AN ASSESSMENT OF SOCIO-ECONOMIC DETERMINANTS OF PEARL MILLET PRODUCTION IN NORTHWESTERN NIGERIA: AN ORDINARY LEAST SQUARE ANALYSIS

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ABSTRACT

Pearl millet is an important staple cereal crop that is a significant source of livelihood and food security to millions of people in northern Nigeria. Over 40% of the population and 30% or more of the cultivable land are devoted to pearl millet production. However, despite its importance, the average yields are low in this country (1.25ton/ha) in comparison to the expected potential yield of (2.5-3.5ton/ha). This huge gap is of great concern and in this light, the need to assess the socioeconomic factors that influence the pearl millet productivity is apparent. Simple random sampling technique was used to select 430 pearl millet farmers in north-western Nigeria, and data were collected by means of structured questionnaire during the 2013/2014 raining season. The methods of analysis employed were descriptive statistics and production function using Ordinary Least Square (OLS) multiple regression criterion to estimate the parameters of the production function through EVIEWS software. The results obtained indicate that technical inputs such as farm size, fertilizer, manure and seed were yield increasing variables. Regression analysis shows that socioeconomic variables like cooperative membership, credit, education level, extension contact, household size, off-farm income and improved seed have a positive and significant relationship with pearl millet output. However, variables of age and household size were found to be negatively associated with total output. To increase food production, supports from government and NGOs to extend access to credit, promote farmers cooperatives and strengthening extension services are highly recommended.

Key words: Socio-economic; Pearl Millet; Production; Ordinary Least Square; Nigeria

INTRODUCTION

Pearl millet is the important member of the genus *Pennisetum* in the tribe panacea. It is a warm-weather cereal crop believed to have been domesticated in western tropical Africa over 5000 years ago. The crop is extensively cultivated throughout the continent from the eastern to South Africa (FAO, 2008), and rated as the sixth most important cereal crop in the world. Sustenance is provided by pearl millet to about 500 million masses in the arid and semi-arid zones, predominantly in Asia and Africa (Gaya *et al.,* 2012).

Pearl millet has been identified to be well adapted to production systems characterized by low soil fertility, high temperature, and low rainfall and has high resistance to pests and diseases thus can grow very well in areas where most cereals, such as maize, wheat or rice cannot subsist (Nambiar *et al.,* 2011). In crop rotation, pearl millet cultivation has been found to reduce nematode problems in potato, soya bean and wheat production, which uncovers its significance in biological methods to pest control (Munawwar et al., 2014). Its seeds and stalks are used as poultry and livestock feed. In fact, millet is termed as the 3rd most important cereal in livestock feed in some parts of Asia, where it largely contributes in the feeding of rural cattle and poultry (Munawwar et al., 2014).

Apart from its cultivation potential, pearl millet is also known to have nutritional value and health benefits. It is rich in iron and zinc, and contains high amount of antioxidants both of which may be beneficial for the overall health and human wellbeing. Pearl millet is not only nutritionally unmatched, but its grains are also superior to major cereals in terms of energy, minerals, protein and vitamins contents (Nambiar *et al.,* 2011; Munawwar et al., 2014)

Pearl millet is normally grown for its grain on 26 million hectares in over 40 countries, mostly in arid and semi-arid tropical (SAT) areas of Africa and a few other countries in Asia, where rainfall is not sufficient (200-600 mm). Pearl millet is an important cereal that makes up about two-third of the total cereal production in Africa. In Africa, it is predominantly grown in Burkina Faso, Chad, Kenya, Mali, Niger, Nigeria, Senegal, Sudan and Uganda, while the major producers in Asia include China, India and Yemen (FAOSTAT 2005).

In Nigeria, pearl millet is a traditional crop, which is grown in many parts of the country especially in the North-eastern and North-western regions of the country where it is considered as staple cereal for over 40% of the populace and 30% or more of cultivable land is devoted for pearl millet production. Ojediran *et al.,* (2010) ranked pearl millet as the most important cereal in the dry sub-humid and semi-arid areas of the country.

Even with its importance, pearl millet in Nigeria is faced with problems of low yield per hectare. Although a lot of efforts were made by both governments and non-governmental organizations (NGOs) to improve the productivity of pearl millet in the country through introduction of improved varieties and associated technologies, but the yields realize by resident farmers (1.25ton/ha) is still far below the average potential of 2.5-3.5ton/ha (FAOSTAT, 2014; Soule *et al*., 2010). This positions the country's yield at 30th in the world ranking (FAOSTAT, 2014).

