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Discriminant Analysis of the Influence of Farmers' Socio-Economic Characteristics on their Participation in Research and Extension Activities in Borno State, Nigeria

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Abstract

This article describes and applies the discriminant analysis model in this study to evaluate the influence of farmers' socio-economic characteristics on their level of participation in Participatory Research and Extension Approach (PREA) activities in Borno State, Nigeria. Data were obtained from 605 respondents selected through multistage and proportionate sampling procedures. Discriminant analysis was used to analyze the collected data. The dicriminant function coefficients (b) revealed positive contribution for the variables: age (b=0.292), education (b=0.257), marital status (b=0.232), land ownership status (b=0.232) and contact point with extension agent (b=0.729). However, negative coefficients were obtained for the variables: gender (b= -0.170), agricultural production motive (b= -0.241), land tenure system (b= -0.193), farming experience (b= -0.273) and farm size (b = -0.117). Based on low values of the Wilks' Lambda (w), high coefficients for F-ratio (F) and relatively large absolute canonical correlation coefficients (s) the result revealed that 'contact point with the extension agent' (w=0.960; F=102.766; s=0.751) 'land ownership status' (w=0.972; F=71.566; s=0.631) and years of farming experience (w=0.897; F=31.366; s=0.396) are the highest discriminating variables and make significant contribution as discriminators between the different levels of participation in PREA. The study recommended the need to attune PREA to the socio-economic and cultural milieu of Borno State and improve on the level of farmers' education, ensure steady access to extension services and more equitable land tenure arrangement.

Keywords: Discriminant analysis, socio-economic characteristics, farmers' participation, research and extension.

Introduction

Discriminant analysis (DA) is a statistical technique used to determine which variables discriminate between two or more naturally occurring groups. Discriminant analysis begins with the desire to statically differentiate between two or more group and predict the group a new case would fall[1]. It is a method used to classify an observation into one or several of a priori groupings dependent upon the individual characteristics. The discriminant function approach is an effective tool for classifying cases into the value of a categorical dependent, mostly a dichotomy. It is used to investigate differences between groups and to discard variables, which are little related to group distinction. If the means for a variable are significantly different in different groups, then this variable discriminates between the two groups. This allows the use of that variable to predict group membership[2].

Discriminant analysis is also used to examine the factors which contribute to observed groupings[3]. The groupings may be made *a priori,* based on field observations, or groups may be formed, for example, through cluster analysis. An example the first type will be a distinction made by researchers between 'forest fields' and 'savannah fields' or a distinction by farmers of fields suitable or unsuitable for cultivation of a particular crop such as millet or soyabean. The second type of discriminant analysis is utilized to examine the factors which contribute most to explaining membership of the different groups. In this case we need to hypothesize which factors are likely to be responsible for or at least associated with differences in the characteristics of the different groups.

Computation of disciminant analysis depends on the number of groups. In the case of two groups, discriminant analysis generates a linear discriminant function. Discriminant analysis attempts to do this by forming one or more linear combination of the discriminating variables. For instance, consider a set of variables X_1, X_2 …. Xn by which is desired to discriminate between two groups as follows[4]:

$$Z = a + W_1X_1 + W_2X_2 + ….. WnXn \quad (1)$$

Where: Z = Total score on the discriminant function, a= constant Ws = Weights or discriminant function coefficients X_i … Xn = discriminating variables scores.

Utilizing the weights (W's) of the discriminant function, the importance and relative importance values of each characteristic can be obtained. Such importance values make it possible to

evaluate each characteristic in terms of its contribution to the difference between the two groups. The importance value of the characteristic (I_i) is obtained as follows:

$I_i = Wi\ (x_ia - x_ib)$ (2)

Where wi is the discriminant function coefficient of the i^{th} characteristics and ($x_ia - x_ib$) shows the differences in the group means for the two groups (group a and group b).

A relative importance value can be computed to show the importance value of a particular characteristic relative to the sum of the importance value of all characteristics. That is, the relative importance value of the i^{th} characteristics (R1) is given by:

$$= \frac{W_1(X_1a - X_1b)}{\sum W_1(X_1a - X_1b)}\ i = 1, n. \quad (3)$$

Once the discriminant function is known, it is possible to compute the Z value for each respondent by substituting the values of the respondents' characteristics into the discriminant function. Performing this operation for each of the two groups yields a frequency distribution of Z values for each group from which mean value (Za and Zb) are computed. The average of these means (Za + Zb)/2 is then used as the critical value in classifying the respondents into respective groups. For example if the mean Z for group a is 20 and the mean Z for group b is -10 the mid-point between the two values is 5. Thus, if the respondents have a Z value of above 5 is assigned to 'group a' rating classification; if the respondent has a Z value of less than 5 he assigned to 'group b'.

