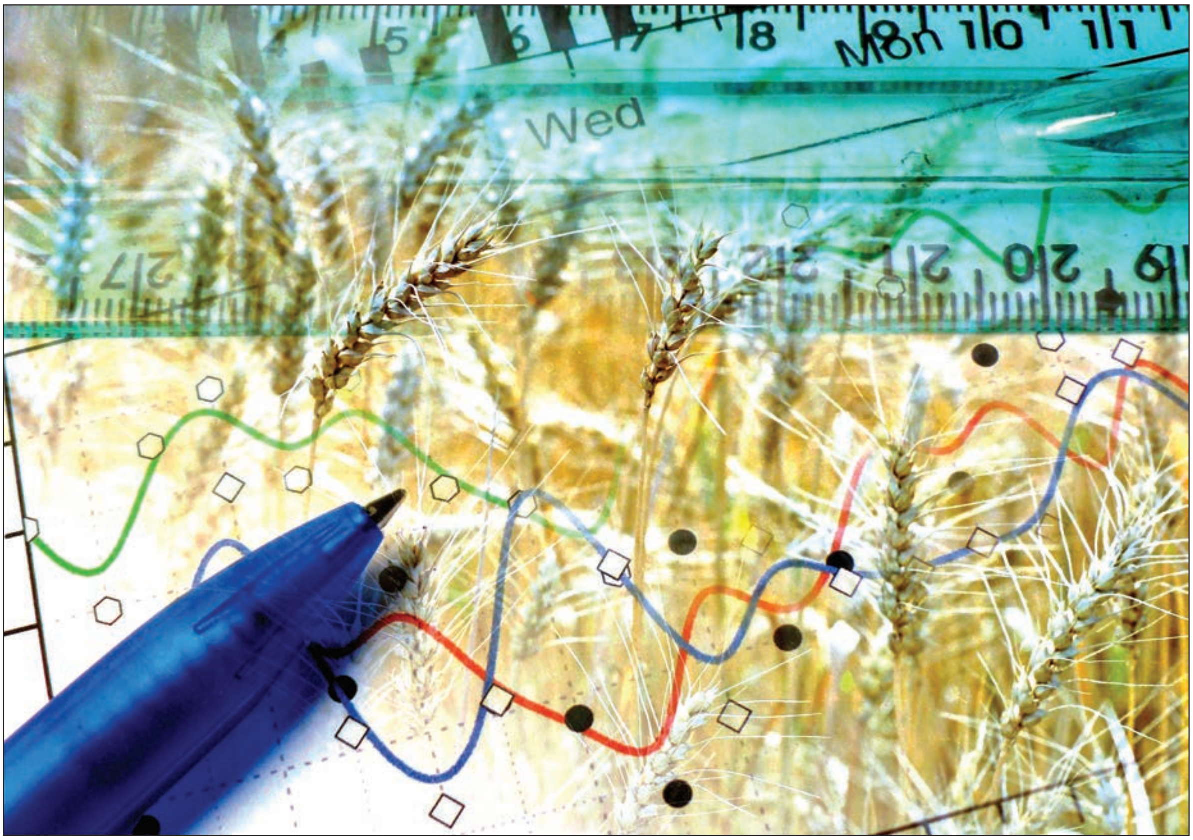

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Determinants of Farmers' Satisfaction with Their Irrigation System in Nigeria

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Abstract: The Logit dichotomous regression model was employed to analyse the satisfaction farmers derive from their irrigation system given certain explanatory variables. It was found that fertilizer availability on time, the output of the farmer, plot size, timely water releases and location of farm plots to head section of branch canals significantly influenced the farmers' satisfaction with their irrigation systems.

Key words: Determinant, farmers' satisfaction, irrigation system

INTRODUCTION

Nigeria, for the past decades has been stressing greater emphasis on irrigation development as a means of increasing food and raw material production as well as achievement to rural development (Barau *et al*., 1999). Irrigation is however a complex system which comprises of different interacting factors such as water, environment, economic and human factors. Among these, the human factor plays a most important role (Maskey and Weber, 1996). It reflects the farmer's managerial ability as indicated by his reaction to the dynamic process of decision making and subsequent implementation that eventually leads to achievements of a set of predetermined irrigation oriented goals (Rao, 1993). A good knowledge of the impact of the human factor on the performance of the irrigation systems is very important for enacting irrigation policies. The understanding of the factors influencing the farmers' satisfaction based on the human factor is therefore very important. Unless farmers are satisfied with their irrigation systems, there would be no incentives or initiatives producible. No irrigation technology regardless of its ecological and economical soundness will have any impact on productivity and income unless it is adopted by a significant proportion of farmers. Consequently, the determination of factors that influence farmers' satisfaction with irrigation systems is very important in designing, executing and adjustment of irrigation-related government policies in the country. The Nigerian government regards irrigation as a catalyst to advance farming technology. High priority has been placed on using large scale irrigation projects known as River Basin Development Authorities (RBDA) to achieve increased cropping intensities and outputs particularly in the northern parts of the country. This study therefore relates the management patterns of the RBDA projects and seeks to identify factors influencing farmers satisfaction.

