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Modeling the Impact of Agricultural Credit Finance and Socio-economic Characteristics of Farmers on Rice Production: Multiple Linear Regression with Categorical Predictor Variables Approach

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ABSTRACT

In this paper, the impact of farmers' access to agricultural credit finance and their socio-economic characteristics on the quantity of rice produced at the end of the 2013/2014 cropping season for rice farmers from some sampled rice-producing communities in Niger state was modeled using Least squares regression approach with categorical input variables. The contributions of each of the dummy predictors to the fitness of the model and hence, its role in the explanatory power of the model, were examined. It was observed that the amount of credit finance received by farmers plays a significant role in the explanatory power of the fitted model while none of the farmers' socio-economic characteristics significantly improves the goodness-of-fit of the model.

Keywords: Agricultural credit finance, Multiple Regression, Categorical Predictors, Modeling, Rice production.

Mathematics Subject Classification: 62J05

Journal of Economic Literature (JEL) Classification: Q12, C25

1. INTRODUCTION

One of the major concerns of every nation in the world is economic development and agriculture plays an indispensable and supportive role in economic development process by ensuring food security and sufficiency as well as expanding industrial economy since its output is a source of raw material for such industries.

Nigeria has an increasing population of over 140 million people and is endowed with abundant human and natural resources. It is also endowed with favorable weather conditions for farming activities. It is unarguably an agricultural nation and most farming activities are carried out in the rural areas and over 70 percent of active farmers in Nigeria constitute the rural dwellers. Unfortunately, these farmers are marginal farmers because their farming activities are undertaken at the subsistence level only. Unfortunately also, more than 75 percent of the total food requirement of the nation is produced by these marginal farmers who are consistently faced with serious constraints of lack of adequate capital, (CBN, 2003).

The major input for the development of agricultural sector has been globally identified to be agricultural credit as it plays a traditional role in bridging financial gap for farmers for increased productivity. More so, agricultural credit plays a fundamental role in determining access to the needed inputs that facilitates farming and other extensive agricultural practices which ultimately transforms into increased output, which establishes a forward linkage (multiplier effect) in terms of development to other sectors as well as higher income and better quality of life for the rural dwellers (Hazell,2005).

The Nigerian Agricultural and Co-operative Bank (NACB) now known as the Nigeria Agricultural Cooperative Rural Development Bank established in 1973 was part of government's efforts to inject oil wealth into the agricultural sector through the provision of credit facilities to support agriculture for increased agricultural output. Others include the Nigerian Agricultural Commercial Bank, Bank of Agriculture, Agricultural Intervention Fund, and other Agricultural credit schemes with various names.

A number of studies have been carried out, in literature, on the impact of agricultural credit finance on productivity. For instance, ordinary least squares method of regression was used by Akpan (1999) on a time series data set of 33 years to examine the contribution of government expenditures to the growth process in Nigeria. He observed that capital expenditure on agriculture, though not statistically significant, has a positive impact on investment in Agric sector.

Some work have also been done on effect of some factors on rice crop yield. For instance, Venkatesan et al (2005) investigates the effect of water stress on yield of rice crop. The authors observed that the rice yield was affected by water stressing but the extent of the effect depends on the percentage of the stress treatment.

Seon et al (2009) estimates the parameters in rice distribution using maximum likelihood methods.

Venkatesan et al (2005) conducted an experiment to study the yield and peak water demand for rice crop under staggered growing season. The authors noted that the monthly peak water demands were less than peak water demand of normal cropping while the average yield per hectare obtained from normal and staggered cropping were comparable.

Chen et al (2013) used predictive regression models to estimate leaf area of rice with leaf length (L) and leaf width (W) measurements.

The present study models the impact of farmers' access to agricultural credit finance, as well as their socio-economic characteristics on quantity of rice produced using Multiple Linear Regression with Categorical Predictor Variables approach. The socio-economic characteristics include age, marital status, household size, level of education, and average annual income.

Many researches often require establishing a relationship between input and output variables, which makes it possible to predict one or more variables in terms of others. For instance, weights of primary school pupils depend on some variables like height, age and so on.

