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ADOPTION OF MIXED CROPPING BY FARMERS IN THE NORTH-WEST ZONE OF NIGERIA

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ABSTRACT

Traditional mixed cropping practices dominate the food production systems in the West African semi-arid tropics. This paper investigated the rates of awareness and adoption of mixed cropping and the factors conditioning the adoption of mixed cropping in the north-west zone of Nigeria. Two States in the north-west zone were selected, namely, Kano and Katsina. The actual surveys conducted in the 2002/2003 agricultural season took place in the Rano and Danbatta zones of Kano State and the Funtua and Ajiwa zones of Katsina State. The results showed that mixed cropping was widely practised in Rano, Danbatta and Ajiwa zones, with adoption rates of 75%, 80% and 93% respectively. However, in Funtua zone, there was a preference by farmers for sole cropping (52% adoption rate), compared to mixed cropping (48% adoption rate). Farmers' socio-economic characteristics were also found to have influenced the adoption of mixed cropping but only four related significantly, namely, age, membership of associations, amount of credit received and land security. The implications of these results are that there is a wider acceptance of mixed cropping practices by farmers in the study area than sole cropping and past conclusions drawn in adoption and diffusion literature to the effect that farmer- and farm-structural characteristics affect adoption of agricultural practices are to some extent supported by evidences from this study.

KEYWORDS: Mixed cropping, adoption rate, factors conditioning adoption, Nigeria.

INTRODUCTION

Mixed cropping (or intercropping) — the growing of two or more crops simultaneously in the same field — is the dominant practice used by smallholder farmers in the drought-prone semi-arid tropics of West Africa (Dalrymple, 1971; Andrews and Kassam, 1976; Papendick *et al.*, 1976; Okigbo, 1978). Specific mixed cropping systems have developed over the centuries in the different regions in tropical Africa and are closely adapted to the prevailing ecological and socio-economic conditions (Steiner, 1982) The implication is that mixed cropping systems differ frequently from one area to another with changes in soils and local climates (Steiner, 1982). At other times, social and cultural conditions may be superimposed on the ecological and economical ones, leading to different cropping systems in the same ecological zone (Steiner, 1982).

Until recently, there was a tendency to associate progressive agriculture in developing countries in general and in the northern part of Nigeria in particular, with sole cropping (Norman, 1974). Agricultural research efforts were therefore largely confined to improving sole crop performance (Fussell and Serafini, 1986). This was probably the case because researchers often held that the biology of crop production suggests a strong relationship between physical inefficiency and the growing of crops in mixtures (Abalu, 1977). However, despite the alleged superiority of sole cropping to mixed cropping and despite efforts by extension workers throughout the northern states of Nigeria to impress farmers with this superiority, there has been no apparent shift from crop mixtures to sole cropping (Abalu, 1977). In general, there is no indication of any decrease in the importance of mixed cropping and government policy in recent times has been to increase production by improving mixed cropping systems (Steiner, 1982). A related argument has been that as long as agriculture is dominated by smallholdings with low or no capital inputs and the hoe is the only farm tool, there is no technical reason for sole cropping and mixed cropping will assume greater importance (Steiner, 1982). Improved management strategies for higher and more stable food production in the semi-arid tropics of West Africa have focused on the advantages of traditional mixed cropping systems and, inherent in them, the production goals of the farmer (Fussell and Serafini, 1986).

This paper aims at achieving two objectives: (1) Estimating the rates of adoption of mixed cropping; and (2) Determining the factors influencing the adoption of mixed cropping in the north-west zone of Nigeria. Some researchers (Feeder *et al*, 1985; Idisi, 1990; Heisey and Mwangi, 1993; Nkonya *et al.*, 1997) have argued to the effect that: (i) The first step towards determining the impact of a farm practice on a target society is to obtain some idea about its rate of diffusion or adoption; (ii) Such information on adoption serve as input into future technology impact assessment processes, and provide a useful feedback for strengthening the research – extension – farmer linkage (Idisi, 1990); (iii) Though many producer technology adoption studies have been conducted in developing countries, the importance of factors affecting technology adoption differ across countries or locations on account of natural resource, cultural, political and socio-economic differences (Feder *et al.*, 1985; Heisey and Mwangi, 1993; Nkonya *et al.*, 1997); and (iv) Extension educators and technical assistants involved in agricultural development need to understand the factors affecting technology adoption to be able to target and deliver effective programmes (Nkonya *et al.*, 1997).

