Albanian j. agric. sci. 2013;12 (1): 33 - 36 *Agricultural University of Tirana*

RESEARCH ARTICLE **(Open Access)**

Statistical analysis of factors affecting crop production in Navrongo, Tono irrigation dam a case study

D. JAKPERIK* AND S. ODURO

University for Development Studies, Tamale, Department of Statistics, Navrongo Campus, Ghana.

Abstract:

This study identified the essential factors of production in the Tono irrigation dam of the Upper East Region. The accessibility and patronage of these factors by farmers in this area was studied and how they influence crop production in the Region. A total of two hundred questionnaires designed by the Ministry of Food and Agriculture for farmers in Navrongo were administered. A snowball sampling design was employed to identify farmers on these facilities in the study area. Pearson correlation coefficient, principal component analysis, and subset regression analysis were used to unveil the relevant information in the study. The results revealed a high correlation between the factors of production being studied with each pair having a probability level less than 0.0001. The full general linear model was highly significant ($F=662.50$, $p<0.0001$) with only two factors (Farm size and Fertilizer) accounting for 98.86% of the total variation in yield. This is a clear indication of multicollinearity and a subset regression analysis was used to identify the best subset that improves yield in the irrigation dam. The best subset comprised of Age, Farm size, seed, and Fertilizer accounting for 97.75% of the total variation in crop production in Navrongo. To enhance yield in Navrongo therefore, high yielding seeds, timely granting of fertilizer credit to farmers who mature enough and responsible with reasonable farm sizes should be encouraged.

Keywords: Subset Regression, Yield, Multicollinearity

1. Introduction

Ghana is mainly an agrarian economy with the majority (about 60%) of its workers engaged in farming. This means the livelihood of the people largely depends on agriculture. Crop production in Ghana is for three main reasons: food for consumption, raw materials for the industry, and production for export.

The Upper East Region being one of the poorest regions in Ghana where the majority of its citizenry can hardly afford a three–square meal, the government of Ghana established the Irrigation Company of Upper East Region (ICOUR) in 1985 to complement the erratic rainfall in the region to improve food production. The company also avails credit facilities among others to empower the farmers in their quest to afford inputs for crop production hence help arrest adverse poverty in the Region. According to ICOUR, about 56,000 youths in the region had far benefited from the block farming program on a farmland area of about 300 hectares with an expected yield capable of sustaining the food security requirement of the region by more than half. The estimated value seed input is 754,875 bags and the gross income per each farmer would be 2,640 Ghana cedis.

This helps the farmers improve on their activities as the time lag between inputs and outputs serves as a great disincentive for many financial institutions to advance credit to these farmers [1]. The company (ICOUR) also motivates the farmers to go for their loans by providing inputs with low interest rates, as high interest rates always hinders accessibility to loan facilities [2]. Credit is supposed to enhance agricultural productivity and thus income leading to improve the standard of living of the farmers. The prognostic factors in this study include labor, expenditure, farm size, age, seed, yield, sex, land ownership, and educational status.

In spite of this immense support, the Upper East Region can hardly feed itself. This therefore calls for an investigation to unveil the essential factors of production to increase crop yield.

The main objective of this study is to identify the essential factors of production in Navrongo using the Tono Irrigation Dam as a case study.

2. Material and methods

Data was obtained through questionnaire administration on farmers in the study area. These questionnaires and interview schedules were designed for MOFA office and farmers in Navrongo.

The sampling design employed was the snowball sampling technique. In all, a total of 200 farmers were interviewed.

Correspondence: D. Jakperik*, University For Development Studies, Tamale, Navrongo Campus, Ghana; email: jdioggban@yahoo.com
(Accepted for publication 30 October 2012)
***ISSN**: 2218-2020, © Agricultural University of Tirana*

The sampling design employed was the snowball sampling technique. In all, a total of 200 farmers were interviewed.

Mainly three models were used in the analysis: The Pearson Correlation Coefficient, Principal Component Analysis, and the Generalized Linear model. The Pearson Correlation Coefficient is given by $r = \frac{N(\sum XY - \sum X \sum Y)}{\sqrt{[N(X^2)-(\sum X)^2][N(\sum Y^2)-(\sum Y)^2]}}$ (1)

Where N is the number of pairs in the sample.

