry sub-humid agro-ecological zones; Kaduna falls in Sub-humid while Kwara falls in humid zone.

Sampling Procedure

A multi-sampling procedure was used for the study. In the first stage, five poor states were purposively selected in Northern Nigeria based on a national research conducted by Africa Development Bank on the poverty status of each state in the federation (NBS, 2005). Secondly, all the communities in each State were stratified into two groups; participating and non-participating communities. In each of the groups, seven communities were selected using simple random sampling technique. In the fourth stage, five farmers were selected randomly from each of the communities to give a total of 70 farmers (35 participating and 35 non-participating) per State. Altogether, 350 farmers were selected for the study; however, only 144 respondents were observed to be cowpea farmers being that five arable crops (cowpea, maize, soybean, yam and cassava) were deployed to the study area under the CBARD project.

Analytical Technique

The analytical techniques used were descriptive and inferential statistics. Preferred improved cowpea varieties introduced by CBARD project in the study area were identified and classified using frequency counts and percentages. The rate of adoption was expressed as the number of farmers adopting the technology as a percentage of the total number of farmers under study (Floyd, Harding, Paddle, Rasali, Subedi, Subedi, 1999). The determinants of adoption were identified using Logit regression model.

Logit Regression Model

In this study, a farmer is defined as an adopter if he or she is found to be growing any of the improved cowpea varieties introduced by CBARDP. Thus, a farmer who has been classified as an adopter could still grow some traditional varieties. The adoption variable is therefore defined as 1 if a farmer is an adopter of improved cowpea variety and 0 if otherwise. Hosmer and Lemeshew (1989) pointed out that the logistic distribution (logit) has got advantage over the others in the analysis of dichotomous outcome variable in that it is extremely flexible and easily used model from mathematical point of view and results in a meaningful interpretation. The parameter estimates of the model are asymptotically consistent and efficient. The standardized coefficients correspond to the beta-coefficients in the ordinary least squares regression models. The binary logistic model does not make the assumption of linearity between dependent and independent variables and does not assume homoscedasticity (CIMMYT, 1993). Another advantage of using the logit model is that it does not require normally distributed variables and above all, the logit model is relatively easy to compute and interpret. Hence, the logistic model is selected for this study. The probability that a farmer will adopt at least one improved crop variety was postulated as a function of some socioeconomic, demographic characteristic and institutional factors. Therefore, the cumulative logistic probability model is econometrically specified as follows:

$$P_i = F(Z_i) = F(\gamma + \sum \lambda_i X_i) = \frac{1}{1+e^{-Z_i}} \quad \text{..... (1)}$$

Where P*i* is the probability that a farmer will adopt at least one improved crop variety or not given X_i; *e* denotes the base of natural logarithms, which is approximately equal to 2.718; X_i represents the ith explanatory variables; and γ and λ are parameters to be estimated. Hosmer and Lemeshew (1989) as cited by Awotide, Awoyemi amd Oluwatayo (2012) pointed out that the logit model could be written in terms of the odds and log of odds, which enables one to understand the interpretation of the coefficients. The odds ratio implies the ratio of the probability (P_i) that a farmer adopt to the probability ($1-P_i$) that the farmer is non-adopter.

$$1 - P_i = 1 - \frac{1}{1+e^{-Z_i}} \quad \text{..... (2)}$$

Therefore,

$$\frac{P_i}{1-P_i} = \frac{(1+e^{-Z_i})^{-1}}{1-(1+e^{-Z_i})^{-1}} = e^{Z_i} \quad \text{..... (3)}$$

The natural log of equation (3.3), will give:

$$Z_i = \ln\left(\frac{P_i}{1-P_i}\right) = \gamma + \lambda_1 X_1 + \lambda_2 X_2 + \cdots + \lambda_m X_m \quad \text{..... (4)}$$

Replacing γ with β_0 and λ with β and if the disturbance term μ_i is taken into account, the Logit regression model is stated below:

$$L = \log of\ odds\ ratio = \ln\left(\frac{Pi}{1-Pi}\right) = \beta o + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + \beta 9X9 + \beta 10X10 + \beta 11X11 + \mu i \quad \text{..... (5)}$$

Where:

L_i is the log of the odds ratio, is not only linear in X but in the parameters too.

β_o is the value of the log odds when all the independent variables are zero.

β_j measures the change in L for a unit change in X_{ij}, indicating how the log odds in favour of participating farmer changes with a unit change in socioeconomic characteristics of farmers.

X_9, X_{10} and X_{11} are dummy variables.

X_1 is farmer's age measured in years,

X_2 is the farmer's household size expressed as numbers,

X_3 is the farmer's education measured as numbers of years invested in formal education,

X_4 is the farmer's cowpea farm size measured in hectare,

X_5 is the farmer's livestock asset measured in Naira,

X_6 is the farmer's farm implement asset measured in Naira,

X_7 is the farmer's household asset measured in Naira,

X_8 is the farmer's off-farm income measured in Naira,

X_9 is the farmer's membership of association expressed as a dummy; 1 for membership, 0 for non-membership,

X_{10} is the farmer's access to credit facility expressed as a dummy; 1 if there is access, 0 if otherwise,

X_{11} is the farmer's access to extension services expressed as a dummy; 1 if contact was made, 0 if otherwise, and

μ_i is the random error term.