For multiple groups, then we can estimate more than one discriminant function. For example, when there are three groups we would estimate i. a function for discriminating between group 1 and groups 2 and 3 combined and ii. another function for discriminating between group 2 and group 3. The first function provides the most overall discrimination between the groups, the second provides second most and so on. It is also important to note that the function will be independent or orthogonal, that is, their conformation to discrimination will not overlap. The maximum number of functions will be equal to the number of groups (k) minus one (k-1) or the number of variables (p) in the analysis whichever is smaller.

In the context of this study four (4) *a priori* groupings were made by the researchers to represent different levels of participation by farmers in activities of the Participatory research and Extension Approach (PREA) as implemented by the project 'Promoting Sustainable Agriculture in Borno state' (PROSAB). The four levels of participation were 'No participation', 'Low participation', 'Moderate participation' and 'High participation' respectively. Socio-economic characteristics of the respondents were hypothesized to contribute to discriminating between the extent of participation in the research and extension activities as embedded in PREA.

PREA was introduced as a strategy for involving farmers and other stakeholders in technology development and its transfer as a key component of PROSAB. PROSAB activities were undertaken in four Local Government Areas (LGAs) in southern part of Borno state over a four year period, 2004-2008. During this time, PROSAB focused on encouraging the active participation of local leaders, farmers, researchers, extension agents and the private sector in the identification of local community problems and their possible solutions. This involved communities in four cycle stages of PREA process: i. situation analysis; ii. action planning; iii. research and experimentation; and 4) monitoring and evaluation[2, 5].

It was against this background that this study carried out a discriminant analysis to determine the influence of the socio-economic characteristics of the respondents' on their level of participation in PREA activities in the study area. The broad objective of this study was to assess the influence of socio-economic variables as discriminators between different levels of participation of farmers in research and extension activities in the southern part of Borno state. The specific objectives were to: i. describe the socio-economic characteristics of the respondents; ii. assess the relative contribution of socio-economic variables as discriminators between the different levels of participation of the respondents in PREA in the study area; and iii. evaluate the significance of the socio-economic variables in discriminating between the different levels of participation of the respondents in PREA.

Material and Methods

Study Area: This study was conducted in Borno state in northeastern Nigeria. Borno State lies between latitudes 11^o to 14 ^{o} north and longitudes 12^o to 15^o east. It has total land area of 69,436 km^2 and is the largest state in Nigeria in terms of land mass. The state occupies the greatest part of the Lake Chad and shares international borders with the Republics of Niger to the North, Chad to the North –East and Cameroon to the East. Borno State has a population of 4,151,193 people[6].

Sampling Procedure: PROSAB operates in three agro-ecological zones in the southern part of the state, Sudan Savanna (SS), Southern Guinea Savanna (SGS) and Northern Guinea Savanna (NGS) in the four LGAs of Biu, Damboa, Hawul and Kwaya Kusar. Multi-stage sampling was used to select respondents for the study. In the first stage, all the three agro-ecological zones were purposively selected to reflect the geographical diversity of the study area. In the second stage, all the four LGAs and 30 communities were purposively chosen to ensure adequate representation of the various communities. In the third and final stage a proportionate sample of 605 farmers were selected due to differences in population of the various communities in the study area. The 605 farmers comprised of 393 males and 212 females.

Sources of Data: Data were collected from both primary and secondary sources. Primary data were collected by means of a structured interview schedule, developed and used for gathering

relevant information from the farmers. The instrument was administered to the respondents with the assistance of the extension agents who interact directly with the farmers at the local level. Secondary information was obtained from PROSAB, the International Institute of Tropical Agriculture (IITA), Borno State Agricultural Development Programme (BOSADP) and the National Population Commission (NPC). The secondary information collected from such sources included census data, baseline information on study area, geographical features, monitoring and evaluation data.

Measurement of Variables: Conceptualization and measurement of participation in PREA: The dependent variable of the study is the level of participation in PREA activities of PROSAB. Participation was measured according to level of involvement in the PREA activities which is regarded as respondents' assessment of the extent to which they partake in decision-making regarding the PREA activities. The different levels of participation were conceptually interpreted accordingly as follows: 'no participation' means the respondent is not involved at all in the activities; low participation implies that the respondent partakes in the activities with little or no input in decision making regarding the activity; with 'moderate participation' there is some consultation with the farmer, however the final decision remains with the researcher or extension agent. 'High participation' means all the decisions regarding the activity are made by the respondent while the researcher or extension agent only act as a facilitator.