This paper has seven components. Sections 1 is the introduction. Section 2 reviews the place of mixed cropping in traditional agriculture in the semi-arid tropics. Section 3 reviews the reasons for the adoption of mixed cropping. Section 4 reviews adoption as a process, stages in the adoption process and the factors conditioning the adoption of practices. The methodology is presented in section 5 and the results and discussion in section 6 The conclusion and recommendations are contained in section 7.

MIXED CROPPING IN TRADITIONAL AGRICULTURE

On the average, mixed cropping covers over 75% of the cultivated area in the West African tropics (Steiner, 1982) In northern Nigeria, Norman (1974) found that crop mixtures were used on 83% of the cultivated area. Similar figures were reported in Niger (Swinton *et al.*, 1985) and Burkina Faso (Matlon and Bonkian, 1980; McIntire, 1982; Sawadogo and Kabore, 1985). A particularly important argument is that for as long as smallholder agriculture continues to dominate tropical African agriculture, mixed cropping is likely to maintain its status as the predominant cropping system used for food production (Okigbo, 1978; Fussell and Serafini, 1986). The number of distinct crop combinations can be large. Norman

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(1974) recorded 156 different associations in northern Nigeria. Nonetheless, 40% of the area was devoted to 2-crop mixtures such as millet with sorghum and millet with cowpea (Fussell and Serafini, 1986). Comparing the findings of Norman (1974) in Nigeria with those of Swinton *et al.* (1985) in Niger, it is apparent that the variety of crop combinations and the intensity of the mixed cropping systems decreases with the annual rainfall, indicating a certain agroclimatic dependence of the potential diversity of mixed cropping, as well as its intensity (Fussell and Serafini, 1986). In general terms, the extent of mixed cropping, that is, the ratio between areas under sole and under mixed crops depends on different factors such as the ecological zones, farm size, and crop species, and so varies from one region to another (Steiner, 1982).

FARMERS' MOTIVATIONS FOR MIXED CROPPING

In the past, most extension programmes started introducing new cropping systems without really knowing what they were trying to replace (Steiner, 1982). Only when it became obvious that farmers were reluctant to accept innovations and adhered to their traditional systems, did researchers start studying farmers' motivations for practising certain cropping systems (Steiner 1982). One of the first was Norman (1974) who, as early as the late 1960s, began studying cropping systems in the Zaria and Sokoto regions of northern Nigeria. On the whole and taking into account local variations in physical, technological and socio-economic conditions, his findings proved to be valid for all of West Africa (Steiner, 1982). Norman (1977) was able to prove that farmers were acting absolutely rationally when continuing their traditional cropping systems.

Some researchers (Parker 1969; Norman, 1974, 1977; Olukosi 1976; Abalu, 1977; Willey, 1979a, 1979b; Matlon, 1984; Lagemann, 1977; Swinton et al., 1985; Fussell and Serafini, 1985; 1986) have shown that farmers have various reasons for practising intercropping. These can be classified into two broad groups: physical and technical, and social and economic, though there is considerable interdependence between these groups. The physical and technical reasons include the following:

(a) increase in the utilization of environmental factors; for example, spatial and temporal differences in growth habits foster complementarity of crops grown in association with temporal differences occurring when crops make their major demands on resources at different times and thus permitting the exploitation of the resource base more fully over time and spatial complementarity occurring when the associated crops make more efficient use of resources over space;
(b) reduction of adverse conditions in the ecosystem; for example (i) reduced crop losses due to pests, diseases and weeds through the association of susceptible and resistant crops or varieties and (ii) the beneficial effect of some crops, for example, legumes, on other crops such as cereals; and
(c) soil protection; for example, given that many crops overlap in terms of the time they are in the ground, the growing of crop mixtures extends the period of the year in which the soil is protected by leaf cover and root systems.