MATERIALS AND METHODS

The study was conducted in Kano River Irrigation Project Phase One (KRIP) which is the major programme of the Hadeja Jama'are River Basin Development Authority (HJRBDA) with headquarters in Kano, Kano state of Nigeria.

A double stage random sampling was employed in drawing the sample for this study. Two irrigation communities were selected randomly from each of the three Local Government Areas that

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embodies the KRIP and from each community, 30 farmers were randomly selected. Therefore out of a population of 4,296 KRIP irrigation farmers (Anonymous, 1989), 180 farmers were sampled for the study. Structured questionnaire facilitated by oral interview was administered to the farmers for the 2003/2004 cropping season. Information collected includes the age, education level and off-farm income of the farmer, quantity of fertilizer application, use of hybridized seed, water availability on time and location of farm plots to head section of field canals.

Kano River Project Phase One (KRIP-1)

The KRIP covers an area of 22,000 ha (Anonymous, 1989) and is situated along the Kano-Kaduna express way. It spreads over three Local Government Areas: Bunkure, Garun Mallam and Kura Local Governments. It is administratively divided into four zones. For efficient water allocation, KRIP is divided into 29 sectors of varying sizes. A sector is a single unit, with independent administrative water management and other operations independent of other sectors.

Water is released to each sector from a main canal through lateral canals. The canals discharge water to distributor canals and finally to the field canals. Each field canal relays water to particular fields consisting of farm plots ranging from 7 to 20 in number. For efficient administrative management, KRIP is divided into four zones.

Model Specification

A satisfaction model was developed to examine the variables determining farmers' satisfaction with their irrigation system. Since the dependent variable (satisfaction) is dichotomous (the farmer stands to be satisfied or dissatisfied) in nature, the Logit model was used in the analysis instead of a normal linear regression. The application of the Logit model in the analysis stands to be the most appropriate because

- The computation of the logistic distribution guarantees the rate of the probabilities estimated to always lie between 0 and 1.
- Unlike the Linear Programming Model (LPM), the probability does not increase linearly with a unit change in the value of the explanatory variables (Gujarati, 1988).
- It is easier to compute and interpret than the Probit and Tobit models (Pindyck and Rubinfeld, 1991).

The logistic technique makes use of the maximum likelihood estimation method to analyze the relationship between dichotomous reactions and explanatory variables. In this model, the satisfaction level of the farmer is assumed to be based on the objective of the utility maximization. The farmer weighs up the marginal advantages and disadvantages of the irrigation system and will therefore be satisfied if the marginal utilities of the irrigation system outweigh the marginal disadvantages. Since the farmer can either be in a state of satisfaction or dissatisfaction, let the status of his satisfaction be represented by j. The underlying utility function for the farmer can thus be represented as:

$$U_{ij} = \alpha\delta\left(H_{ij}, E_{ij}, I_{ij}\right) + \varepsilon_i \quad (1)$$

$$j = 0, 1, i = 1, 2, 3\ldots n$$

Where:

j = 0 for dissatisfaction

j = 1 for satisfaction. The non observable utility function that ranks the i-th farmers' preference is given by U (H_{ji}, E_{ji}, I_{ji})

H = A vector of human factor as captured by farmer specific characteristics

E = A vector of economic factors
I = A vector of environmental factor as captured by irrigation system specific attributes

Since utilities are random, the farmer will be satisfied in his irrigation system if the preference comparison is such that $U^a > U^b$ or if the non observable (latent) variable $Y^* = U^a - U^b > 0$; otherwise the farmer will be dissatisfied. Thus the probability of satisfaction for the ith farmer can be given by

$$\begin{aligned} P_i &= P(Y=1) = P\left(U^a > U^b\right) \\ &= P\left\{\left(\alpha^a\right)\delta_i\left(H_I^a, E_i^a, I_i^a\right) + \varepsilon_i^a > \left(\alpha^b\right)\delta_i\left(H_i^b, E_i^b, I_i^b\right) + \varepsilon_i^b\right\} \\ &= P(\mu_i) > -\delta_i(H_i, E_i, I_{ii}\beta) \\ &= \delta(X_i\beta) \end{aligned} \tag{2}$$

