Factors Influencing Adoption of Chemical Pest Control in Cowpea Production among Rural Farmers in Makarfi Local Government Area of Kaduna State, Nigeria

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ABSTRACT mediues to test this area compared with that of southern TDARTZBA.

This study examines the factors influencing the adoption of chemical pest control in cowpeas production in Makarfi Local Government Area of Kaduna State, Nigeria. Data were collected using stratified random sampling method from 61 farmers adopting chemical pest control and 79 non-adopters making up a total of 140 respondents. A Probit analysis was used to ascertain factors influencing farmers' adoption of chemical pest control while the t-test was used to determine whether there is statistical significant difference between the productivity of adopters and non-adopters to enable us draw inference on the food security and poverty reduction ability of the chemical pest control practice. The results reveals that the adoption of chemical pest control in cowpeas production is influenced by farmers' age, marital status, educational qualification, the desires of farmers for higher yields and the contact with extension activities. The results also helped to establish that chemical pest control could help the farmers in making sure that higher yields are obtained from cowpeas production thus helping the rural farmers to become food secured since cowpeas are very good protein rich food. Moreover, the result of the yields from adopters has shown that the practice could help farmers realize marketable surplus that will lead to higher income generation thereby reducing poverty among the rural farmers.

Keywords: Adoption, Chemical Pest control, Cowpeas production, Food security, Poverty reduction.

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Cowpea is an important protein food consumed by virtually all people of various economic classes in Nigeria. This crop is produced mostly in the northern parts of the country while the bulk of the shortfalls in production are augmented through the cross-border trade between Niger and Nigeria through the porous border informal trade (Abdusallam, 2004). There are no practical reasons why Nigeria should not be self sufficient in cowpea production to meet her local food demand. However, the prevalent of insect pest and diseases poses serious threat to cowpea production and these two problems have been the major impediments to the goal of our realization of self-sufficiency in cowpea production.

Pests are insects, birds, rodents, monkeys, weeds, fungi, bacteria and fungi that feed on growing plants, injure them and kill them, and introduce diseases (Kolawole et al, 1979, Agrios, 2005). Chemicals that are used for pest control are known as pesticides.

A lot of extension activities have been on for many years on the need for farmers to adopt chemical pest control in cowpea production in Nigeria. Few of the many advantages of chemical pest control in cowpea production includes the fact that it enhances plant vigour and healthy growth, lead to higher plant yields and consequently increased productivity,

and leads to improved quality of the harvested crops (Agrios, 2005). However not all farmers are presently adopting this all-important agronomic practice. This paper examines the factors influencing the adoption of chemical pest control in cowpea production in the study area.

RESEARCHMETHODOLOGY

Study area and data collection

This study was carried out in Makarfi Local Government Area of Kaduna State. Makarfi Local Government shares boundary with Zaria Local Government in the south and Kano State in the north. The climate of this area is that of northern Guinea Savannah with rainfall ranging between 700 1000 mm per annum. This rainfall is fairly distributed over a period of 3-5 months in the year; each year has two seasons (i) the rainy season, which starts around May, and ends in September, and (ii) the dry season that lasts for about 7 months compared to 5 months of rain. The dry season starts in October and ends in April (Kowal and Kassam, 1987). The lighter rainfall in this area compared with that of southern parts of the country makes the area to be more conducive for cowpea production.

Data for this work were collected from 140 respondents in the study area between November 2005 and February 2006. The respondents were made up of 61 cowpea farmers that adopted chemical pest control practice in their production and 79 non-adopters. These respondents were selected using stratified random technique from the list of adopters and non-adopters provided by the Makarfi Local Government Agricultural Department. The villages covered were Makarfi, Mayere, Gubuchi, Doka and Tashayari all in Makarfi Local Government Area. The information collected were whether a farmer has adopted chemical pest control or not as the dependent variable. Those that adopted were scored 1 while the non-adopters were scored 0. Information on factors influencing their adoption was also collected. Moreover, socio-economic characteristics of farmers such as age, education, family size and marital status were also collected. Also collected were production information such as hectares of land cultivated, labour used and the yields realised. All these information were analysed to determine the factors influencing adoption of chemical pest control in the area and also to determine the impact of the adoption of crop yields as well as food security and poverty reduction in the area.