According to Onyuka *et al.* (2017), the gap between actual yield realized on farmers' fields and the potential farm yield is largely ascribed to management practices, which depends on socioeconomic characteristics of farmers. This highlights that agricultural performance does not only depend on the productivity of technical factors (land, labour, seed, fertilizer, capital), but increased farm output is also directly related to socioeconomic factors of the farmers. Sudheer (2011) further states that for any research in social sciences, it is very essential to investigate the socioeconomic characteristic features of sample households like age, sex, assets, education, farming experience, farm size, family size etc. to have unblemished notion on the economy and to arrive to any sensible conclusions.

Despite a major role the pearl millet plays in the livelihood and food security in Nigeria, no single study was found to investigate the socioeconomic determinants of pearl millet production in the country. Therefore, this study becomes crucial in determining socioeconomic factors affecting pearl millet production.

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(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-8492, ISSN: 2186-8484 Print
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MATERIALS AND METHODS

The Study Area

The study was undertaken in Kano and Jigawa states of Northwestern Nigeria. Kano State is considered as an agricultural and commercial state, and it is located on 12°37' N, 9°29' E, 9°33' S, and 7°43' W (Olofin *et al.,* 2008). It has a daily mean temperature of 30 °C to 33 °C during March to May and has a lowest temperature of 10 °C during the months of September to February. The states are characterized by uni-modal rainfall pattern with a mean annual rainfall of 600mm. Kano State has an estimated total land mass of 20,760 Square meters with 1,754,200 hectares of agricultural land and 75,000 hectares of grazing land and forest vegetation. The state has a total of 44 Local Government Areas (L.G.As) and projected population of 13,383,682 people (NPC, 2006).

Jigawa state is situated in between latitudes11.00°N to 13.00°N and longitudes 8.00°E to 10.1 5°E. About 4,361,002 people inhabit the state (NPC, 2006). Over 80% of the population is involved in peasant farming and livestock husbandry. The State has a total estimated land area of nearly 25,000 square kilometres: over 80 per cent of the land is confirmed as arable and put to cultivation of crops during the limited raining period. Almost 14 per cent (approximately 54,000 hectares) merely comprised of irrigable wet lands apt for agricultural production throughout the year (JSIHB, 2013).

Sources and Method of Data Collection

The study made use of primary data. Primary data was collected with the aid of structured questionnaire from cross sections of independent pearl millet farmers in the study area. A structured questionnaire study was conducted during 2013/2014 production season to collect data from a cross-section of pearl millet farmers in Kano and Jigawa States of the North-western, Nigeria.

Sampling technique and sample size

Kano and Jigawa states were selected based on the high concentration of pearl millet farmers in the northwest region. Random sampling technique was used to obtained data from a cross-section of 430 households that grew pearl millet in the 2013/2014 cultivation season. A total 500 questionnaires were dispersed (300 in Kano state and 200 in Jigawa state with 20 in each randomly selected Local Government Areas). Even though 285 questionnaires from Kano and 190 Jigawa states were successfully returned, comprehensive information was obtainable in only 256 and 174 questionnaires from these two states, respectively. Therefore the final sample size for the study stands at 430 farmers.

Analytical Techniques

The analytical tool that was employed in this study is OLS model using EVIEWS software.

The Pearl Millet Production Function

The relationship between farm inputs and pearl millet output was estimated using OLS technique and the implicit form of the model is as follows:

$$\mathbf{Q= (X_1, X_2, X_3, X_4, X_5, X_6, \mu)} \qquad \mathbf{(1)}$$

Where:

Q=Pearl millet output (Kg/ha)

X_1= Farm size (ha)

X_2= Fertilizer (Kg)

X_3= Manure (Ox-cart)

X_4= Seed (Kg)

X_5= Labour (Man-days)

X_6=Agrochemicals (Litres)

μ=Random error term

The explicit Cobb-Douglas functional form of the linear model was estimated using OLS technique and presented as:

$$lnQi+\beta0+\beta1lnX1i+\beta2lnX2i+\beta3lnX3i+\beta4lnX4i+\beta5lnX5i+\beta6lnX6i+\mu i \quad \textbf{(2)}$$

Farmers Socioeconomic Factors affecting the output of pearl millet

Multiple regressions are adopted in this study because, according to Doughery (2007), it makes possible to discriminate between the influences of the regressors, making allowances for the fact that they may be correlated. The regression parameter of each explanatory variable provides an estimate of its effect on regresant, controlling for the influence of all the other explanatory variables.