A 4- point Likert-type scale was constructed to determine level of participation which were scored as indicated in the parenthesis: i. No participation, ii. Low participation, iii. Moderate participation and iv. High participation. Participation score of a respondent was determined by summing up the total scores got in terms of his or her indicated level of participation in the PREA activities of PROSAB.

Analytical Model: Discriminant analysis was employed to analyze the effects of the socio-economic characteristics of the respondents on their participation in PREA and their discriminators between the different levels of respondents' participation in PREA activities. The model was specified as follows:

$$Z = b_Q + b_1X_1 + b_2X_2 + b_3xX_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10+} b_{11}X_{11} \quad (4)$$

Where: Z = Total score on the discriminant function, bs = beta coefficients (weights or discriminant function coefficients) in respect of the socio-economic variables X_{1---} X_{11} which was estimated.

Q=Level of participation score: [No participation (1), Low participation (2), Moderate participation (3), and High participation (4)]

X_1, $X_{2.....}$ X_{11} = Socio-economic characteristics of the respondents (discriminating variables) were:

X_1 = Age (years).

X_2 = Educational status (Number of years in formal education)

X_3 = Family size (number)

X_4 = Farming experience (years)

X_5=Ownership of personal farm (dummy: 1 = owner, 0 = otherwise)

X_6=Marital status (Married= 1, not married= 2)

X_7=Farm size (in hectares)

X_8=Gender (male= 1, female= 2)

X_9=Extension contact (Ever received advice from extension agent Yes =1, No=0)

X_{10}=Production motive (subsistence=1, commercial=2, Both=3)

X_{11}= Land tenure system (family owned =1; community ownership=2; rented land; leased land =3; other= 4)

Results and Discussion

Descriptive Analysis of Socio-economic Variables: Table-1 provides data relating to the mean and standard deviation of socio-economic characteristics of respondents per their level of participation in PREA. The data revealed varied trend in the mean and standard deviation of the variables considered. The respondents falling under 'no participation' category have a mean age of 36.37 years and standard deviation of 9.55 which rises to a mean age of 38.80 years with lower standard deviation of 9.27 for the 'high participation' group. The implication is that, relatively, younger respondents are less likely to participate in PREA activities than the older respondents. Age increases experience and responsibility which may explain the higher propensity for participation with increase in age.

In terms of educational variable, the results depicted in table-1 also indicate a mean number of years of schooling of 8.33 years for 'no participation', 9.13 years for low participation decreasing to 8.03 years for 'moderate participation'. The result shows that farmers with lower level of education participate more in PREA activities than those with higher level of education. This is probably due to the tendency for rural-urban migration of the relatively highly educated individuals. This finding supports the assertion by that as the educational level of the general populace increases automatic acceptance of externally instituted policies and programmes could no more be guaranteed[7]. This is because the literate public has an innate inquisitiveness to know the brain behind decisions made about them and their environment.

With respect to mean household size, the result did not reveal much variation between the different levels of participation (table -1). However, there appears more dispersion in household size among the 'no participation' group (SD = 5.27) compared to those respondents indicating 'high participation' (SD = 4.71). The table also shows that the higher the farming experience of the respondents, the less their level of participation. The 'no participation' group of respondents has a mean farming experience of 16.66 years. However, those in 'high participation' category recorded a mean years of experience of 14.68 years. The mean and standard deviation values with respect to farm size for the different levels of participation as evident from the table do not show much variation.

Table-1
Descriptive Statistics for selected Socio-economic Characteristics of Respondents by Level of Participation in PREA

Variable	No participation		Low participation		Moderate Participation		High Participation	
	Mean	SD*	Mean	SD*	Mean	SD*	Mean	SD*
Age	36.37	9.55	37.58	7.59	37.51	7.54	38.80	9.27
Education	8.33	5.56	9.13	5.18	8.03	5.26	7.16	5.35
Household size	7.47	5.27	6.76	4.50	7.02	4.36	7.40	4.71
Farming experience	16.66	13.25	12.44	12.59	12.34	12.19	14.68	13.66
Farm size	3.36	2.47	2.85	2.08	2.98	2.54	3.16	2.73

Key: SD* = Standard deviation **Source:** Field Survey, 2010

Table - 2
Summary of Unstandardised and Standardized Canonical Discriminant Function Coefficients for Discriminating between Different Levels of Respondents' Participation in PREA activities