Where:
X_i = Matrix of explanatory variables
β = Vector of parameters to be estimated
μ_i = Random error term
$\delta(X_i\beta)$ = The cumulative distribution function for μ_i estimated at $X_i\beta$

The probability that a farmer will be satisfied is thus a function of the explanatory variables and the unknown error term. If it is assnmed that the error term follows a Logistic distribution, then $\delta(.)$ can be estimated using a logistic distribution model. Following Eq. 2 and using a logistic distribution, the Logit model that will capture the above underlying utility maximization is:

$$P\left(Y=1\middle|X_{ij}\right) = \delta(X_i\beta) = \frac{e^{X_i\beta}}{1+e^{X_i\beta}} \tag{3}$$

The odds ratio which defines the probability of satisfaction relative to non satisfaction is given by:

$$\frac{P_i}{1-P_i} = e^{X_i\beta}$$

In the empirical Logit model, it was assumed that H, E and I vectors influence farmers' satisfaction. However, due to inadequate data on E (economic variables such as taxes, subsidies and prices of inputs), it was difficult to consider these in the analysis. While economic factors are important in influencing decisions of farmers, such variables are quite hard to capture in cross-sectional surveys. This is because; it is possible that farmers received free seeds or extension advice on the technology and inputting the price for such inputs could be quite problematic. To account for these, the level of disposable income as captured by the financial status of the farmer was used as proxy for the underlying economic variable and the irrigation specific attributes were used as proxy for the environmental factors.

The dependent variable indexes if the farmer is satisfied or not (Table 1). The variable takes the value of 1 if the farmer is currently satisfied with irrigation system and 0 otherwise. The explanatory variables are as explained below:

AGE refers to the age of the farmer measured in years. It was hypothesized that as the age of the farmer increases, the farmer becomes more and more dissatisfied with their irrigation system. This is because older farmers may have risk preferences different from those of young farmers.

Table 1: Definition of variables

Variables	Definition
Satisfaction	Value 1 if farmer is satisfied with irrigation system
AGE	The actual age of the farmer (years)
EDU	Number of years a farmer spent in a formal school; 0 if no formal education
FERT	Value 1 if fertilizer is available on time to at adequate quantity; 2 if fertilizer is available on time and at adequate quantity; 0 otherwise
HYV	Value 1 if farmer uses high yielding variety and 0 otherwise
OUTPUT	The total harvest of the farmer from his irrigated plot (kg)
OFFI	Value 1 if a farmer has any off-farm income; 0 otherwise
WAT	Value 1 if farmer responds yes to having water available on time; 0 otherwise
PSIZE	Value 1 for large plot size; 0 otherwise
FINSTA	The sum of money available to the farmer (Naira)
LAC	Value 1 if farm plot is located close to the head of branch canal and 0 otherwise

EDU measures farmers' educational attainment. This was hypothesized to have a positive effect on satisfaction. This is due to the ability of the educated farmers to become aware of improved innovations and to adopt them in their farming practices.

FERT measures the fertilizer availability on time. It is expected for farmers who received fertilizer on time and in adequate measure to have a positive inclination towards satisfaction. With the availability of fertilizer on time and in adequate quantity, farmers would better combine irrigation water and fertilizer for higher productivity.

HYV variable measures the high yielding variety of seeds. High yielding seed variety will result in increase in output which will tilt the farmer towards satisfaction.

OUTPUT refers to the total harvest of the farmer from his irrigated plot. It was measured in kilograms. It could affect the farmers' satisfaction with their irrigation system either positively or negatively. If the output is high it is expected for satisfaction to be high and low output will lead to farmers' dissatisfaction.

OFFI refers to the off-farm income of the farmer. It is expected that farmers with off-farm income source might concentrate less on crop production and thus be less satisfied with their irrigation system.

PSIZE variable measures the plot sizes. The size of a farmer's plot may influence his attitude towards the irrigation system since the impact of irrigation on small and large plots differ. Farmers are expected to be likely dissatisfied with their irrigation system the larger their plot sizes.

WAT is a variable that measures the availability of water on time. The availability of water on time is expected to make farmers inclined to be satisfied.

FINSTA refers to the farmers' fiuancial status. It was hypothesized that the higher the disposable income level of the farmer, the more the farmer will be able to purchase all necessary inputs on time and also be able to meet all necessary requirements. This will lead to a good output, thereby making the farmer to be more satisfied with the irrigation system.