The social and economic reasons, on the other hand, include the following:

(a) tradition;
(b) shortage of land;
(c) greater gross returns per acre than sole cropping;
(d) yield advantages of 20 – 30% over the component crops grown as sole crops;
(e) diversified and continuous food supply over a prolonged period;
(f) risk insurance; for example, stability may result from one crop compensating for the poor performance of another or other crops, hence reduced probability of incomes falling below the subsistence level;
(g) division of labour and crop specialization between sexes, for example, a situation in which food crops are grown mainly by women and cash (permanent crops) by men and another one in which women plant vegetables and spices or interplant okra and roselle between crops such as yam cultivated exclusively by men.

ADOPTION AS A PROCESS, STAGES IN THE ADOPTION PROCESS AND FACTORS CONDITIONING ADOPTION DECISIONS.

Adoption has been defined as the decision to make full use of innovation as the best course of action (Rogers, 1965), or the reported use of recommended farm practices on a continuous and large-scale basis (Atala, 1988). The adoption process is the mental process through which an individual passes from first hearing about a new farm practice to final adoption (Rogers, 1965). Wilkening (1953) described the adoption of new idea as "... a process composed of learning, deciding, and acting over a period of time. The adoption of a specific practice is not the result of a single decision to act but of a series of actions and thought decisions". There is, however, no complete agreement as to the number of stages in the adoption process, although there is general consensus on the existence of stages, and that adoption is seldom an "impulse" decision (Rogers, 1965). Five stages identified in the adoption process: are awareness, interest, evaluation, trial and adoption (Rogers, 1965). The awareness stage is one in which the individual is exposed to the new idea but lacks complete information about it. The primary function of the awareness stage is to initiate the sequence of later stages that lead to eventual adoption or rejection of the innovation. At the interest stage, the individual becomes interested in the new idea and seeks additional information about it. The function of the interest stage is mainly to increase the individual's information about the innovation. At the evaluation stage, the individual mentally applies the innovation to his present and anticipated future situation, and then decides whether or not to try it. A sort of mental trial occurs at the evaluation stage. At the trial stage, the individual uses the innovation on a small-scale in order to determine its utility in his own situation. The main function of the trial stage is to demonstrate the new idea in the individual's own situation and determine its usefulness for possible complete adoption. At the adoption stage, the individual decides to continue the full use of the innovation. The functions of the adoption stage are consideration of the trial results and the decision to ratify sustained use of the innovation

Agricultural adoption has been studied extensively (see, for example, Griliches, 1957; Just and Zilberman, 1983; Feder *et al.*, 1985; Leathers and Smale, 1991; Caswell and Zilberman, 1986). The decision of a farmer to adopt a farm practice (for example, mixed cropping) is reported to be influenced by a number of different factors that include the biophysical conditions of the .farm, certain characteristics of the farmer, and the farm household, and institutional settings under which the farm operates, and the perception of the farmer on the benefits and drawbacks of the practice (Zurek, 2002). Commonly explored farm characteristics influencing adoption include farm size, land tenure and other biophysical traits (Rahm and Huffman, 1984; Nowak, 1987; Baidu-Forson, 1999). Household characteristics include gender, age, education of household head, family size and other demographic traits (Clark and Akinbode, 1968; Alao, 1971; Nkonya *et al.*, 1997; Ersado *et al.*, 2004). Institutional factors include credit constraints, availability of information and availability of extension services (Clark and Akinbode, 1968; Alao, 1971; Havens and Flinn, 1976; Voh, 1979; Atala, 1988; Ersado *et al.*, 2004). Farmers' perception of technology-specific characteristics include productivity, sustainability, yield (Shiferaw and Holden, 1998). This study concentrates on the institutional and farm- and farmer-characteristics influencing the adoption of mixed cropping.