Socio-economic Variable	F1		F2		F3	
	USTD	STD	USTD	STD	USTD	STD
Gender	-0.351	-0.170	0.781	0.379	-0732	-0.355
Age	0.036	0.295	0.023	0.192	0.081	0.675
Education	0.049	0.257	-0.115	-0.609	0.029	0.152
Marital status	0.724	0.232	-0.343	-0.110	-0.537	-0.172
Agricultural Production motive	-0.342	-0.241	0.347	0.245	0.655	0.462
Land ownership status	0.707	0.322	0.230	0.105	-0.915	-0.417
Land tenure system	-0.160	-0.193	-0.251	-0.303	0.122	0.148
Contact point with extension agent	0.528	0.729	0.100	0.138	0.097	0.133
Farming experience	-0.021	-0.273	-0.001	-0.014	0.018	0.235
Farm size	-0.048	-0.117	0.218	0.314	-0.148	-0.363
Constant	-3.812		-1.802		-1.791	
Eigen value	0.070		0.030		0.008	
Percentage of variance	65.0		27.8		7.1	

Key: USTD = Unstandardized; **STD**=Standardized; **F1**=Function 1; **F2**= Function 2; **F3**=Function 3
Source: Discriminant Analysis of Field Survey Data, 2010.

Relative Importance of the Discriminating Variables: Table - 2 presents the summary of data for the discriminant analysis of the four levels of participation in PREA activities (No participation, Low, Moderate and High participation). The step-wise procedure was adopted to select the best discriminating variables. The analysis yielded three discriminant functions for the four levels of participation. The first function (F1) provided an estimate for discriminating between "No participation group and all the other participation groups (low, moderate and high combined), while the second function (F2) explained discrimination between the low and moderate groups. The third function (F3) accounted for discrimination between moderate and high participation groups. The criteria for evaluating the relative contribution of each of the variables as discriminators between the different levels of participation are the values of standardized cononical coefficients, structure coefficient, eigen values, functions at group centroids and values of Wilks Lambda. The results of the analysis are presented in table-2. The standardized discriminant function coefficients are used in expressing the relative importance of the discriminating variables entered in the model. Standardizing the values is necessary so as to have a common scale of measurement for comparative purposes as the variables are not measured in the same units.

Table - 2 revealed that among the ten socio-economic variables, five made positive contribution while the other five made negative contribution to discrimination between 'no participation' and all the other three levels of participation combined (F1). The positive signs obtained for the standardized coefficients for age, education, marital status, land ownership status and contact point with extension agent under F1 (function 1) suggest that a respondent's chance of participation in PREA activities increases with positive increase in these variables. Negative coefficients were obtained for gender, agricultural production motive, land tenure system, farming experience and farm size. This implies that the variables decrease the probability of the respondents' participation in research and extension activities.

In discriminating between low and moderate participation (F2) the variables found to make positive contribution are gender, age, agricultural production motive, land ownership, contact point with extension agent and farm size. Negative signs are obtained

for education, marital status, land tenure system and farming experience. Function 3 indicated positive signs for age, education, agricultural production motive, tenure system, contact point with extension agents and farming experience. The socio-economic variables showing negative signs as discriminators between moderate and high participation as per the values of the standardized function coefficients are gender, marital status, land ownership and farm size. It appears that some of the variables like gender, education, marital status, land ownership, land tenure, farming experience and farm size are not consistent as discriminators between the different levels of participation as they make positive contribution at one level and negative at another. This can be explained by the fact that their impact as discriminators will differ as to the extent to which such characteristics influence extent of involvement in PREA.

It is important to note that the larger the standardized coefficient (b), the larger is the respective variables' unique contribution to the discrimination (irrespective of the sign of the coefficient) specified by the respective discriminant function. Thus, it is apparent from the analysis that age (b=0.295), land ownership (b=0.322) and contact point with extension agent (b=0.729) are the highest discriminating variables in function 1, while in function 2, education (b= -0.609), gender (b=0.379) and farm size (b=0.314) made the largest contribution. With function 3, the variables, age (b=0.675) agricultural production motive (b=0.462) and farm size (-0.363) are the highest discriminators. This result means that appropriate attention should be given to improving education, farm size, land ownership, gender focus and agricultural production motive of the respondents as well as due recognition to their age in order to motivate them to be more involved in PREA activities.

Table-2 further displays Eigen values and percentages. The Eigen value is the ratio of the between-groups sum of squares to the within-group sum of squares. The largest Eigen value corresponds to the eigenvector in the direction of the maximum spread of the group means. From the analysis, it is clear that function 1 has the largest Eigen value (0.070), followed by function 2 (0.030) and Function 3 (0.008). The first function therefore accounted for most of the dispersion being responsible for 65% of the variance.