LAC is a variable that measures the distance of the canal to farm plots. It is expected that farmers with farm plots located near the head of canals will get more water than those farther away. It was therefore hypothesized that location of farm plots in the head canal section will be more satisfied with irrigation system.

RESULTS AND DISCUSSION

The result of the initial estimation of the Logit model on Table 2 shows the estimates of the full Logistic regression model for the KRIP irrigation system. The result shows that age, education, high yield variety, off-farm income, financial status and distance of farm plots to canal were found not to have any statistically significant influence on he farmers' satisfaction with their irrigation system (Table 2).

Table 3 shows estimates of the reduced Logit model which included only significant variables. Based on the t-statistic of the reduced Logit model, the output of the farmers and water availability on time were the most important variables in determining the farmers' satisfaction.

The relative importance of the influence of the explanatory variables is reflected in their coefficients (β) which show the magnitude of change in the log of odds ratio for any change in the explanatory variables. This however does not explain the change in the probability. In this study, all the coefficients have positive signs except for plot sizes (PSIZE). The negative sign of PSIZE implies that increment in the plot sizes of farmers will cause the log of odds in favour of satisfaction to decrease. In other words the probability of farmers being satisfied in terms of the role of the system in increasing their farm income diminished with the increase in plot sizes. A unit increase in PSIZE variable will lower the probability of the farmers' satisfaction to 0.28 ceteris paribus. The farmers were however found to be satisfied if fertilizer was available on time and at adequate quantity, output is high, water is available on time and their farm plots located near the head section of field canals.

The -2 Log Likelihood measures the goodness of model employed in the study. It indicates the difference between the estimated Logistic model and the perfect model. The values of -2 Log Likelihood for both full and reduced models showed that there is a significant relationship between the log of odds ratio, probability of satisfaction and the explanatory variables included in the model. The R-square values and the overall percentage of correct predictions also suggest that the estimated satisfaction model had a good explanatory power.

The reduced Logit model (Table 3) shows that if fertilizer is available on time and at adequate quantity, the farmer has a good output that can generate a revenue that will improve his social status,

Table 2: Full logistic regression model of socio-economic factors of the farmers operating the KRIP irrigation system

Variables	Coefficient (β)	t-value	Exp (β)
AGE	0.018	1.321	1.018
EDU	0.765	1.483	2.149
FERT	1.632	3.749	5.114
HYV	0.533	1.254	0.587
OUTPUT	2.103	4.049	8.191
OFFI	0.037	0.837	1.038
PSIZE	-1.003	2.905	0.367
WAT	1.978	4.092	7.228
FINSTA	0.425	1.236	1.530
LAC	1.137	1.615	3.117
CONSTANT	2.539	2.847	12.667
Overall percentage of cases correctly predicted			100.000
-2 log likelihood			0.001
Nergelkerke R^2			1.000
Box and Snell R^2			0.780
Model Chi Square			69.840

*: p>0.05

Table 3: Reduced logistic regression model of socio-economic factors of the farmers operating the KRIP irrigation system

Variables	Coefficient	T	Exp (β)
FERT	1.513*	3.630	4.540
OUTPUT	1.932*	4.967	6.903
PSIZE	-0.956*	-2.826	0.384
WAT	1.918*	4.125	6.807
LAC	1.185*	3.126	3.271
CONSTANT	2.126*	2.947	8.381
Overall percentage correctly predicted			99.930
-2 log likelihood			0.009
Nergelkerke R^2			1.000
Box and snell R^2			0.690
Model Chi Square			61.570

*: p<0.05

the cultivated area is larger than 0.4 ha and water is available on time, then the probability of farmers being satisfied is estimated to be 0.728 (73%). Based on this outcome, it could be predicted that the farmers were likely satisfied. Nevertheless, if the plot sizes were small and other variables held constant, then the probability of farmers being satisfied is estimated to higher than 90%. If measures are put in place such that the farmers' output increases by a unit, then the odds in favour of his satisfaction will be increased by a factor close to 7 with the probability of his satisfaction with the irrigation system increasing to 87.30%. If water is released on time and at adequate quantity, the farmer's satisfaction will also increase by a factor of 6 and the odds of his satisfaction increase to 87.19%.

CONCLUSION

In this study, adequate fertilizer availability on time, output and adequate releases of water were found to have a great impact on the farmers' satisfaction with the KRIP irrigation system. Since fertilizer accessibility is largely dependent on cash availability of the farmer in Nigeria, policy makers must therefore pay special attention to agricultural credit system in order to realize the full benefit of the irrigation technology.

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