METHODOLOGY

The study was carried out in two States in the north-west zone of Nigeria, namely: Kano and Katsina. These States have a high agricultural production potential and are considered representative in terms of biophysical characteristics and population .density for the larger part of northern Nigeria (NARP, 1995; Ogungbile *et al.*, 1999). Given that each State is divided into three agroecological zones, two Agricultural Development Programme (ADP) zones (Table 1) were purposively selected in each State (one located in the southern-most and wettest parts and the other in the northern-most and driest parts of a State). Actually, purposive sampling ensured that one does not end up with a sample concentrated in one ecological zone. In Kano State, the actual survey took place in the Rano and Danbatta ADP zones while in Katsina State, the survey took place in the Funtua and Ajiwa ADP zones (Table 1). These zones have often served as sites for collecting diagnostic data and validating new and improved technologies, with results subsequently extrapolated to other areas with similar agroecological and socio-economic conditions (Ogungbile *et al.*, 1999).

The units of analysis were the individual farm operators. Two hundred and forty (240) farmers, consisting of 60 farmers from each of the four ADP zones were randomly selected, based on the sample frame of farmers obtained from the ADP zones (Table 1). Data collection was through face-to-face structured interview conducted between the 2002 and 2003 agricultural season by four trained interviewers, themselves ADP staff, in each of the two States.

CALCULATION OF ADOPTION RATES

Three methods are established in literature for the calculation of technology adoption rates. In one method, and where crops are involved, the adoption rate is the ratio of the land area under the technology of interest to the total area under the crop in reference, multiplied by 100 percent. Studies in this category include Akino and Hayami (1975), Ahmed and Sanders (1991) and Lopez-Pereira *et al.* (1991). In these and related studies, adoption rates are computed within the broader objective of assessing the economic impact of research – generated technologies , and under the assumption that adoption follows some logistic trend or behaviour (Phillip *et al.*, 2000). This assumption enables the researcher to project future adoption rates along a logistic curve, using observed adoption rates for some initial years of technology introduction (Phillip *et al.*, 2000).

A second method refers to adoption as the use by farmers of a number of improved practices and is usually measured by an adoption score (number of improved practices used) or by an adoption quotient (number of improved practices used over total number of recommended practices) (Herdt and Capule, 1983). Scores may be arbitrarily scaled to arrive at some categorization of adoption; for example, low, medium and high (Ramaswamy, 1973).

The third method multiplies the ratio of adopting farmers to the total farmers in the sample by 100 percent (for example, Floyd *et* al., 1999). This method is very popular mainly because of its simplicity and is adopted in this study in computing adoption rates.

THE EMPIRICAL MODEL

The decision of the farmer to adopt mixed cropping can be seen as a binary choice between the two alternatives of adoption or non-adoption. From an econometric point of view, the dependent variable which represents the choice of the farmer is in this case not continuous but represents a discrete 0 (= non-adopter)/1 (=adopter) choice. The expected value of the dependent variable can be interpreted as the probability that a particular farmer with certain characteristics will adopt mixed cropping (Kennedy, 1992). This probability though can only take values between 0 and 1. Estimating the probability of adoption according to different farmer's characteristics can be done in various ways. A linear probability model is one option, which estimates in a linear regression the dependent, discrete variable Y, depending on certain farmers' characteristics X (equation 1). Results for Y from the estimation can be translated into the adoption probabilities (Maddala, 1993).

