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Factors affecting farmers adoption of cowpea spraying technology in kebbi south, Nigeria

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Abstract
The study assessed the factors affecting farmer's adoption of cowpea spraying technologies in kebbi south using cross-sectional data obtained by interviewing respondents with the aid of structured questionnaires. A probit model was employed to analyze the determinants of farmer's adoption of cowpea spraying technologies in the study area. The study revealed that participation in the spraying of cowpea by farmers was higher for the following: male farmers, producers with more years of farming experience, farmers with more extension contacts, and respondents with smaller families. Furthermore, the study revealed that female farmers were less in the spraying technology. Decreased in the participation of female was due lack of technical know-how on operational procedures of the spraying machines, Inadequate land, finance, education and cultural beliefs. Those that were found to have participated much were experienced female farmers. The study recommends the expansion of the extension programmes more to female farmers so as to encourage them to participate in the spraying technology such that it addresses the problems inhibiting the effectiveness of farmer's participation in the spraying technology.

Keywords: cowpea, spraying technology, adoption; kebbi south

Introduction
Kebbi south has become synonymous with cowpea due to her extensive contribution to the production of the crop at the state level. Socio-economic factors play a prominent role towards the production of cowpea crops and this can be seen in many dimensions such as education, poverty environment belief and taboo this are as many societies in rural Africa as really complex. Therefore their effect will help policy makers in the country to make more informed decisions in improving production and livelihood of the farmers (Anonymous, 2010) [3].

Cowpea, *Vigna unguiculata* (family: *leguminosae*) is grown and consumed for its high protein content (23 – 25%). The crop grows well in the Guinea and Sudan Savannahs of Nigeria. Nigeria is the largest producer of cowpea in the world. Pests and diseases are the most important impediment to cowpea production. In storage, cowpea is also affected by pests and diseases leading to their deterioration, and loss of nutritive value. The diseases found on cowpea are mainly fungi while the other pests are insects and rodents. Insects are by far the most important limiting factor in the efficient storage of cowpea. Losses of up to 30 – 70% have been recorded on stored cowpea in the absence of insect pest control measures. (Anonymous, 2010) [3].

Agricultural industry was accorded scanty attention after the discovery of oil in commercial quantity in Nigeria. This has created a gap between the demand and supply of domestic food requirements. Consequently, the country has found it increasingly difficult to feed her teeming population and supply the local industries from the domestically produced food and raw materials. The annual widening gap between food and raw materials demand and supply in the country gave room for concern (Zalkuwi *et al*., 2014) [7].

Cowpea storage may be conducted for the purpose of maintaining regular supply throughout the year, sale in times of scarcity at high prices to fetch more money, preservation of seeds for planting at the next cropping seasons and it also encourages price stabilization when governments buys surplus cowpea at the time of harvest at low prices and release them periodically in times of scarcity to force prices down and prevent inflation. The various storage methods adopted by farmers depend on the purpose of storage and the quantity of cowpea produced or procured for storage. The main thrust of this paper is to highlight some of the control methods and practices recommended for efficient cowpea storage (Adejumo and Raji, 2007) [2].

Cowpea is an important cash crop as well as food crop to many farmers in the Sudan – sahelian Nigeria. It is used as fodder for the livestock and at the same time to maintain soil fertility through its ability to fix atmospheric soil nitrogen even in very poor soils (Jacobson and Crosby, 2011). In order to boost the production of this important crop in Nigeria, efforts had been made to provide appropriate technologies for the production and post – harvesting management to the farmers.

Methodology
Study Area and Data
This research was carried out in Southern Kebbi State (Zuru Emirate), Nigeria. Zuru Emirate is one of the four Emirates in Kebbi state. The Emirate comprises of four Local Government Areas (LGAs) namely; Danko-Wasagu, Fakai, Sakaba and

Zuru. The Emirate is located within latitudes 11º and 12º N and longitudes 4º and 5º E of the equator (NPC. 2006) [6]. The state was carved out of the former Sokoto State in 1991; the Emirate is located in the extreme South-eastern part of the state and covers an area of approximately 9,000 square kilometers. It is located on a hilly terrain and is bounded to the north by Gummi Local Government Area of Zamfara State, North-west by Koko Local Government Area, South-west by Yauri Local Government Area, North-east by Bukkuyum Local Government Area of Zamfara State and south by Rijau Local Government Area of Niger state (Girma, 2008).