General theoretical considerations of the modelling of adoption behaviour

Since the early work on adoption by Rogers (1962), efforts that have been made to explain the determinants of adoption have received a boost. There are two major groups of paradigms for explaining adoption found in literature: the innovation-diffusion, and the economic constraint paradigms.

The innovation-diffusion model, following the work of Roger, contended that access to information about an innovation is the key factor determining adoption decisions (also Agrarwal, 1983). The appropriateness of the innovation is already assumed here, and the problem of technology is reduced to communicating information on technologies to potential end users. By emphasizing the use of extension, media, and local opinion leaders, or by the use of experimental station visits and on-farm trials, "sceptic" non-adopters can be shown that it is rational to adopt (Adesina and Zinnah, 1993).

In contrast, the economic constraint model (Aiken *et al.*, 1975) contends that economic constraints, reflected in asymmetrical distribution patterns of resource endowments, are the major determinants of the observed adoption behaviour. A lack of access to capital (Havens and Flinn, 1976) or land (Yap and Mayfield, 1978; Ogunfiditimi, 1981) is seen as factor significantly constraining adoption decisions. While attempts have been made to assert the superiority of the economic constraint model over the innovation

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model (Hooks et al., 1983), such conclusions have been challenged (Nowak, 1987; Ogunfiditimi, 1987).

Many other concepts have recently been developed and used to quantitatively determine adoption processes. One of these concepts, which is implicitly used in one form or the other in agricultural economics literature (Gould *et al.*, 1989; Norris *et al*, 1987; Lynne *et al.*, 1988 Adesina and Zinnah, 1993), suggests that the perceived attributes of innovation conditions determine adoption behaviour. Farmers, as reasoned, have subjective preferences for technology characteristics (Ashby and Sperling, 1992; Ashby *et al.*, 1989; Ogunfiditimi, 1981) and these could play a major role in technology or practice adoption. The adoption or rejection of technologies or farm practices by farmers may be based upon farmers' perceptions of the appropriateness or inappropriateness of the characteristics of the practices under consideration.

A number of studies have investigated the influence of various socio-economic factors on the willingness of decision makers to use new technologies (Nerlove and Press, 1973; Shakya and Flinn, 1985). From most of these studies of adoption behaviour, the dependent variables are constrained to lie between 0 and 1 and the models used are exponential functions. One common feature of these models is that Univariate and Multivariate Logit and Probit models and their modifications have been used extensively to study adoption behaviour of farmers and consumers (Nerlove and Press, 1973; Schmidt and Strauss, 1975; Garcia *et al*, 1983; Akinola, 1987; Akinola and Young, 1985; Adesina and Zinnah, 1993). Maddala (1983) and Shakya and Flinn (1985) have recommended Probit models for the functional forms with limited dependent variables that are continuous between 0 and 1, and Logit model for discrete dependent variables.

Following Rahm and Huffman (1984), farmer adoption decisions are reasoned to be based upon utility maximization. If for example we define a varietals of soil maintenance technology by j, where j = 1 for the institutional arrangement evolving for the acquisition of manure through manure contract to facilitate manure availability for soil fertility maintenance and j = 0 for the old management practice of not applying anything to the soil for the purpose of maintaining the soil fertility. The non-observable underlying utility function that ranks the preference of the ith farm household is given by U (M,; A,). From this, the utility derivable from chemical pest control practice depends on M that is a vector of farm and farm household-specific attributes of the adopter and A which is a vector of the attributes associated with that particular technology in question. Though the utility function is unobservable, the relation between the utility derivable from a jth management practices is postulated to be a function of the vector of observed farm, farm household specific characteristics (e. g., farm size, age, family size education, member of association, marital status et cetera) and the practices or technology characteristics (e. g. enhance yield increase, desire for clean seed production et cetera) and a disturbance term having zero mean: well to ear assiver the energy of the second of the second as over a second as the second as

$$\mu_{ji} = \alpha_j F(Mi, A_i) + \epsilon_{ji} \quad j = 1, 0, i = 1, \dots, n$$
 (1)