$$Y_i = \beta X_i + \mu_i \quad (1)$$

with $E(\mu_i) = 0$ and Xi = farmer's characteristic. Nevertheless, there are a few drawbacks to this model, which at one time was preferred by researchers for its computational ease: First, the estimated probabilities might fall outside the range of 0 to 1, which results in wrong estimates for the adoption probability. Second, the error term, μ_i is not normally distributed and may have heteroscedasticity problems, which can then result in inefficient estimators of β, when using the OLS estimation method (Maddala, 1983; Kennedy, 1992). As a result, mainly non-linear estimation techniques are used in recent times (Zurek, 2002; Ranaivoarison, 2004). Probit and Logit models are the most prevalent choices, as with them estimated probabilities fall between 0 and 1. A Probit model is based on a cumulative normal probability function, while a Logit model uses cumulative logistic probability function (Pindyck and Rubinfeld, 1981) Both models lead to similar results, as only the scale of the β coefficients is different and the logistic probability function has a fatter tail (Pindyck and Rubinfeld, 1981; Maddala, 1983; Davidson and McKinnon, 1993). As the Logit model is easier to calculate (Pindyck and Rubinfeld, 1981), it is often preferred to the Probit model and is used in this study to calculate the adoption probabilities for mixed cropping, subject to the socio-economic characteristics of farmers in the north-west zone of Nigeria.

The Logit model can be specified as follows (equation 2) (Pindyck and Rubinfeld, 1981):

$$P_i = f(\alpha + \beta X_i) = \frac{1}{1 + e^{-(\alpha + \beta X_i)}} \quad \ldots\ldots\ (2)$$

With: e = natural logarithm (=2.718)

Pi = adoption probability, given certain farmer's attributes

Xi = attribute of i-th farmer

Equation 2 can be transformed into equation 3 (Pindyck ad Rubinfeld, 1981; Kennedy, 1992) which depicts the logarithm of the probability that a farmer chooses one of the two alternatives:

$$Log\frac{P_i}{1-P_i} = \alpha + \beta x_i \text{ .... (3)}$$

The Logit model can be estimated for two different kinds of data: grouped or ungrouped data (Kennedy, 1992). In case a grouping is possible and the sample is large enough, OLS estimation can be used, but in a situation in which a grouping is difficult or the sample is not big enough, one can also employ maximum likelihood procedures, which are today readily available in most statistical packages (Pindyck and Rubinfeld, 1981; as cited in Zurek, 2002). In this study, a maximum likelihood procedure is used to estimate the following equation (equation 4); for this, the statistical programme SPSS was used:

$$\text{Log (P(adoption)/1 – P (adoption))} = \beta_0+\beta_1x_1 + \beta_2x_2 + \ldots \beta_nx_n\ldots \text{ (4)}$$

A list of all the independent variables used in the Logit Model along with their units and hypothesized signs are given in Table 1.

RESULTS AND DISCUSSION

AWARENESS AND ADOPTION OF MIXED CROPPING:

The extent of awareness and adoption of mixed cropping in the locations surveyed are shown in Table 2. The results (Table 2) show that all the farmers interviewed were aware of mixed cropping but there were differences in the rates of adoption of mixed cropping among locations. The preference for mixed cropping in Rano, Danbatta and Ajiwa zones (for which larger percentages of rates of adoption of mixed cropping were estimated) agree with those of Byrnes (1966), Basu (1969), Abalu (1977), Voh (1979), Steiner (1982), Norman *et al.* (1982), Okigbo (1978), Baker (1981) and Elemo *et al.* (1990) to the effect that:

(i) the growing of crops in mixtures is a widely used traditional practice in northern Nigeria;
(ii) farmers will adopt a farm practice whose value they are convinced of;
(iii) experiments on mixed cropping in Nigeria date back to the early 1920s;
(iv) 80% of the cultivated area in West Africa is under mixed cropping and that the percentage is higher in the Anglophone than in francophone countries due to the influence of the former colonial administration and, after independence, of technical advisers;
(v) tropical African agriculture is dominated by smallholdings and mixed cropping is mainly practised on smallholdings;
(vi) since units of production and consumption are intimately linked, pronounced complexity arises from the multiple objectives of crop enterprises which are to produce food and cash and that these find expression in multiple farm enterprises where mixed cropping is predominant and limited resources allocated to maximizing output of the whole farm rather than just an enterprise.