The multiple regressions was used in this study as was done in other studies to explain the variation in production among pearl millet farmers, using output as the dependent variable and a range of socioeconomic factors of pearl millet farmers as the explanatory variables (Xaba, 2013). The model is explicitly expressed as:

$$Q_i=\alpha_0+\alpha_1S_1+\alpha_2S_2+\alpha_3S_3+\alpha_4S_4+\alpha_5S_5+\alpha_6S_6+\alpha_7S_7+\alpha_8S_8+\alpha_9S_9+\alpha_{10}S_{10}+\varepsilon_i \quad \textbf{(3)}$$

Q_i= Pearl millet output (kilogram)

S_1= Age (years)

S_2= Gender (1=male, 0=female)

S_3= Marital status (1=married, 0=otherwise)

S_4= Education (years)

S_5= Experience (years)

S_6= Cooperative (1=member, 0=otherwise)

S_7= Access to Credit (1=access, 0=otherwise)

S_8= Extension Contact (1=access, 0=otherwise)

S_9= Household size (number)

S_{10}= Distance to market (Kilometer)

α_0= Constant

ε_i= Error terms

Results of pre-estimation OLS regression diagnostics for variables used in production function

Without corroborating that our data have met the assumptions underlying OLS regression, our results may be deceptive. In order to check on how well our data meet these assumptions, we in particular consider the following assumptions:

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ISSN: 2186-8492, ISSN: 2186-8484 Print
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One of the OLS assumptions is that the relationships between the regressors and regresant (outcome variable) should be linear in parameters. This assumption need to be checked prior to running the regression analysis. A linear regression model of the response variable (pearl millet output) and the predictors (production inputs) is built to predict output of pearl millet by farm size, fertilizer, manure, labour, seed and agrochemicals. Before the regression analysis, we first observed the scatterplots of the output against each of the input, so we would have some idea about potential problems if exist. The created scatterplot as shown by figure 1.0 suggests a strong positive relationship the output and each of the input used. This is indicated by the points falling very close to the line, which implies that as each of the variable input increases, the output also increases.

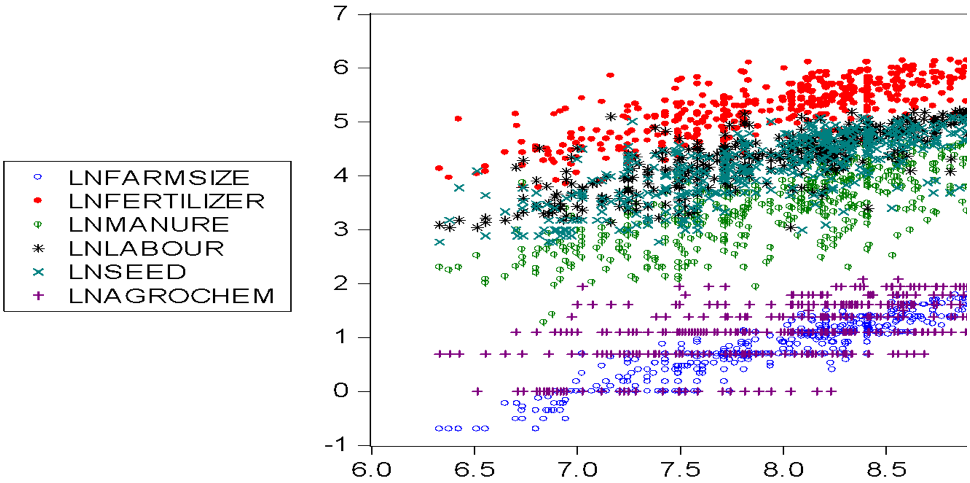

Figure 1.0**:** Scatter Plot Showing Linear Relationship between Output and Inputs

Also, to further confirm the results of the scatterplots, correlation analysis of the pearl millet output and each of the inputs was performed. The correlation analysis results in Table 1.0 reveal a strong linear relationship between the output and each of these variable inputs as shown by the large correlation coefficient values of 0.93, 0.76, 0.72, 0.79, 0.74 and 0.57 for farm size, fertilizer manure labour seed and agrochemicals, respectively.

Table 1. Correlation coefficients showing linearity relationship between Inputs and Outputs

	Output	Land	Fertilizer	Manure	Labour	Seed	Agrochemical
Output	**1.00**						
Land	0.93	**1.00**					
Fertilizer	0.76	0.78	**1.00**				
Manure	0.72	0.75	0.62	**1.00**			
Labour	0.79	0.81	0.69	0.63	**1.00**		
Seed	0.74	0.73	0.58	0.57	0.62	**1.00**	
Agrochemical	0.57	0.62	0.50	0.46	0.49	0.44	**1.00**

Having fulfilling this linearity assumption, we went ahead and conducted the multiple regression analysis.