The estimated population of the Emirate is 582, 106 people (NPC, 2006) [6]. The various indigenous cultural and ethnic groups of the Emirate are the Dakkarkari, Fakkawa, Dukkawa, Kelawa, Kambarawa, Katsinawan laka and Achifawa. Other nonindigenous ethnic groups in the area are the Hausa, Fulani, Yoruba, Igbo and other tribes found in Nigeria. The different religions found in the area are Islam, Christianity and traditionalist, like any other African society, these came as a result of the interaction with the outside world (NPC, 2006) [6]. However, the traditional worship of different deities is still upheld in the area with many festivals celebrated at various times of the year. The weather is marked by a single rainy season and long dry season, the average rainfall of the area is between 1025mm and 1050mm/annum. Mean temperature range between 31^{oC} and 38^{oC}, the rainy season is between April to October. The climatic condition of the area is characterized by hot and wet seasons as in the tropics; the months of November to February are the hamattan period. The soil type is sandy loam and rich, which makes it suitable for agriculture (NPC. 2006) [6]. It is important to point out that production of agricultural goods in pre–colonial Zuru society was geared mainly towards the production of use–values. This is not to say that exchange did not take place. There was exchange between the produce peasant families and commodities of non-peasant households who specialized in the production of agricultural implements and other necessities which were fundamental in the working of family units. Animal husbandry was practiced side by side with crop production, even though on limited scale. The people of Zuru Emirate depend largely on the pastoral Fulani for meat, milk and butter. Hunting was the second important economic activity after crop production. Hunting was regarded as a supplementary occupation and was carried on throughout the year because it provides a means of getting meat for consumption. It also serves as a source of obtaining skins of animals for shoes, warfare robes and for making local drums. Other important economic activities are local handicrafts like pot-making and weaving by women and blacksmithing by men (NPC, 2006) [6].

Empirical Model

Due to the binary nature of the dependent variable, that is participation in the adoption of the cowpea spraying technology, we employed the probit model to analyze the data. The probit model is suitable for small datasets and has been widely applied to the estimation of participation models in the literature (for example, 8, 13, - 15).

As a binary situation, farmers either participated in the adoption of the technology or otherwise. Therefore, if we denote participation in the adoption of the spraying technology y = 0 if the farmer did not participate. The predicted probabilities are then constrained to lie between 0 and 1. With the probit model only the values of 0 and 1 can be observed for y_i, but there is a latent variable y_i that determines y_i (20).

Following (21), the probit model can be written as

$$E\ (yi/xi) = (F\ (ß'xi) + 0(1 - F\ (ß'xi) = F\ (ß'xi) = \phi\ (ß'xi)$$

Where ϕ is the cumulative distribution function of the standard normal distribution, xi represents a vector of random explanatory variables and ß is a vector of parameters to be estimated.

We specify the empirical model of the probit regression as follows:

$$Y_i = ß_0 + \sum^{8}_{j} = ß_{ji}\ x_{ji} + v_i$$

Where y_i is the latent variable representing farmers' participation in the adoption of the spraying technology, x_1 to x_8 are the independent variables influencing participation namely gender, education, farm size, household size, farm income, farming experience, extension contact, and the interaction of gender and farming experience, respectively. V_i is a random disturbance term.

The latent variable (y_i) is related to the observable binary variable (y_i) through the expression:

$$Yi\ \begin{cases} 1\ if\ y_i * > 0 \\ 0\ if\ y_i \leq 0 \end{cases}$$

Due to the non-linearity of the probit model, the parameters do not represent the marginal effects of the explanatory variables. The marginal effects are more informative and easy to understand and explain. The result of the marginal effects provide useful guideline for decision-making by policymakers. The marginal effect is the differential of equation (1) with respect to x_i (21):

Where ϕ denotes the probability density function of the standard normal distribution.

Our choice of variables for this study is based on intuition and literature (13 – 15), (22), (23) as these have been shown to play key roles in farmers' participation in the adoption of the cowpea spraying technology.

We present the definition of the explanatory variables used in the study and our prior expectations of their relationship with the dependent variable in Table 1. A positive sign means that the variable in question is expected to increase the probability of participation in the adoption of the spraying technology and vice versa.

We expected the gender of the farmer to have a positive relationship with participation implying that we expect male farmers to have higher participation in the adoption of cowpea spraying technology compared to their female counterparts. This is due to the inherent bias against women farmers in most developing countries in terms of access to resources and

participation in programmes.