The equation (1) does not restrict the function in F to be linear. Since utilities U_{ji} are random, the ith farm household will select the alternative j = 1 if $U_{1i} > U_{0i}$ or the non-observable (latent) random variable $Y = U_{1i} U_{0i} > 0$. The probability that Y_i equal one

(i.e), that the farm household adopts a chemical pest control practice is a function of the independent variables.

$$P_{i} = P_{r}(Y_{i} = 1) = P_{r}(U_{1i} > U_{0i})$$

$$= P_{r}[\alpha_{1}F_{i}(M_{i},A_{i}) + e_{1i} > \alpha_{0}F_{i}(M_{i},A_{i}) + e_{0i}]$$

$$= P_{r}[e_{1i} - e_{0i} > F_{i}(M_{i},A_{i})(\alpha_{0} - \alpha_{1})]$$

$$= P_r(\mu_i > -F_i(M_i, A_i)\beta)$$

$$= F_i(X_i\beta) \dots (2)$$

Where X is the n x k matrix of the explanatory variables, and β is the k x 1 vector of parameters to be estimated, P, (0) is a probability function, is a random error term, and F (X, β) is the cumulative distribution function for evaluated at X, β . The probability that a farm household will adopt participation in chemical pest control is a function of the vector of explanatory variables and the unknown parameters and an error term.

Statistical consideration of Probit modeling for chemical pest control adoption behaviour

The concern here is to estimate the determinants of farmers' participation in the adoption of chemical pest control in cowpea production for improved productivity.

As a first step, it is assumed that the adoptions of chemical pest control practice by different classes of farmers are a linear function of farm household characteristics and the attributes inherent in chemical pest control practice. However, the decision as to whether a farmer adopts or not is based on self-selection rather than random assignment. Thus adoption A, should be endogenised using an index function model (e.g. Heckman, 1976; Maddala, 1983; Greene, 1997 and Greene, 2003). This index to estimate farm household adoption of chemical pest control in cowpea production is:

Where A* is an unobservable index variable denoting the difference between the utility of adopting chemical pest control in cowpea production (U_{11}) and the utility of not adopting the practice (U_{01}). If $A_i^* = U_{11}^*$, $U_{01}^* > 0$, then the individual household will adopt a chemical pest control practice. The term $Z'\gamma$ provides an estimate of $U_1^* 1 U_1^* 0$, using farm household characteristics and the attributes of the chemical pest control measure, Z_1^* , as the explanatory variables, while U_1^* is an error term unobserved by the researcher and assumed to be normally distributed $U_1^* \sim N(0,1)$. This model is estimated with a standard Probit log-likelihood function. The LIMDEP econometrics software was employed for the analysis of this work.

Variables in the adoption participation of chemical pest control adoption

This work is based on the estimation of model 3 earlier discussed above in section 2.3. The participation of farmers in chemical pest control is the dependent variable in the analysis. Those that participated were scored 1 while the non-adopters were scored 0. There were eight explanatory variables influencing adoption decision of farmers to adopt chemical pest control in cowpea production in the study area. They are age of household head, marital status, household size, educational qualification of household head, extension contact of the household head, desire of household for clean seed production and membership of the household head in farmers' association. The desire of household head for clean seed was among the questions posed to the farmers in which the respond yes if clean seed was one of their reason for adopting chemical pest control and no if it was not. In other word, yes was scored 1 while no was scored 0. Lastly was the assumption by the farmers that adoption of chemical pest control would lead to higher cowpea yields since pest destroying production would be minimized. This was also a dummy variable in which farmers say yes if the assumed it would increase their yield and no if they do not think it would increase their yields.