Sole cropping, however, was more widely practised in Funtua zone (Table 2). According to Abalu *et al.* (1979), there is evidence that the relative emphasis placed on sole cropping in an area may be a reflection of an established technology for the sole stands production and the success of external support systems (that is, external institutions) which encourage the growing of sole crops according to the official recommendations made by agricultural research establishments.

FACTORS AFFECTING ADOPTION OF MIXED CROPPING:

The maximum likelihood estimates of the Logit model for determining the factors influencing the adoption of mixed cropping are presented in Table 3. Four of the nine coefficients tested were found to be statistically significant. These were age, membership in associations, and amount of credit received in Rano zone and land tenure security in Funtua zone. The age variable was positively related, as expected, to the adoption of mixed cropping in Rano zone. A positive coefficient for age implies that the older the farmer, the greater the adoption of mixed cropping. This was expected because a central part of the traditional farming systems in most parts of tropical Africa is mixed cropping which has developed over the centuries and reflect specific resource management systems related to the prevailing environmental conditions and the culture of the people (Steiner, 1982; Okigbo, 1994). The assumption is that more experience and knowledge of the farming system associated with age is expected to encourage the adoption of mixed cropping (Shieferaw and Holden, 1998; Lapar and Pandey, 1999). This finding is consistent with those of Adesina and Seidi (1995) and Adesina and Baidu-Forson (1995).

The membership of associations variable was negatively related with adoption of mixed cropping in Rano zone, contrary to expectation. This meant that a longer membership of farmers' groups was associated with lower levels of adoption. The reason may be that the improved access to credit and information associated with the membership of farmers' cooperatives may encourage shifts to, and investments in agricultural and non-agricultural businesses perceived as more rewarding than mixed cropping.

The credit variable was negatively related with adoption of mixed cropping in Rano zone. The implication is that enhanced access to credit is associated with reduced levels of adoption. A possible explanation is that the improved access to credit may encourage investments in other income – earning activities believed to be more profitable than investment in mixed cropping.

Land tenure security, as a variable, was significantly and positively related to the adoption of mixed cropping in Funtua zone. A positive sign for land tenure security means that more ownership of land is associated with higher levels of adoption. According to Shively (1997), tenure security can influence access to credit, the length of a household's planning horizon, or a household's willingness to invest.

CONCLUSION AND RECOMMENDATIONS

The paper has shown that farmers were generally aware of mixed cropping as a farm practice and that mixed cropping systems dominated the food production systems in the study area at the time of the survey, based on the estimated rates of adoption of the practice by farmers. The paper also found farmers' socio-economic characteristics to be useful in explaining the adoption of mixed cropping, though only four factors were significantly related with adoption, namely, age, membership in farmers' groups, amount of credit received and land tenure security. Thus, past conclusions drawn in adoption and diffusion literature to the effect that farmers' personal attributes and farm-structural characteristics are important determinants of adoption of farm practices are to some extent supported by evidences from this study. The following recommendations become important:

(1) Given the observed farmers' preference for mixed cropping, research should be directed at improving management practices for traditional mixed cropping systems that will increase and stabilize the output of the major staple crop products in the study area. This should, however, not preclude the possibility of looking at new mixed cropping systems. These researches ought to be conducted on a continuous basis so that desirable mixed cropping systems generated by these researches can be tested at or extended to the farm level.

(2) The dominance of sole cropping in Funtua zone has also meant that the use of high-yielding material improved or selected under sole crop conditions is also necessary. This is better than having to continuously grow varieties with low yield potentials.