Effects of some socio-economic factors on a response variable of interest have also been studied. For instance, Linda et al (2006) investigates the effect of socio-economic factors affecting adoption and success of Accounting information systems in small businesses. The authors observed empirically that environmental characteristics, experience and manager's characteristics are important determinants of the adoption and success of AIS software in small businesses.

Some variables are continuous with numerical measurement scale (interval or ratio) and hence with underlying normal distribution while some are counts, classified into sets of categories with non-numerical measurement scale (nominal or ordinal). The later variables are categorical and this study is concerned with models for categorical data. Such data have frequency counts for each category as the number of occurrences in that category. Since the data is categorical and the values of a categorical variable do not convey numerical information, the standard approach to modeling categorical variables (Alan, A., 2007) is used in this work whereby each categorical variable is represented in the model by its corresponding dummy-variable.

2. GENERATION OF THE DATA

Sample survey was conducted with structured questionnaires to generate quantitative information for households. The data so generated mostly relate to socio-economic parameters. A stratified Simple Random Sampling technique was used for this study. The study population, which consists of the entire rice-producing communities in Minna metropolis in Niger state, Nigeria, was divided into four (4) strata. A simple random sample of twenty (20) credit finance beneficiaries was taken from each stratum making a total of eighty (80) farmers. Structured questionnaires were issued to every member (farmer) of the sample and at the end of the administration there were no refusals from each of the strata.

2.1 Theoretical Model

As stated above, the factors examined in this study were age, marital status, and household size, level of education, average annual income and amount of credit collected by the respondent. Classification of each of these factors was done as follows: Age was classified into three groups: 1 = below 30 years, 2 = between 30 and 45 years, 3 = above 46 years. Marital status was classified into three groups: 1 = single, 2 = married, 3 = others. Household size was classified into three groups: 1 = below 4, 2 = between 5 and 8, 3 = above 9. Level of education was classified into three: 1 = primary/sec. education, 2 = tertiary education, 3 = others. Average annual income was classified into three: 1 = below #80,000.00, 2 = between #81,000.00 and #121,000.00, 3 = above #121,000.00. Amount of loan collected was classified into three: 1 = below #20,000.00, 2 = between #21,000.00 and #50,000.00. 3 = above #50,000.00. The quantity of rice produced (in bags) is a function of these levels.

2.2 Model Fitting

The method of analysis used in this study was the multiple regressions on dummy-coded categorical predictor variables called the least squares dummy variable (LSDV) regression. Standard multiple regression analysis is a linear transformation of the predictor variables *X* such that the sum of squared deviations of the observed and predicted response *Y* is minimized (Draper and Smith, 1998). Over *n* observations, the multiple linear regression model involving *k* explanatory variables, in matrix form, is

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \tag{2.1}$$

where **y** is an *n*-dimensional column vector of responses, ***X*** is a model matrix of order *n* x *p*, $\boldsymbol{\beta}$ is a *k*-dimensional column vector of model coefficients, and $\boldsymbol{\varepsilon}$ is an *n*-dimensional column vector of residuals, all given, respectively, as

$$\underline{\boldsymbol{Y}} = \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ \cdot \\ y_n \end{pmatrix}, \quad \underline{\boldsymbol{\beta}} = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \cdot \\ \beta_k \end{pmatrix}, \quad \underline{\boldsymbol{X}} = \begin{pmatrix} 1 & x_{12} x_{13} \ldots x_{1k} \\ 1 & x_{22} x_{23} \ldots x_{2k} \\ 1 & x_{32} x_{33} \ldots x_{3k} \\ & \ldots \ldots \ldots \ldots \ldots \\ 1 & x_{n2} x_{n3} \ldots x_{nk} \end{pmatrix}, \underline{\boldsymbol{\varepsilon}} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \cdot \\ \varepsilon_n \end{pmatrix} \qquad (2.2)$$

For the purpose of testing hypotheses about the values of model parameters, model (1) above also assumes that:

- $\varepsilon \sim i.i.d.\ N(0, \sigma^2)$
- The variance of the error term is constant across cases and independent of the variables in the model.
- The value of the error term for a given case is independent of the values of the variables in the model and of the values of the error term for other cases.