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According to Kebede *et al* (1990), family size has been recognised to play a vital role in the adoption of any particular farm practices or technologies. In African context, family is known to play dual and opposing roles in determining what occurs on the farm (Akinola, 1987). On the one hand, it provides the human factor in farming through labour and management inputs. It also has certain demands, which may motivate the adoption of new practices, or technologies that would increase the farmer's income as a means of meeting these demand. Furthermore, the strength of family ties has the effect of encouraging the farmer to improve his earning power because many family workers tolerate, for a time, extremely bad conditions of employment or very poor wages, either in kind or cash, as a result of their family loyalty. This therefore puts the farm operator in a financially advantageous position to spend more money on adoption of new practices especially when the practices in question demanded more expenses.

Conversely, family demands may compete with the farm enterprises for scarce financial resources of farmer. Dependants' family members of farmer may create financial constraints that will make it difficult for farm operator to have the financial wherewithal to embrace new technology or production practice (Akinola, 1987).

Moreover, the marital status of a farmer may have a significant influence in his production decision. In African society, married men are considered to be more responsive since it is assumed that a person having family would want to have the best results that would translate to more output and consequently income to meet the family need. It is therefore logical to assume that marriage will have positive influence on adoption since in some cases men fall back on their wives' saving for the purchase of input for farm production.

Another variable is age of the household head. The age can have both negative and positive influence on adoption. On the one hand, age is associated with experience and people with experience in farming tend to adopt innovation since they must have tried various farming practices with a view to adopting the best practice. On the other hand older people particularly in the rural areas tend to be skeptical about new innovation and most often would prefer to stick to their age long traditional practices rather than taking a risk getting involved in new practices.

Furthermore, education could play an important role in influencing farmers' adoption of innovation. This is because an enlightened individual would have access to information and have better understanding of the desirability and consequently the benefits derivable from such innovation. Extension contact could play a positive role in facilitating farmers' awareness of innovation and consequently adoption (Ogunfiditimi, 1987).

The most economically logical reason for farmers' adoption a particular innovation or new farm practices would definitely be the expectation of higher yields and consequently increased income. It is the belief here that chemical pest control in cowpea production would lead to yields increase and better income for farmers. Moreover, chemical pest control would help in the production of clean seed that would consequently attract better price in the market.

Finally, it is expected that farmers belonging to farmers' organization like cooperative could help to influence adoption of chemical pest control since group influence could play an important role in the way farmers are influenced in making production decisions.

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RESULTS AND DISCUSSION

Socio-economic characteristics of two groups of farmers in the study area

Table 1 compares the socio-economic characteristics of farmers that adopted chemical pest control and those not adopting in the study area. The variables being compared are age of household head, family size, educational qualification of household head, extension contact with the households. From the results of the independent T-test, there was no statistically significant difference between the mean of these variables for the adopters and no-adopters of chemical pest control in cowpea production in the study area. However, the non-adopters were marginally older than the adopters. This is expected since younger people tend to be better risk takers than older ones. They were equally marginally populated than the adopters' household. Too many family members to cater for could rob the farmer of the necessary finance to adopt innovation. However, more people in the household could also help in increasing the labour force available for farm operation.

The adopters were also marginally better off in education compared with non-adopters. This is expected since education attainment tends to have positive influence on adoption behaviour of an individual.

Finally, extension contact of adopters of chemical pest control was marginally better than non-adopters in this study area. This is expected since extension contact would normally expose farmers to innovation and consequently translate to adoption.

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TABLE 1: The results of independent T-test of socio-economic variables influencing adoption of chemical pest control among cowpea farmers in the area

Variables and American Mariables and American	Chemical pest control Adopters (Mean)	Non-adopters	Statistic	Remarks
Age a milet nert rente	43.62	43.68	-0.04	
Family size	9.68	11.00	-4.49	THE CHARLES OF THE PRINTERS.
Education qualification	1.53		0.31	
Extension contact	4.167	3.833	0.89	

Source: field survey, 2005. NS = Not significant.