Education increases farmer's awareness of the benefits of interventions and access to information. Hence, we expect the variable to have a positive impact on participation. However, participation is likely to decrease if educated farmers engage in off-farm activities due to their higher opportunity cost of labour. We therefore hypothesize an indeterminate sign for the education variable.

With respect to farm size, we hypothesize a positive relationship with participation in the cowpea mass spraying technology. This is because farmers with larger farm holdings are likely to be influential members of the society and thus more likely to accept and adopt new farming technologies such as spraying technology. Similarly, we expected farm income to have a positive effect on participation because households with higher income are likely to be influential members in the society.

Table 1: Definition and expected signs of the variables in the probit model

Variable	Definition/measurement	Sign
Participation in spraying	Dummy: 1 if farmer participated; 0 for otherwise	
Gender	Sex of famer: 1 if male; 0 for otherwise	+
Education	Dummy: 1 if educated; 0 for otherwise	+/-
Farm size	Farm size in acres	+
Farm income	Farm income in kebbi south	+
Extension contact	Number of extension visits per annum	+
Household size	Total number of household members	+/-
Farming experience	Years of farming experience	+

Extension agents are channels for information flow to farmers so we expect extension contact to have a positive impact on participation in the cowpea spraying technology. Communities without extension agents are less likely to be involved in the acceptance and adoption of new technologies just as farmers who are unable to access extension services. We expect household size to exert either positive or negative influence on participation. This is because we anticipate that larger households may have social influence that is likely to aid their accessibility to the spraying personnel. However, labour-constrained small households may be desperate to get their farms sprayed and may therefore be more eager to search for spraying personnel. Finally, we expect farmers who are more experienced in cowpea production to be more knowledgeable about farming and more familiar with extension agents and the spraying personnel, which are likely to facilitate their participation in the adoption of the spraying technologies.

Result and Discussion

We present the results of the study together with the discussion of the relevant findings in the following section. Table 2 presents the descriptive statistics of the respondents according to their participation status: the mean, standard deviation and the test of the mean different of the variable use in the model. From the results, gender education status, farm size and farming experience did not exhibit any significant difference between the participants and non-participants, it highlights the perceived marginalization of women farmers in developing countries with regards to access to production resources and participation in development programmes due to their low social and political power (24 – 25).

About 88% of the respondents had been to school and obtained some level of formal education. We recorded education as a dummy variable and therefore were unable to give sufficient information about the levels of educational attainment. The average years of farming experience among the respondents was 15 with average farm size equal to 8 acres and household size averaging 10 members. Furthermore, the average income from cowpea production was NGC 1999.while 36% of the respondents made contact with an extension agent during the farming season. Even though farm income was a little higher for non-participants, the mean difference was not significant.

Table 2: Descriptive statistics of respondents according to participation status

Variable	Mean	Std. Dev.	Participant (N=54)	Non-participants (N=24)	*t*-test
Gender	0.82	0.39	0.83	0.79	-0.44
Education	0.88	0.32	0.89	0.86	-0.18
Farm size	7.76	5.76	7.70	7.73	-0.03
Farm income	1937	2029	1874	2078	0.41
Extension contact	0.36	0.81	0.50	0.04	-2.39**
Household size	9.99	2.94	9.48	11.1	2.34**
Farming experience	15.3	7.72	15.6	14.6	-051

**significant at 5% level

Contact with extension agents was higher for adoption of cowpea spraying technologies, and the mean difference was statistically significant, implying that the variable is likely to play an influential role in farmers' participation in the adoption of the spraying technology. The number of household members was higher for non-participants and the mean difference was statistically significant. Hence, household size is likely to influence participation in the adoption of the spraying technology among farmers.

Factors influencing farmer's participation in the adoption of cowpea spraying technology.

We present the factors influencing participation of farmers in the adoption of spraying technology (estimated by the probit model) in Table 3 Chi-square value of 16.98 for the model is statistically at 5% indicating that the independent variables jointly explain the probability of participating in adoption of the spraying technology. Four out of the seven explanatory variables were significant determinants of participation with three of the variables confirming our prior expectations. Specifically our results showed that gender, extension contact, household size and years of farming experience significantly influenced farmers' participation in the adoption of cowpea spraying technology. Our aim was to help stakeholders understand the degree to which the estimated coefficients from the probit model affect participation in the adoption of cowpea spraying technology. Hence besides the estimation of the probability of participation, we also estimated the marginal effects of the coefficients and discussed the significant

variables.