The prediction of Y is accomplished by

$$\widehat{\boldsymbol{Y}} = \boldsymbol{X}\widehat{\boldsymbol{\beta}} \qquad (2.3)$$

Since the data were categorical, each of the categorical variables was re-coded into a number of separate, dichotomous variables (dummy variables). Then, each value of the variables was represented in the model with an indicator variable consisting of only these codes, leaving one of the levels of every variable out of the regression model (as a reference category) to avoid perfect multicollinearity, which will prevent a solution. The differential effect estimates for other levels were then compared with this category. Based on these, a full (unrestricted) model was formulated for the entire data. Then the ordinary least squares (OLS) normal equations were derived and the solutions to the normal equations were obtained by the means of which a fitted model for the data was obtained. Then the significance of the variations in the realized quantity of rice was tested from the statistical viewpoint; but since all the predictors in the model were dummies, their significance was judged jointly using the analysis of variance technique.

Six (6) restricted models were drawn from the formulated (unrestricted) model based on the combinations of the included categories (dummy predictors) and the proportions of the total variation in ***Y*** explained by these variables were examined.

Next we examined the changes in goodness-of-fits of the unrestricted model and the restricted models (i.e., the models we got when we impose the null hypothesis restrictions on the unrestricted model). This was to enable us assess the significance of the contribution of each of the regressors to the explanation of the total variation in Y. The null hypothesis here stated that the parameters of the added regressors (dummies here) were all zeros.

3. RESULTS AND DISCUSSION

Now, the quantity of rice produced was a function of the factor levels listed in Section 2.1; therefore we formulated the full (unrestricted) model for the entire data as

$$Y_i = \mu + \alpha_2 S_{i2} + \alpha_3 S_{i3} + \beta_2 U_{i2} + \beta_3 U_{i3} + \gamma_2 V_{i2} + \gamma_3 V_{i3} + \lambda_2 W_{i2} + \lambda_3 W_{i3} + \psi_2 X_{i2} + \psi_3 X_{i3}$$

$$+\omega_2 Z_{i2} + \omega_3 Z_{i3} + \varepsilon_i \qquad (3.1)$$

Where,

$\boldsymbol{Y_i}$ is the quantity of rice (in bags) for the *i*th respondent; $\boldsymbol{\mu}$ denotes the expected bags of rice for farmers in the reference categories, that is, below 30 years of age, not yet married, four (4) in the family and below, primary/secondary education level, average annual income of #80,000.00 and below, and, credit amount of #20,000.00 and below. $\boldsymbol{S_{ij}}, \boldsymbol{U_{ij}}, \boldsymbol{V_{ij}}, \boldsymbol{W_{ij}}, \boldsymbol{X_{ij}}, and \boldsymbol{Z_{ij}}$; (*i* = *1,. . .,n, j =2,3*) denotes, respectively, the value of the ith case of the jth included category of the factors Age, Marital status, Household size, education level, Average annual income, and Credit amount collected by the respondent. $\boldsymbol{\alpha_i}, \boldsymbol{\beta_i}, \boldsymbol{\gamma_i}, \boldsymbol{\lambda_i}, \boldsymbol{\psi_i}, \text{and } \boldsymbol{\omega_i}$ denotes, respectively, the value of the ith partial coefficient (*i=0, . . .,3*) for an associated predictor. Each of these coefficients measures differential effects on *Y* for the associated included category compared with the corresponding level reference category. A coefficient with positive value indicates higher expected value of *Y* for the associated category than the corresponding reference category while the one with negative value indicates less expected value of *Y* for the associated category than the corresponding reference category. $\boldsymbol{\varepsilon_i}$ is the random error component term ($\varepsilon \sim N(0, \sigma^2)$).