(3) Though membership of farmers' groups and amount of credit received were variables found to be negatively related with the adoption of mixed cropping in this study, several other studies (Wang, 1967; Ramaswamy, 1973; Herdt and Capule, 1983; Njoku, 1990; Saito, 1994; Braverman *et al.*, 1995; Barbier, 1998) found membership of associations and (4) access to credit to be positively related with adoption of farm practices. For example, membership of farmers' organizations helps achieve scale economies in commercial production or market transactions, improved bargaining power vis-à-vis external agents, and gains through risk-sharing.

Table 1: Main characteristics of the selected ADP Zones in Kano and Katsina States.

State	ADP zone	Relative climate	Rainfall (mm)	No. of Local Government Areas	No. of villages	Headquarters of Extension service	*No. of farmers in ADP zone	No. of farmers selected
Kano	I	Wet	909	11	269	Rano	34394	60
	II	Dry	710	11	385	Danbatta	35032	60
Katsina	I	Dry	416	11	127	Ajiwa	34543	60
	II	Wet	1050	7	78	Funtua	34440	60

Source: Adapted partly from Ogungbile *et al.*, 1999; *Field survey, 2002-03.

Table 2: List of independent variables used in the Logit model and their units and expected signs.

Variable	Unit	Expected sign
Age (x_1)	Years	+
Household size (x_2)	Number of persons	-
Formal education(x_3)	Years	+
Membership of associations (x_4)	Years	+
Farm size (x_5)	Hectares	+
Credit (x_6)	Naira (₦)	+
Off-farm income (x_7)	Naira (₦)	+
Extension contact (x_8)	Number of visits	+
Land tenure security (x_9)	Number of plots owned	+

Table 3. Distribution of farmers according to rates of awareness and adoption of mixed cropping.

State/ADP	Aware		Not aware		Adopted		Not adopted	
zone	No.	%	No.	%	No.	%	No.	%
Kano:								
Rano	60	100.0	0.0	0.0	45	75.0	15	25.0
Danbatta	60	100 0	0.0	0.0	48	80.0	12	20 0
Katsina:			0.0					
Funtua	60	100.0	0.0	0.0	29	48.3	31	51.7
Ajiwa	60	100.0	0.0	0.0	56	93 3	4	6 7

Source. Field Survey (2002/03)

Table 4: Maximum likelihood estimates of Logit model for adoption of mixed cropping

Variables	Coefficients			
	Rano	Danbatta	Funtua	Ajiwa
X_1	0.01426	-0.001417	0.008622	-0.009102
	(0.006)[b]	(0.005)	(0.009)	(0.009)
X_2	0.01604	0.01498	0.0004930	0.002691
	(0.014)	(0.013)	(0.013)	(0.010)
X_3	-0.01074	0.007776	-0.008384	-0.009993
	(0.010)	(0.022)	(0.015)	(0.011)
X_4	-0.02724*	0.001576	-0.01857	0.001087
	(0.013)	(0.007)	(0.013)	(0.009)
X_5	0.03092	0.05035	0.04832	-0.01367
	(0.027)	(0.038)	(0.026)	(0.024)
X_6	-0.00004608**	-[a]	-0.000006074	-0.000004878
	(0.000)		(0.000)	(0.000)
X_7	-0.000001343	-0.0000009155	-0.0000008026	- 0.0000003375
	(0.000)	(0.000)	(0.000)	(0.000)
X_8	-0.003472	0.03159	-0.03537	0.0003265
	(0.018)	(0.021)	(0.028)	(0.015)
X_9	-0.03511	-0.01441	0.157*	0.01250
	(0.038)	(0.056)	(0.079)	(0.057)

Indicators	Results			
	Rano	Danbatta	Funtua	Ajiwa
Number of iterations	10	10	10	10
Likelihood ratio index	9.373	10.279	35.907	0.014
Number of farmers correctly classified	96.7%	91.7%	88.3%	98.3%
Model chi-square	32.468	26.592	45.515	29.377

**= Significant at 1%; * = Significant at 5%.
Figures in parentheses are standard errors
a = no credit was obtained by any farmer in Danbatta zone
Source: Field Survey (2002/03)

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