OLS Estimates of Production Function

In order to distinguish the contribution of potential inputs in pearl millet production, the production function in equation (2) was estimated using OLS. Table 2.0 contains the results from the analysis which reveal that the coefficient of determination (R^2) of 0.78, indicating that about 78% of variation in pearl millet output was explained by inputs (farm size, fertilizer, manure, labour, seed and agrochemicals) included in the OLS model.

Table 2. OLS Estimates of the Pearl Millet Production Function in North Western Nigeria

Variable	Coefficient	Std. Error	T-Statistic	Prob.
Constant	5.8623***	0.1981	29.5878	0.0000
Lnfarm size	0.6953***	0.0441	15.7839	0.0000
Lnfertilizer	0.0816***	0.0314	2.5955	0.0098
Lnmanure	0.0465**	0.0228	2.0341	0.0426
Lnlabour	0.0969***	0.0333	2.9118	0.0038
Lnseed	0.1199***	0.0248	4.8429	0.0000
Lnagrochemicals	0.0006^{NS}	0.0235	0.0259	0.9793
R^2	**0.78**			
F –Statistic	506.50***			**0.000**

*** and ** stand for significant at 1% and 5% levels, respectively, NS =Not Significance

All of these variable inputs with exception of agrochemicals were found to be positive and significant. Farm size and manure were significant at 1% level, while fertilizer, labour and seed were significant at 5% level of probability. This implies that increase in each of these inputs results in increase in output of pearl millet.

Results of Post-estimation OLS Regression Diagnostics for Production Function

These are the diagnostic tests carried out after the regression model has been estimated. The four most important of these tests are performed in this paper.

Firstly, the data was checked for functional form specification using Ramsey reset test and as presented in Table 3.0, the result shows insignificant p-value of 0.128 (p>0.05), meaning that the null hypothesis that the model is appropriately specified is failed to be rejected.

Another assumption of OLS which is non-compulsory is the normality of error terms or residuals. This assumption states that, conditional upon the explanatory variables, the errors are normally distributed. A Jaque-bera test was used to check whether the data meets the normality assumption and our result indicates insignificant p-value of 1.42 (p>0.05), signifying that the residuals have normal distribution. Hence, we fail to reject the null hypothesis.

The data was also tested for the presence of multicollinearity. It is expected that no single explanatory variable should be linearly correlated with another explanatory. Tolerance value (1/VIF) and variance inflation factor (VIF) were used to evaluate the incidence of multicollinearity. The average VIF and 1/VIF values of 2.00 and 0.40 presented in Table 3.0

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ISSN: 2186-8492, ISSN: 2186-8484 Print
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indicate the absence of multicollinearity problem in the data set. Therefore, the null hypothesis of no direct correlation among the regressors is failed to be rejected.

Table 3. Results of Diagnostic tests for the OLS regression model

Diagnostic test statistics	Test-Statistics	P-value	Decision Rule
Normality Test	Jaque-Bera	**1.42**	Fail to reject H_0
Functional Form Specification	Ramsey RESET Test	**0.128**	Fail to reject H_0
Heteroscedasticity test	Breusch-Pagan-Godfrey	**0.054**	Fail to reject H_0
Multicollinearity test	Variance Inflation Factor (VIF)=**2.00**	-	Fail to reject H_0
	Tolerance Value (1/VIF)= **0.40**	-	Fail to reject H_0

Heteroscedasticity is a violation of one of the requirements of OLS in which errors variance are not constant (Gujarati and Porter (2009). The data was checked for problem of heteroscedasticity applying Breusch-Pagan-Godfrey test. As shown in Table 3.0, the test was insignificant with p-value of 0.054 (p>0.05), suggesting that the null hypothesis that there is no heteroscedasticity (random terms have constant variance) is failed to be rejected). Based on the above results, it is established that the data have met all the OLS assumptions and hence fit for analysis.

Farmers Socioeconomic Factors Influencing Pearl Millet Production

The socioeconomic determinants of pearl millet production were identified using OLS technique. In this study, pearl millet output per season per hectare was used as a dependent and the results are presented Table 4.0. The statistics obtained from the production function showed that the estimated model yielded F-statistic value of 40.450 which is an indication that the overall model is significant at 1% level. The R^2 value of 49% depicts the goodness of fit of the model (i.e. model fitted the data well). It also means that 62% variation in output of pearl millet in the study area was accounted by exogenous variables included in the model, while the remaining 51% could be due to other factors not captured in the model (weather, disease, soil, flood etc.) or errors in measurement.