Several models can be drawn up from the unrestricted model (3.1) above to give the quantity of rice (in bags) for any or group of the included categories depending on the combinations of these categories. For example we can have:

(i) $Y_i = \mu + \varepsilon_i$
(ii) $Y_i = \mu + \alpha_2 S_{i2} + \varepsilon_i$
(iii) $Y_i = \mu + \alpha_3 S_{i3} + \beta_3 U_{i3} + \gamma_3 V_{i3} + \lambda_3 W_{i3} + \varepsilon_i$
(iv) $Y_i = \mu + \alpha_3 S_{i3} + \beta_3 U_{i3} + \gamma_3 V_{i3} + \lambda_3 W_{i3} + \psi_3 X_{i3} + \omega_3 Z_{i3} + \varepsilon_i$ etc.,

where

- model (i) gives the realized quantity of rice (in bags) for a farmer that is 30 years of age or less, not yet married, with household size of four (4) or less, primary/secondary education level, average annual income of #80,000.00 or less, and, credit amount of #20,000.00 or less.
- model (ii) gives the realized quantity of rice for a farmer that is between 31 and 45 years of age, not yet married, four (4) or less in the household, primary/secondary education level, average annual income of #80,000.00 or less, and, credit amount of #20,000.00 or less, etc.

In matrix form, model (3.1) can also be expressed as

$$\underline{\boldsymbol{Y}} = \underline{\boldsymbol{X}\boldsymbol{\beta}} + \underline{\boldsymbol{\varepsilon}} \tag{3.2}$$

where

$$\underline{\boldsymbol{Y}} = \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ \cdot \\ y_n \end{pmatrix}, \quad \underline{\boldsymbol{\beta}} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \beta_1 \\ \cdot \\ \omega_3 \end{pmatrix}, \quad \underline{\boldsymbol{X}} = \begin{pmatrix} 1 & s_{12}s_{13}u_{12}\dots z_{13} \\ 1 & s_{22}s_{23}u_{22}\dots z_{23} \\ 1 & s_{32}s_{33}u_{32}\dots z_{33} \\ & \dots\dots\dots\dots\dots\dots \\ 1 & s_{n2}s_{n3}u_{n2}\dots z_{n3} \end{pmatrix}, \quad \underline{\boldsymbol{\varepsilon}} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \cdot \\ \varepsilon_n \end{pmatrix}.$$

Now, since X is the model matrix, we have the OLS normal equations given by

$$(\boldsymbol{X}'\boldsymbol{X})\boldsymbol{\beta} = \boldsymbol{X}'\boldsymbol{Y} \tag{3.3}$$

And the solutions to the normal equations are

$$\widehat{\boldsymbol{\beta}} = (\boldsymbol{X}'\boldsymbol{X})^{-\mathbf{1}}\boldsymbol{X}'\boldsymbol{Y} \tag{3.4}$$

where $\boldsymbol{\beta}$ is as defined earlier.

Using Equation (3.4), we have the fitted model for the data as

$$\hat{Y} = 33.57 + 1.54S_2 - 0.63S_3 - 8.35U_2 + 8.92U_3 - 0.59V_2 - 2.99V_3 - 1.42W_2 - 4.04W_3 - 2.98X_2 - 6.56X_3 + 42.21Z_2 + 52.96Z_3 \tag{3.5}$$

From this model, the point estimates indicate that,

(i) Farmers of between 31 and 45 years of age and those above 45 years of age, realized, respectively, one and a half (1½) bags of rice more than, and above half (> ½) bag of rice less than those farmers of below 30 years of age.

(ii) Married farmers realized close to 8½ bags of rice less than those ones that are single while those in the other category (divorced, widowed, etc.) realized 9 bags of rice more than those that are single.

(iii) Farmers with household size of between 5 and 8 and those that are more than 9 in the household, realized, respectively, above half (½) bag and close to 3 bags of rice lessthan those farmers that are below 4 in the household.

(iv) Farmers that attained tertiary education level and those that attained other (Quranic, nomadic and adult) education levels, realized, respectively, close to 1½ bag and 4 bags of rice less than those farmers with primary/secondary school education level.

(v) Farmers with average annual income of between #81,000.00 and #121,000.00 and those with income of above #121,000.00 realized, respectively, close to 3 bags and above 6½ bags of rice less than those farmers with average annual income of below #80,000.00.