A principal component analysis is concerned with explaining the variance-covariance structure of a set of variables through a few linear combinations of these variables. Its general objectives are data reduction and interpretation. The number of principal components that should be retained is dependent on how uncorrelated variance we wish to sacrifice. The general form of the formula used to compute scores is

$$Y_i = b_{i1}X_1 + ... + b_{ip}X_p \quad (2)$$

Y is the dependent variable; X_i^s are the independent variables.

3. Results

In all 129 farmers representing 64.5% were males with 71(35.5%) females. The majority of the farmers (65.5%) hired the land on which their crops were cultivated. Also 3.5% of the farmers had tertiary education which seems to suggest that crop cultivation in this area is mainly seen as a preserve of the least educated in society. Of the 200 farmers who were offered credit, only 17.5% were given skill training whiles 82.5% received no training. Eighty-six percent of the farmers indicated that they could not stand the challenges of crop production if credit was not given to them.

Table 1: Pearson Correlation Coefficients, H_0: Rho=0

	Seed	**Fertilizer**	**Age**	**Land**	**Farm Size**	**Expenditure**	**Yield**
Seed	1.0000	0.8352 <0.0001	0.3203 <0.0001	0.7672 <0.0001	0.8517 <0.0001	0.8237 <0.0001	0.8359 <0.0001
Fertilizer		1.0000	0.4534 <0.0001	0.8514 <0.0001	0.9797 <0.0001	0.9258 <0.0001	0.9731 <0.0001
Age			1.0000	0.4491 <0.0001	0.4296 <0.0001	0.4036 <0.0001	0.4297 <0.0001
Land				1.0000	0.8643 <0.0001	0.8558 <0.0001	0.8513 <0.0001
Farm Size					1.0000	0.9555 <0.0001	0.9883 <0.0001
Expenditure						1.0000	0.9448 <0.0001
Yield							1.0000

Table 2: Proportion of variance explained by principal components

Component	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
PC1	4.7175	3.9308	0.7862	0.7862
PC2	0.7866	0.5618	0.1311	0.9174
PC3	0.2248	0.0434	0.0375	0.9548
PC4	0.1814	0.1065	0.0302	0.9851
PC5	0.0749	0.0602	0.0125	0.9975
PC6	0.0148		0.0025	1.0000

From Table 2 above, the correlation between all the variables is significant since all the p-values for each pair is <0.0001. Strong positive correlation is seen between fertilizer and farm size (0.9797), fertilizer and yield (0.9731), fertilizer and expenditure (0.9258), labor and yield (0.8513) respectively.

Since the principal component analysis was conducted using the correlation matrix, the variables are standardized which means each variable has a variance of 1 and the total variance is equal to the number of components used in the analysis. PC1 explains 78.62% of the total variation in yield whiles PC2 explains about 13.11% of the total variation in yield. In all PC1 and PC2 explains about 91.74% of the total variation in yield. However, since the correlation matrix was used, we retain the principal component whose eigenvalue is greater than 1, accordingly, PC1 was retained. The variable that has a higher loading on the first principal component is the farm size.The model is significant with probability less than 0.0001. It has an R-square of 0.978860 and coefficient of variation is 9.729819. The table below presents the test of significance of parameter estimates.

Table.3: ANOVA based on the GLM procedure

Source	*DF*	*Sum of Squares*	*Mean Squares*	*F Value*	*P>F*
Model	13	162911.6622	12531.6663	662.50	<.0001
Error	186	3518.3378	18.9158		
Corrected Total	199	166430.0000			

Table 4: Test of Significant for Parameter Estimates

Source	*DF*	*Type III SS*	*Mean Square*	*F Value*	*Pr>F*
Age	1	15.044952	15.044952	0.80	0.3736
Farm Size	1	2739.368942	2739.368942	144.82	<.0001
Seed	1	32.632904	32.632904	1.73	0.1906
Fertilizer	1	139.619708	139.619708	7.38	0.0072
Labor	1	11.533082	11.533082	0.61	0.4359
Expenditure	1	3.411441	3.411441	0.18	0.6716
Sex	1	0.140118	0.140118	0.01	0.9315
Educational Status	5	183.967744	36.793549	1.95	0.0888
Land Owner	1	9.995529	9.995529	0.53	0.4682