The coefficient of farmers' education is positive as expected and significant at 5% level. The result implies additional year of education, causes increase in pearl millet output. This is in conformity with an assertion by Nwaru (2004) that the natural latent of farmers and their inherent enterprising qualities are very much improved by their educational level. Similar results were echoed by Anigbogu *et al.,* (2015) and Xaba (2013).

The coefficient of access to credit (62.17) had a positive sign as expected and significant at 1% level. This implies that holding all other predictors constant, access to credit increases pearl millet output. This is in agreement with Xaba (2013). In the same way, the coefficient of extension contact was positive and significant at 1% level, signifying that increase in extension contact would cause pearl millet output. This is probably due to the fact that trainings on best agricultural practices which farmers would have access to through contact with extension agents which improve their skills on crop production and increased revenue. The result of is akin to one obtained by Onyago *et al.,* (2016) which indicates that access to extension was significant in explaining farm output at 5% level.

Table 4. Regression results showing effects of socio-economic factors on pearl millet production

Variable	Coefficient	Std. Error	T-Statistic	Prob.
Constant	2713.2	213.72	12.695	**0.0000**
Age of farmers	-16.277	4.8117	-3.3827	**0.0008**
Agrochemical use	-166.69	116.16	-1.4350	0.1520
Cooperative Membership	264.83	122.36	2.1643	**0.0310**
Access to Credit	1271.9	147.12	8.6452	**0.0000**
Educational Level	294.84	129.62	2.2746	**0.0234**
Experience	8.1940	6.3083	1.2989	0.1947
Extension Contact	1307.2	128.85	10.145	**0.0000**
Household Size	-31.857	10.056	-3.1680	**0.0016**
Off-Farm Income	450.22	129.15	3.4862	**0.0005**
Seed Type	282.77	131.05	2.1577	**0.0315**
R-Squared	**0.49**			
F-Statistic	**40.450**			**0.0000**

Furthermore, the coefficient of age is negative and significant at 1% level, meaning that age is negatively related with profit. The implication of this is that as farmers become older, their vigour and strength tend to decrease, in this manner, the outcome of any endeavour and gain by farmers are affected. This result is the same with one reported by Ayoola et al., (2011) who found negative relationship between farmers' age and farms output.

Conversely, the coefficient of household size (-31.857) carries negative sign as expected and significant at 1% level, meaning that holding other things constant, output of pearl millet will decrease by 31.857% for 1% increase number of household members. This is in line with literature, as observed by Amusa et al., (2011) and Sibiko *et al.,* (2013) who argued that due to increased expenditure on alternative essential goods placed by population pressure on the household limited resources, large household size leads to low output.

The coefficient of cooperative membership is also positive as expected and significant at 5% level. This indicates that being a member of cooperative society could increase pearl millet output.

The coefficient of off-Farm Income was 450.22 with a p-value of 0.0005 and hence, statistically significant at 1% level. The positive and significant coefficient of off-Farm income suggests that farmers that have other source of income apart from farming tend to obtain more output in pearl millet production. According to (Reardon and Kelly 1989) access to off-farm income increases the availability of farm resources for crop production. This is because non-farm income can provide the cash necessary for procurement of inputs where sufficient credit is not obtainable. Our findings support the one reported by (Anigbogu *et al.,* (2015).

The coefficient of seed type was positive and significant in favour of farmers that planted improved pearl millet seeds over recycled (farmers owned) seeds. This implies that sowing improved pearl millet seed increases the farmer's chances to obtain high yield and hence higher income. This result is in tandem with findings of Maseatile (2011) and Deme, *et al.,* 2015).

CONCLUSION AND RECOMMENDATIONS

ISSN: 2186-8492, ISSN: 2186-8484 Print
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In this paper multiple regressions was used to assess the socioeconomic determinants of pearl millet production in north-western Nigeria. The overall conclusion of this study is that great potential exists for improving pearl millet production in northern Nigeria. Results of the production function analysis indicate that technical inputs such as farm size, fertilizer, manure and seed were yield boosting variables. Age of farmers, cooperative membership, and access to credit, education level, extension contact, household size, off-farm income and type of seed planted are the major socioeconomic factors influencing pearl millet output in the study area. Based on the findings, the study recommends that there is need for introduction of agricultural cooperative societies among the farmers which will help them access the identified important variables. The government and other relevant authorities should also make agricultural loan available and accessible to smallholder farmers at affordable rate. This will enable farmers to procure the needed inputs (improved seed, fertilizers, chemicals etc) for production at right time which will go a long way in improving the productivity and output of the pearl millet farmers in the study area. Extension services should also be strengthened by educating the farmers for improved technologies for increase productivity. Finally, the findings of this study will help the policy makers to make proper policies for increasing pearl millet productivity by improving farmers' proficiency in the study area.

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