Factors influencing the adoption of chemical pest control in cowpea production in the study area.

Factors influencing farmers' adoption of chemical pest control was analysed using Probit regression model stated as follows in equation 4:

Where A_i is the index for adoption of chemical pest control, Z_i is the explanatory variables and, is the stochastic error term.

The explicit form of this model is as shown in equation 5:

Pr(Chem. adoption) = f(Age, Marital, Family size, Education, Extension, Yield Increase, Clean seed, Association member) (5).

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That is, the probability that a farmer adopts chemical pest control in cowpea production is a function of his age, marital status, family size, educational qualification, extension contact, his expectation of higher yields, and his expectation of clean seed production and his membership of farmers' association.

The Probit model used in this study has a good fit prediction with a Chi-square value of 154.20 that was significant at 1% level with the Log likelihood function of 95.88. From eight variables in the model as shown in Table, five were statistically significant in explaining farmers' adoption behaviour of chemical pest control in cowpea production in the study area. In line with apriori expectation, age, marital status, educational qualification, extension contact, and the desire for higher yields were statistically significant I explaining farmers' adoption of chemical pest control in cowpea production. The age has direct relationship with experience especially in rural farming communities, and it means that the more experience a farmer is in this area, the higher the probability of adopting chemical pest control in cowpea production.

Also, married farmers as shown by the model results are more conscious of the need to get better yields so that they could meet their family food needs as well as having marketable surplus to generate income for family financial needs and hence married farmers are better adopters of chemical pest control for cowpeas production in the study area.

The study also validated the expectation that the higher the level of education of a farmer, the more likely for the farmers to adopt yield increasing productivity method like chemical pest control in cowpeas production in the study area. Moreover, the desire for yield increase was found to be statistically significant at 1% showing that higher yields increase implication of this practice is one of the main reasons for farmers' adoption of chemical pest control in cowpeas production in the study area.

Furthermore, extension contact was found to be significant and this shows that farmers having regular contact with extension agents are more knowledgeable about the advantages of using chemical pest control in cowpeas production and are consequently better adopters of this production practice.

The household size has negative coefficient that was not significant and shows that large household could discourage adoption of production innovation since the responsibility of caring for such large population would have adverse effect on the finances of the household head.

Finally, it was also found that the desires for clean seed production and membership of farmers association have no significant influence on the adoption of chemical pest control in the study area.

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 State but in the whole of Nigeria and hence help in making this vital protein rich food.

well secured thus enhancing the general food security of the country.

2. Better yields among the adopters would translate not only in food security for the family, but would also lead to the production of marketable surplus. This marketable surplus would translate to higher income generation for the farmers thus helping in

poverty reduction among the rural farmers in the area.

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TABLE 2: Results of Probit model for the adoption of chemical pest control in cowpea production by farmers

bees meets his expectation of higher yields, and his expectation of clean seed

Variables	Coefficients	St. Deviation	T-ratio	P-value
Age of Farmer	0.4599*	0.2730		0.092
Marital status of farmer	1.6378*	0.8341	1.96	0.049
Household family size	-0.7366	0.7315	-1.01	0.31
Educational qualification of farmer	0.9175**	0.3235	2.84	0.005
Extension contact by farmers	0.9023*	0.3989	2.26	0.024
Desire for yield increase	4.0292***	0.5743	7.02	0.0005
Desire for clean seeds production	-0.4648	0.5327	-0.87	0.38
Vlember of farmers'	0.2618	0.5351	0.49	0.62
Model CHI-SQ =154.20*** Log Likelihood function = -				
95.88 140 am (1966) 140 and 1966				

^{* =} Significant at 10% level, ** = Significant at 5% level, *** = Significant at 1% level.

Source: field survey, 2005.