From the above table, only two of the nine study variables are significant. Namely, farm size and fertilizer. Based on the above statistics, a subset regression was conducted to identify a best subset that will optimize yield using the Mallows C(p) approach. Age, Farm size, seed, and Fertilizer constituted the best subset of variables that optimizes yield. The subset had a C(p)=3.8359, four variables in the model, and R-square of 0.9775.

4. Discussion

The results show a strong positive correlation between crop yield and fertilizer [3] indicating that increase in fertilizer access to farmers will lead to a corresponding increase in yield. This will increase food production and enhanced food security. The other variables that had significant correlation with yield are seed, labor, farm size, and expenditure.

Land being the main farm component which accounts for nutrients in the soil serves as the medium that greatly determines yield. The variable that had significant contribution to the first principal component, explaining about 78.62% percent of the total variation in yield was the farm size. This is expected as increase in farm size should lead to a corresponding increase in yield.

From table 3.3 the general linear model is significantly different from zero and explains about 98% of the total variation in crop production in the study area. Farm size and fertilizer were the two most influential variables (Table 3.4) that defines yield in the study area. This result is a clear indication of the presence of multicollinearity [4]. We therefore went further to perform a subset regression to identify the group of variables that increases yield. Age, Farm size, Seed, and fertilizer were the variables which constitute the best set of variables for enhancing yield. This sounds well as the elderly people seems to be more duty conscious and are likely going to be committed to their farms as compared to their younger counterparts. Also, new improved seed as they have always been given to cultivate may also increase production than the traditional seeds used by the rural folks. Access to fertilizer credit will increase yield [5] as most farmers are unable to afford on their own. Some [6] however argued that credit-use farmers misuse resources hence hindering productivity.

This subset thus accounts for 97.71% of the total variation in crop yield in Navrongo. It was also the parsimonious subset that had least mean square error [7].

5. Conclusion and recommendations

The most influential variables that enhances crop yield in Navrongo are Age, Farm Size, Seed, and Fertilizer. Particular attention should be paid to these variables for increase production.

Additionally, the various stakeholders should increase their credit allocations to credit-use farmers in Navrongo and also educate them on the modern farming methods as most farmers were not trained before receiving the credit. As a monitoring tool to guide against misappropriation and hence default, farmers should be encouraged to form groups of minimum membership who will serve as guarantors for one another.

6. Refrences

1. De Janvry and Sadoulet E.: **Rural Poverty and Differentiated Rural Development Programs**. Rev. Econ. 1995,18:3-36
2. Kohansal M R, Ghorbani M, and Mansoori H.: **Effect of Credit Accessibility of Farmers on Agricultural Investment and Investigation of Policy Options in Khorasan Razavi Province**. Journal of Applied Sciences 2008, 8(23): 4455-4459.
3. Schiantarelli F, and Jaramillo F.: **Access to Long Term Debt and Effects on Firms' Performance;Lessons from Ecuador, The World Bank, Policy Research Working Paper Series**: 1725 *European Journal of Business and Management* 1999: 7 ISSN 2222-1905 (paper) ISSN 2222-2839 (Online) www.iiste.org
4. Samprit C, and Ali S.H.: **Regression analysis by example - 4th edition**, John Wiley & Sons, INC Publication; 2006.
5. Tomoya M, and Takashi Y.: **The Impacts of Fertilizer Credit on Crop Production and Income in Ethiopia, National Graduate Institute for Policy Studies** 2010.
6. Ashaolu O F, Momoh S, Philip B B, Tijani I A.: **Microcredit Effect on Agricultural Productivity: A comparative Analysis of Rural Farmers in Ogun State, Nigeria**. International Journal of Applied Agricultural and Apicultural Research 2011, 7(1).
7. Alvin R C.: **Methods of Multivariate Analysis** 2nd Edition, John Wiley & Sons, INC Publication; 2002.