(vi) Farmers that received between #21,000.00 and #50,000.00 and those that received above #51,000.00 as agricultural credit finance during the cropping season under review realized, respectively, above42 bags and close to 53 bags of rice more than those farmers that collected below #20,000.00 as credit finance during the same season

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3.1 Testing for qualitative effects

Having fitted the model to the data as given by Equation (3.5), we then test whether these variations in the realized quantity of rice were significantly different from a statistical standpoint. Here we used the analysis of variance technique to jointly judge the significance of the predictors. The six restricted models we derived from the unrestricted model (3.1) were given in Table 3.1 together with their corresponding explained proportions (in percentage).

Table 3.1: Proportion of variation in rice yield explained by the linear regression models

s/n.	**Model**	**Prop. Explained (%)**
1	$\hat{Y} = 62.92 - 7.92\hat{S}_2 + 1.69\hat{S}_3$	2
2	$\hat{Y} = 61.72 - 7.66\hat{S}_2 + 0.37\hat{S}_3 + 1.19\hat{U}_2 + 28.58\hat{U}_3$	6.3
3	$\hat{Y} = 64.90 + 2.42\hat{S}_2 + 5.10\hat{S}_3 - 0.37\hat{U}_2 + 20.66\hat{U}_3 - 3.87\hat{V}_2 - 41.97\hat{V}_3$	27
4	$\hat{Y} = 61.30 + 2.08\hat{S}_2 + 2.39\hat{S}_3 + 0.83\hat{U}_2 + 21.53\hat{U}_3 - 2.93\hat{V}_2 - 39.45\hat{V}_3 + 11.01\widehat{W}_2 + 2.67\widehat{W}_3$	28.2
5	$\hat{Y} = 63.21 + 0.19\hat{S}_2 - 0.32\hat{S}_3 + 1.76\hat{U}_2 + 22.89\hat{U}_3 - 4.70\hat{V}_2 - 40.74\hat{V}_3 + 14.03\widehat{W}_2 + 4.11\widehat{W}_3 - 7.63\hat{X}_2 - 0.29\hat{X}_3$	28.8
6	$\hat{Y} = 33.57 + 1.54\hat{S}_2 - 0.63\hat{S}_3 - 8.35\hat{U}_2 + 8.92\hat{U}_3 - 0.59\hat{V}_2 - 2.99\hat{V}_3 - 1.42\widehat{W}_2 - 4.04\widehat{W}_3 - 2.98\hat{X}_2 - 6.56\hat{X}_3 + 42.21\hat{Z}_2 + 52.96\hat{Z}_3$	47

From the Table we observed that the proportion of the total variation in *Y* accounted for by each of the first two models was very low, while it was fair and nearly the same for models three, four and five, and nearly half (47%) for model six. This indicates that there was no significant improvement in the fit when the first ten predictors were introduced into the function. However by introducing the last two predictors into the function we obtained an improvement in the fit since this accounted for nearly 50% of the total variation in ***Y***. Hence, model six (6) was the best model as given by this test. Now, for us to know whether this improvement in fit was statistically significant, we looked at the overall significance of each of the six models using the analysis of variance technique and the F statistic. Our hypothesis is

$H_0: b_1 = b_2 = . . . = b_k = 0$

$H_1: \text{not all b}'\text{s are zero}$

The test statistic is

$$F^* = \frac{R^2/(K-1)}{(1-R^2)/(N-K)}$$

where R^2 is the proportion of the total variation in Y explained by the regression. K = number of partial coefficients (including the intercept), N = sample size.

The analysis of variance (as generated by the SPSS package) for each of the six regression models were as given respectively in **Table 3.2** (titled Table 2 by the package).