From reviewed literature, the determinants of the adoption of improved cowpea varieties include farmer's age, household size, education, income, asset, off farm income, membership of an association, access to credit facility and livestock owned by household. Evidences from economic theory as well as past studies on adoption, guided the choice of the included explanatory variables. The multidisciplinary independent variables include the farmer, the farm and institutional factors postulated to influence technology adoption (Feder and Slade, 1984; Feder *et al.*, 1985; Polson and Spencer, 1991; Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995; Manyong and Houndekon, 1997, Zeller *et al.*, 1998; Shiferaw and Holden, 1998; Zeller *et al.*, 1998; Negatu and Parikh, 1999; Lapar and Pandy, 1999; Chianu and Tsujii, 2004; Dvorak, 1996; Oluoch-Kosura *et al.*, 2001; Bamire *et al.*, 2002; Bezuayehu *et al.*, 2002; Bekele and Drake, 2003, Awotide, Awoyemi and Oluwatayo (2012); Adetule, Owoeye and Sekumade (2017). In summary, *a priori* expectation of signs of the independent variables is stated thus: β_3, β_4, β_5, β_6, β_7, β_8, β_9, β_{10} & $\beta_{11} > 0$ while β_1 & β_2 may be < 0 or > 0.

Results and Discussions

Socio-economic characteristics of respondents

The average age of household head in the study area was about 50.57 ± 11.27 (50 years 7 months) with no significant differences ($t = 1.44$, $p > 0.10$) recorded between the mean ages of adopters 51.61 ± 10.74 (51 years 7 months) and non-adopters 49.47 ± 11.79 (49 ½ years). Most of the respondents were married with adopters being older than non-adopters implying that most adopters may be more experienced in the farming business than non-adopters. The mean household size was about 14 ± 7.39 with no statistical significant difference ($t = 1.05$, $p > 0.10$) between adopters' and non-adopters' household sizes (Table 1). Furthermore, the number of respondents that had formal education was more among non-adopters compared to adopters. This implies that acquisition of formal education influenced adoption positively. The mean farm size for cowpea was 1.77 ± 1.25 hectares; with adopters farm size not significantly different ($t = 1.46$, $p > 0.10$) from non-adopters. Ninety-five respondents (66 %) out of the sampled households (of which 64 were adopters and 31 were non-adopters) were members of one farmers' association or the other. About 75.69% respondents, with 72 (50%) being adopters, had contact with extension agents; 50% of adopters had access to credit while non-adopters who had access to credit facilities numbered 10 (14.29%). This implies that contact with extension agents as well as access to credit facilities influenced adoption positively.

Table 1: Socio-economic characteristics of the respondents

Variables	Whole Sample	Adopters	Non-Adopters	t-value
Age				
41 – 50	45 (31.25)	20 (27.03)	25 (35.71)	
Mean	50.57	51.61	49.47	1.44
Sex				
Male	137 (95.14)	70 (94.59)	67 (95.71)	
Marital Status				
Married	140 (97.22)	73 (98.65)	67 (95.71)	
Household Size				
6 – 10	39 (27.08)	19 (25.68)	20 (28.57)	
Mean	14.05	14.68	13.39	1.05
Education				
Secondary	41 (28.47)	19 (25.68)	22 (31.43)	
Farm Size				
0.10 – 2.50	113 (78.47)	53 (71.62)	60 (85.71)	
Mean	1.77	1.92	1.61	1.46
Membership of Association				
Member	95 (65.97)	64 (86.49)	31 (44.29)	
Access to Credit Facilities				
Access	47 (32.64)	37 (50.00)	10 (14.29)	
Access to Extension Services				
Contact	109 (75.69)	72 (97.30)	37 (52.86)	

NOTE: *** = Significant at 1%, ** = Significant at 5%, * = Significant at 10%; values in parenthesis are percentages.

Rate of adoption of improved cowpea varieties

Improved cowpea varieties were introduced to each state based on its agro-ecological potency in supporting the crop. The five (5) cowpea varieties were IT90K-277-2, IT89KD-288, IT97K-499-35, IT98K-573-1-1 and IT98K-573-2-1. The identified attributes influencing farmers' preference includes; high yield, early maturity, resistance to diseases, good taste, availability of free seeds and the support of extension services. Adoption rate of improved cowpea varieties was determined in the study following Floyd *et al.* (1999); Akinola (2008); Awotide *et al.* (2012) and Adetule *et al.* (2017) as the number of farmers adopting the technology as a percentage of the total number of farmers under study. In Table 2, the adoption rate for each improved variety is presented. For cowpea varieties, adoption rate ranged between 4.17 % and 22.22 % with IT97K-499-35 recording the highest rate of adoption among 144 cowpea farmers interviewed.