Implication of chemical pest control for poverty reduction and food security in the study area

The implication of the adoption of chemical pest control against non-adoption was also examined by comparing the mean per hectare yields of farmers adopting as against non-adopters in the area. While farmers adopting this practice had mean yields of 1892 Kg per hectare, those not adopting had mean yields of 827 Kg per hectare. The farmers here usually measure their threshed harvest with bags weighing 100kg each. The total number of bags harvested is therefore multiplied by 100 to get total harvest per hectare. There was statistically significant difference in the yields of adopters and non-adopter at 1% level. The high difference in these yields underscores the importance and the need of chemical pest control in cowpea production in the area. The high yields among adopters of chemical pest control in cowpea production in the study area have two implications.

- 1. It has and will continue to help increase availability of cowpeas not only in Kaduna State but in the whole of Nigeria and hence help in making this vital protein rich food well secured thus enhancing the general food security of the country.
- 2. Better yields among the adopters would translate not only in food security for the family, but would also lead to the production of marketable surplus. This marketable surplus would translate to higher income generation for the farmers thus helping in poverty reduction among the rural farmers in the area.

TABLE 3: Results of Independent T-test comparison of cowpea yields per ha with and without chemical pest control

Variables	Chemical control	No control	T-statistic	
Mean Yield/ha	1891,95***	827.07	stating of large	
Standard Deviation			ovv. dremanieveb Hams Hamer Farmer F	
Observation (N)	61	79	Technicity Fublic	

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Source: field survey, 2005. *** = Significant at 1% level.

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This paper has shown that there are factors influencing the adoption of chemical pest control in cowpea production in the study area. The age of household head, marital status, household size, educational qualification of the household head, extension contact of the farmers, and the desire of the farmers to realise higher yields were factors found to be significant in influencing farmers' adoption of chemical pest control in cowpea production in the study area.

It was found that the yields of cowpea were much higher among the adopters of chemical pest control in the area than the non-adopters. Based on this significant yields increase, it could be concluded that the use of chemical pest control will not only lead to food security among farmers in the production area but will help in general food security all over the country since cowpea is an important protein food consumed far beyond the immediate production area. The high yield increase would also help greatly in poverty reduction among the rural farmers engaged in cowpea production in the country. It is therefore imperative that chemical pest control should be encouraged through extension activities in the production areas across the length and breathe of the country.

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were sourced from published and upparatied documents related to the problem. A total of 162 respondents orang non some 54 FGs were selected intolegit a distinguity procedure, non whom date on personal characteristics FG membership; FG development. EG economic activities and constraints were collected. The data collected was subjected to frequency counts and pentage analysis. The main conclusions and implications were that majority of Figs in the study area were established in the ind 1980s a phenomenon which was inspired by government's policy at the time. Apartion their leadership situative, the rest of their mode of operation is informat. Compered with their years of existence, their achieved growth and development was registible and problematic, Their oppilents were low treracy, fack of functs, leck of functs, leck of feetings and organizational skills and poor leadership. Their current condition has implications for agricultural extension services in the area. Extension organizations should ensure that extension workers accurre special training and skills to enable them deal effectively with the extension issues of group formation community organization and pluralistic extension approaches in this regard, a key tole of extension is development of technical and organizational eappacities of the FGs to analysism organize themsissines and takes charge of their own growth and development inpowered the Gs are platforms for selving inemicale me and mountaines our best for sustained et et evelopins.

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Key Words: Farmers, groups, states, Nigeria, capacity, improvement

MOTTHEATH

As one of its institutional and organizational objectives. Nigeria's current National Policy an Integrated Rural Development (IRD) proposes to establish an appropriate framework and incentive structure conductive to the development of demand-driven projects and programmes in the rural sector (Anonymous, 2000). This implies that, in order to succeed the strategy will place emphasis on collaborative efforts between government and other stakeholders in the rural sector, including the participation of beneficiaries, NGOs, the private sector and grassroots rural groups. Therefore grassroots rural groups are expected to be able to define their development needs, plan and mobilize their people and resources to develop themselves. Traditionally farmers are organized in groups to be able to cater for a common interest, but more often to off set labour shortages during seasonal activities.

Today the growing worldwide popularity of participatory approaches and other group-based.