Table 2: Analysis of Variance Table for the fitted Models

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1027.800	2	513.900	.794	.456
	Residual	49815.750	77	646.958		
	Total	50843.550	79			
2	Regression	3198.307	4	799.577	1.259	.294
	Residual	47645.243	75	635.270		
	Total	50843.550	79			
3	Regression	13707.144	6	2284.524	4.491	.001
	Residual	37136.406	73	508.718		
	Total	50843.550	79			
4	Regression	14345.768	8	1793.221	3.488	.002
	Residual	36497.782	71	514.053		
	Total	50843.550	79			
5	Regression	14631.853	10	1463.185	2.788	.006
	Residual	36211.697	69	524.807		
	Total	50843.550	79			
6	Regression	23717.133	12	1976.428	4.882	.000
	Residual	27126.417	67	404.872		
	Total	50843.550	79			

From the last two columns of this table we observed that each of the first two models was not significant while the last four were each significant with the best model being model six. These results agree perfectly with those of Table 3.1 above.

3.2 Assessing the significance of individual Regressors

Here we examine changes in goodness-of-fits of the unrestricted model and restricted models (i.e., the models we got when we impose the null hypothesis restrictions on the unrestricted model). This enables us to assess the significance of the contribution of each of the regressors to the explanation of the total variation of Y. The null hypothesis states that the effects of the added dummy regressors (measured by the associated coefficients), were all zero.

We first test the effects on the realized quantity of rice of the included categories of education. In this case our hypothesis is

$$H_0: \lambda_2 = \lambda_3 = 0$$
$$H_1: \lambda_2 = \lambda_3 \neq 0$$

Imposing the null hypothesis restriction on the formulated unrestricted model 3.1, we have the restricted regression model

$$Y_i = \mu + \alpha_2 S_{i2} + \alpha_3 S_{i3} + \beta_2 U_{i2} + \beta_3 U_{i3} + \gamma_2 V_{i2} + \gamma_3 V_{i3} + \psi_2 X_{i2} + \psi_3 X_{i3}$$
$$+\omega_2 Z_{i2} + \omega_3 Z_{i3} + \varepsilon_i \qquad (3.6)$$

Now the test statistic is

$$F^* = \frac{(e_r' e_r - e'e)/m}{e'e/(n-K)}$$

where

$e_r' e_r$ = residual sum of squares for the restricted model, $e'e$ = residual sum of squares for the unrestricted model, m = number of variables left out of the restricted model, K = number of partial coefficients (including the intercept) in the unrestricted model, and n = sample size.

Now from Table 3.2 above, the computed sum of squares of error (SSE) for the fitted unrestricted model was given as

$$SSE_U = 27126.417$$

Based on the null hypothesis restriction, the fitted restricted model was

$$\hat{Y}_i = 30.73 + 1.72 S_{i2} - 1.51 S_{i3} - 8.20 U_{i2} + 9.26 U_{i3} - 0.20 V_{i2} - 2.74 V_{i3} - 2.79 X_{i2}$$
$$-7.00 X_{i3} + 41.63 Z_{i2} + 53.11 Z_{i3} \qquad (3.7)$$

The computed SSE for this fitted restricted model was

$$SSE_R = 27271.427$$

Substituting into the test statistic above, we have

$$F^{*} = \frac{(27271.427 - 27126.417)/2}{27126.417/67} = 0.18$$

and $F_{0.05}(2,67) = 3.15$. Now since $F^{*} = 0.18 < F_{0.05}(2,67)$ =3.15, this indicates that the addition or inclusion of the two variables in question did not have any significant effect on the goodness – of – fit of the model. This implies that level of education of the respondent had no significant effect on the explanatory power of the model. Thus we cannot reject the null hypothesis.

Next we test the effects on the realized quantity of rice of the included categories of the respondents' yearly average income. In this case our null hypothesis is

$$H_0: \psi_2 = \psi_3 = 0$$

against

$$H_1: \psi_2 = \psi_3 \neq 0$$

Imposing this restriction on the unrestricted model, we have the restricted regression model

$$Y_i = \mu + \alpha_2 S_{i2} + \alpha_3 S_{i3} + \beta_2 U_{i2} + \beta_3 U_{i3} + \gamma_2 V_{i2} + \gamma_3 V_{i3} + \psi_2 W_{i2} + \psi_3 W_{i3} + \omega_2 Z_{i2}$$