The general implication of the findings is that farmer's socio-economic characteristics play a significant role not only in their participation in research and extension activities, but also determine the extent of such involvement. The result is in consonance with other studies on social participation and participation in development. For instance, in a statistical study of some determinants of membership participation in Western Nigeria Rural Cooperatives found that personal characteristics like sex, age, level of education, occupational status; length of residence in community correlate highly with members' participation in social organizations[10]. This study specifically indicated that women are more active participants than men, age increases participation in economic activities and that education is not a significant factor in social participation in the rural areas as most of the ruralites are illiterates. Sutherland et al (2001).Some scholars underpinned the importance of gender and as a determinant in participation in project activities[9]. They emphasized that projects should recognize that men and women have different needs and problems as well as skills and knowledge. Based on their work in the ITDG-Chivi project in Zimbabwe, they noted the significance of gender consideration to stimulate participation in development activities. They also indicated how the use of participatory approaches by the project has assisted in identifying different needs of different social groups.

Table - 3
Structure Matrix of Discriminating Variables

Variable	F1	F2	F3
Age	0.152	0.400	0.624
Gender	-0.054	0.566*	0.385*
Education	0.190	0.768*	-0.009
Marital status	0.198	0.244	-0.36
Household size	-0.091	0.216	0.309*
Size of farm	-0.223	0.167	-0.025
Land tenure system	0.021	0.264	0.215
Land ownership	0.631*	0.123	0.247
Agricultural production motive	0.121	0.370*	0.433*
Years of farming Experience	-0.396	0.160	0.340
Knowledge of existence of Extension agent in your community	0.068	0.189	-0.102
Advice from the extension agent	0.033	-0.129	0.012
Contact point with the Extension agent	0.751*	0.248	0.104

Key: *Largest absolute correlation between each variable and the discriminant function
F1=Function 1; **F2**= Function 2; **F3**=Function 3
Source: Discriminant Analysis of Field Survey Data, 2010.

Significance of Socio-Economic Variables in Discriminant Analysis: Canonical correlation makes it possible to evaluate the significance of the contribution of the socio-economic characteristics of the respondents in the discriminant analysis. In table-3 structure matrix of the discriminant analysis is presented. The matrix provides another way to study the usefulness of each variable in the discriminant function. The structure coefficients presented in the table are the product moment correlations between the discriminating variables and discriminant functions. The ability of a discriminant function to separate groups can be judged from the magnitude of the canonical correlation. If the total structure coefficient is equal to or greater than 0.30 it is considered meaningful[10]. The analysis presented in Table 3, therefore, indicated that the structure coefficients with the highest relationship to function 1 were contact point with extension agents (s=0.751), land ownership (s=0.631), years of farming experience (s=-0.396) while education (s=-0.768), gender (s=0.566) and agricultural production motive have the highest

correlation coefficients with Function 2. Function 3 exhibited high correlation with the variables, farming experience (s=0.340), gender (s=-0.385), age (s=0.624), agricultural production motive (s=0.433) and household size (s=0.309). Positive correlation implies direct relationship implying their values increases in the same direction while negative correlation entails inverse relationship indicating that when one variable increases the other decreases concomitantly.

Conclusion

This study examined the influence of the respondents' socio-economic characteristics on their level of participation in research and extension activities. Results of discriminant analysis based on the criteria of values of standardized canonical coefficient, correlation matrix, Eigen values, values of Wilk's Lambda and classification routine identified that age, education, marital status, land ownership status and contact point with extension agent are positive discriminators while negative coefficient were obtained for gender, agricultural production motive, land tenure system, farming experience and farm size. Age, land ownership and contact point with extension agents are the highest discriminating variables. It became apparent from the study, therefore, that socio-economic characteristics of farmers exert a significant influence on their involvement in research and extension activities.

Taking into cognizance the findings of the study, the following recommendations are hereby proffered: i. There is a need to involve farmers more intensely in research and extension activities. This is to ensure that they are not only passive participants or collaborators as evidenced from the results of the study which shows low to moderate participation. ii. It is essential that the level of education, access to extension services, including ready access to inputs and credit and encouraging favourable land tenure arrangement for more equitable ownership of land to both male and female farmers should be emphasized. iii. PREA should be more attuned to the socio-economic and cultural milieu of Borno state. In this regard it is recommended that PREA activities should take cognizance of the religious practices, cultural practices like festivals, market days, funerals as well as differential consideration of the needs of male and female as well as youths.

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