Table 2: Adoption Rate of improved varieties of cowpea

Cowpea Varieties	Rate of Adoption
IT90K-277-2	29 (20.14)
IT89KD-288	24 (16.67)
IT97K-499-35	32 (22.22)
IT98K-573-1-1	8 (5.56)
IT98K-573-2-1	6 (4.17)

NOTE: Values in parenthesis are percentages

Determinants of adoption of improved cowpea varieties

The results of the Logit likelihood regression model (Table 3) showed that the log likelihood ratio of – 62.31 between the dependent

variable and the set of explanatory variable indicates the fitness of the model. In addition, the significant Chi-square (74.89 %) is indicative of the strength of the joint effect of the covariates on the probability of adoption of improved cowpea varieties among the respondents. The results also showed that the decision on whether or not to adopt improved cowpea varieties was significantly influenced by respondents' access to extension services ($\beta = 3.02$, $p \leq 0.01$), membership of farmers' association ($\beta = 1.04$, $p \leq 0.10$), livestock asset owned ($\beta = 1.89$ E-06, $p \leq 0.05$) and farmers' access to credit facilities ($\beta = 1.63$, $p \leq 0.01$). This implies that farmers' access to extension services and credit facilities, livestock owned as well as their involvement in farmers' association would increase the adoption of improved cowpea varieties in the study area. The findings agree with Wallys, Tollens and Manyong (2003); and Akinola (2008); Awotide *et al.* (2012) and Adetule *et al.* (2017) that the technologies are viewed as a good being promoted as a basket of options from which the farmers can make a choice. Farmers' association is a major medium through which technology can be transferred to a group of farmers within a locality. It is also a means of scaling up technology that must have been proven over time. Hence, as extension visits to the household increased, adoption of improved varieties increased. It could also be deduced that as the commitment of a farmer to his association increases, the more he would readily adopt any technology introduced by that association. The result underscores the importance of extension visits in promoting adoption of improved technologies. It has been succinctly argued that increased household exposure to extension programs, in form of multiple visits by extension personnel and through information dissemination and technical support to farmers, greatly increases the farmers' awareness of available technologies and their potential benefits.

In addition, livestock asset owned by farmer as well as access to credit was positive and statistically significant. This implies that increased accessibility to credit facilities and increased livestock asset of a farmer would increase probability of adoption of improved cowpea varieties. In order words, farmers with easy access to funds as well as farmers possessing more livestock assets would readily be motivated to adopt new varieties compared to farmers with lower fund and small livestock assets. The reason may simply be that farmers with bigger assets have more resources at their disposal to handle a new variety without affecting their regular farming activity. With respect to other variables, none was statistically significant. Experience (age being the proxy) was negative but insignificant. Education, household size, farm implement and household assets were also negative and statistically insignificant. However, farm size for cowpea and off farm income was found to be positive but statistically insignificant. The foregoing reveals that contact with extension, access to credit facilities, membership of association and livestock asset owned were the most important variables influencing the adoption and use of improved cowpea varieties in Northern Nigeria.

Table 3: Logit model estimates of the determinants of adoption of improved cowpea varieties

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X	t-value
CONSTANT	-3.0281	1.3284	-2.28	0.023		
AGE	-0.0246	0.0231	-1.07	0.286	50.57	1.14
HSZ	-0.0218	0.0362	-0.60	0.548	14.05	1.05
EDU	-0.0230	0.0426	-0.54	0.589	8.49	1.01
FSZ	0.0173	0.1967	0.09	0.930	1.77	1.46
LSASET	1.89e-06	8.01e-07	2.36	0.018	429,003.50	2.67***
FMASET	-3.56e-07	6.91e-06	-0.05	0.959	34,136.11	2.21**
PHYASET	-2.67e-07	1.07e-06	-0.25	0.803	207,213.00	2.17**
OFFINC	2.32e-05	1.34e-05	1.73	0.084	21,768.75	1.76*
ASSO	1.0399	0.5334	1.95	0.051	0.66	5.87***
CRE	1.6275	0.5174	3.15	0.002	0.33	4.95***
EXT	3.0169	0.8424	3.58	0.000	0.76	7.05***
Chi-square		74.89				
Log likelihood function		-62.31				
Pseudo R^2		0.38				

Note: *** = Significant at 1%,
** = Significant at 5%,
* = Significant at 10%

Conclusion

The study identified the factors influencing the adoption of improved cowpea varieties in Northern Nigeria, and concludes that farmers' access to extension services and credit facilities, membership of farmers' association, as well as livestock asset possessed influenced adoption decisions of improved cowpea varieties positively and significantly in northern Nigeria. In view of the above findings, it is suggested that preferred improved cowpea varieties should be multiplied in the study area. This can be achieved if IITA can dole out parent stock seeds to reputable seed producing companies in order to ensure the availability of certified seeds to farmers. If well implemented, this initiative will ensure the replacement of low yielding varieties with better yielding improved varieties, thereby ensuring increased crop productivity, food security, income generation and improved livelihoods. In addition, since access to extension services and credit facilities played key roles, employment of extension officers by the State Government as well as the establishment of microfinance banks with the aim of providing credit facilities for farmers will contribute immensely to encourage more production in the study area.

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