$$+\omega_3 Z_{i3} + \varepsilon_i \qquad (3.8)$$

The fitted model was

$$\hat{Y}_i = 32.96 + 2.15 S_{i2} + 0.23 S_{i3} - 9.20 U_{i2} + 9.38 U_{i3} + 0.19 V_{i2} - 2.04 V_{i3} - 2.28 W_{i2}$$

$$-4.73 W_{i3} + 42.62 Z_{i2} + 52.01 Z_{i3} \qquad (3.9)$$

The computed residual sum of squares for this model was $SSE_R = 27351.775$

Substituting into the test statistic, we have

$$F^{*} = \frac{(27351.775 - 27126.417)/2}{27126.417/67} = 0.28$$

and $F_{0.05}(2,67)$ =3.15. Now since $F^{*} = 0.28 < F_{0.05}(2,67)$ =3.15, the null hypothesis cannot be rejectedthis indicates that addition or inclusion of these variables did not significantly improve goodness – of – fit of the model. That is, level of average annual income of the respondent had no significant effect on the explanatory power of the model Thus we cannot reject the null hypothesis.

Finally, we test the effects on the realized quantity of rice of the included categories of the credit finance received by the respondent. In this case our null hypothesis is

$$H_0: \omega_2 = \omega_3 = 0$$

against

$$H_1: \omega_2 = \omega_3 \neq 0$$

Imposing this restriction on the unrestricted model, we have the restricted regression model

$$Y_i = \mu + \alpha_2 S_{i2} + \alpha_3 S_{i3} + \beta_2 U_{i2} + \beta_3 U_{i3} + \gamma_2 V_{i2} + \gamma_3 V_{i3} + \lambda_2 W_{i2}$$

$$+\lambda_3 W_{i3} + \psi_2 X_{i2} + \psi_3 X_{i3} + \varepsilon_i \qquad (3.10)$$

The fitted model was

$$\hat{Y}_i = 63.21 + 0.19S_{i2} - 0.32S_{i3} + 1.76U_{i2} + 22.89U_{i3} - 4.70V_{i2} - 40.74V_{i3}$$

$$+14.03W_{i2} + 4.11W_{i3} - 7.63X_{i2} - 0.29X_{i3} \qquad (3.11)$$

The computed residual sum of squares for this fitted model was $SSE_R = 36211.697$.

Substituting into the test statistic, we have

$$F^* = \frac{(36211.697 - 27126.417)/2}{27126.417/67} = 11.22$$

and $F_{0.05}(2,67)$ =3.15. Now since $F^* = 11.22 > F_{0.05}(2,67)$ =3.15, this indicates that the full model improves goodness – of – fit significantly by including these two variables. That is, amount of loan received by the respondent significantly adds to the explanatory power of the model. Thus we reject the null hypothesis in favor of the unrestricted model.

4. CONCLUSION

A mathematical model for the effect of agricultural credit finance and socio-economic characteristics of farmers on quantity of rice realized at the end of farming season has been developed. The developed model, as given by Equation (3.5), accounts for nearly 50% of the total variability in rice yield as given in Table 3.1. Assessment of the proportion of this total variability in rice yield (Y) explained by each of the dummy predictors of the farmer's socio-economic characteristics (education, annual average income, etc.) shows no significant improvement in the model's goodness-of-fit, as indicated by their low proportions (models 1 through 5 in Table 3.1). This implies that the farmer's socio-economic characteristics have no significant effect on the quantity of rice realized at the end of the planting season. However, each of the dummy predictors of the agricultural credit finance significantly improves the goodness–of-fit of the model (model 6 in Table 3.1), thus emphasizing the important role of agricultural credit finance in rice productivity. This implies that access to agricultural credit finance by farmers plays significant role in the quantity of rice yield at the end of the production season, all other things being equal. The provision of agricultural credit for economic development by the government is a step in the right direction yet the smooth distribution of the credits to the target group and the efficient use of such credits has become an important factor for increased productivity. Hence, government's realization of this vintage fact and the adoption of the proposed recommendations will contribute in revolutionizing Nigeria's agricultural sector and transforming the macro economy.

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