The coefficient for gender is positive and statistically significant at 10% with a marginal effect of 63.5%. From the result, men had a higher probability of participation compared to women. This observation is consistent with (19) and (26). The reason for this finding is that in a typical rural setting, household heads are usually males who are the decision-makers in terms of access to resources and participation in programmes. Women often need the permission of their husbands to participate in programmes thus constraining their participation rates.

Contact with extension agents had a positively significant effect on participation. This means that as the number of contacts with extension agent's increases, the likelihood to participate in the Programme increases. An additional contact with extension agent increases participation in the adoption of the cowpea spraying by 3.02%. The result is in line with our *prior* expectation. The implementation of agricultural projects and programmes of the government of Nigeria is usually through the Agricultural Extension Services Directorate of the Ministry Agriculture and Rural Development (MoARD). MoARD also collaborates with other institutions as well as farmer groups to extend services to farmers. Extension agents therefore facilitate access to agricultural interventions and services such as the cowpea spraying technology.

Table 3: Maximum likelihood estimates of the probit participation model

Variable	Coefficient	Std. Errors	P>(z)	Marginal effect
Gender of farmer	2.203*	1.230	0.073	0.635
Educational level	-0.423	0.654	0.518	-0.122
Household size	-0.168**	0.071	0.017	-0.048
Farm size	-0/013	0.032	0.696	-0.004
Extension contact	1.047**	0.471	0.026	0.302
Farming experience	0.114*	0.061	0.060	0.033
Gender Experience	-0.118*	0.070	0.093	-0.034
Constant	1.454	1.802	0.420	-
Log-likelihood	-39.7			
Wald chi2 (8)	17.0**			
Pseudo R2	0.18			
Percentage correctly classified	74.4			

*significant at 10 percent level; **significant at 5 percent level

Household size was significant at 5% but with 4.8% marginal effect. Farmers with larger households are therefore 4.8% less likely to participate in the adoption of the spraying technology for every additional member added to the farm household. This is because larger households may be less labour-constrained which may lead to less urgency in following up the spraying personnel. Larger households may also be preoccupied with meeting the family basic needs such as food, clothing and shelter, such that they may have little or no time left to follow up spraying personnel.

Farming experience was a significant factor influencing participation in the adoption of the spraying technology and had a marginal effect of 3.3%. This implies that an additional year of farming experience leads to a 3.3% increase in the adoption in the spraying technology. Our result in this regards is plausible and expectant. More experienced household heads have over time, developed some understanding of new farming technologies that can help raise farm yields and become more acquainted with extension agents which may enhance their participation in programmes.

The interaction between gender and farming experience was negative and significant at 10 percent level even though the influence of the individual variables on participation was positive. The interaction between the two variables showed that female farmers with experience in cowpea farming were 3.4% more likely to participate in the adoption of the mass spraying technologies compared to their male counterparts. The introduction of the interaction term is thus useful as it provides additional information on how the variables in the model influence farmer's participation in the spraying technology.

Conclusion and Recommendations

The study adopted the binary probit model to estimate the determinants of farmers' participation in the adoption of cowpea spraying technology in kebbi south. Eighty (80) cowpea farmers were selected from four communities in kebbi south senatorial district for the study. The respondents were randomly selected and interviewed with the aid of structured questionnaires. Our results revealed that farmer characteristics including gender of the farmers, contact with extension agents, household size and farming experience has significant influence on participation in the adoption of cowpea spraying technology. We therefore propose the following recommendations to enhance farmers adoption of cowpea spraying technologies in the study area.

First, there is the need to eliminate the gender inequality in access to and participation in the adoption of the spraying technology. Women's participation in agricultural programmes have been shown by this and other research findings to be lower than men and effort to enhance women's participation will go a long way to increase cowpea output in kebbi south and Nigeria at large.

Furthermore, scaling up extension service delivery to farmers will enhance participation in the adoption of the cowpea spraying technology as shown by the significant effect of extension contact on improved technology participation. In particular, the use of mass extension methods requires emphasis as a panacea to the limited number of extension agents in the country. For example, mass communication through radio, television and communication vans are potential means to reach farmers in remote areas. In addition, there is the need to strengthen farmer-based groups to serve as channels for the dissemination of extension services to farmers which may facilitate the acceptance and adoption of the spraying technologies in the study area.

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