ESTIMATION OF INPUT USE EFFICIENCY IN RICE FIELDS OF NGO-KETUNJIA DIVISION OF CAMEROON: A MARGINAL ANALYSIS APPROACH

Gama E. N., [1]***** **L.D. Tanwarong**[2] **and A. E. Ehien**[1]

[1]**Department of Agricultural Economics and Extension, Faculty of Agriculture. Federal University Dutse, Jigawa state, Nigeria.**
[2]**Department of Agribusiness Technology, College of Technology, The University of Bamenda. North-West Region, Cameroon**
*Corresponding author: e-mail: gamaemmanuel@gmail.com. Tel: 07059628915

ABSTRACT

The study was carried out to examine the input use efficiency of rice farmers in Ngoketunjia Division of Cameroon. Using a two-stage sampling procedure, data were collected with the use of structured questionnaire administered to 165 respondents from the study area. However, data from 160 farmers sampled were analyzed while 5 others were discarded for incompleteness. Data collected were analyzed using descriptive statistics and regression analysis. Marginal analysis of input utilization was used to estimate the level of inputs used in production. The findings revealed that 88.2% of the rice farmers were in their active age of 20-50 years; female respondents constituted 56.3% of the sampled farmers while 71.9% were married. While 91.2% had attained formal education, 8.8% had never been to school. About 51.9% were visited by extension agents, 42.2% had household size of between 1-10 hectares; 29.3% between 11-25 hectares and 29.3% above 26 hectares. The multiple regression model used showed that age, education, household size, experience, farm size and labour were positive and significantly affected productivity at 1% level of probability. The efficiency ratios of farm size (0.004), seeds (0.005), labour (1.919), agro-chemicals (0.005) and off-farm income (0.054) showed that rice farmers were inefficient in the use of these inputs. It was recommended that farmers should organize themselves into cooperatives in order to facilitate easy access and use of these inputs. Government should use effort to educate farmers on input use.

Key words: Efficiency, Input-use, Marginal analysis, Ngoketunjia Division, Rice productivity,

---

Rice has been an important food crop in Cameroon where its consumption has grown particularly among urban dwellers (Fani *et al.* 2016). In 1990s in Cameroon, rice was considered a delicacy eaten only on feast days and special occasions (Goufo, 2008a). Various factors triggered not only the structural increase in rice consumption, but also rice production in the country. Fonjong (2007) identified the most important factors that influenced consumption to include rapid urbanization, population growth and associated changes in family occupational structures.

On the production side, Bime *et al.* (2015) identified a positive rate of harvested area expansion and a marginal rate of rice yield expansion. As such, rice production increase could be attributable to the opening of new rice fields. Fon and Fonchi (2016) observed that Cameroon's national rice production (in 2014) was estimated at 170,000 tons of paddy while demand was estimated at 600,000 tons. To meet production shortfall and consumption need, the country relied on importation which steadily increased over the years as internal production could only cover 17% of the country's needs (Molua, 2010). Cameroon's inability to produce rice to meet domestic demand is indicative of the inefficient use of inputs by the farmers. The inefficient use of resources shows that rice productivity could be increased through efficient use of scarce farm inputs. Increasing rice output may require the transformation of semi-subsistence, low-input and low-productive farming systems. As such, there is the need for farmers to adopt an improved production system to achieve sustainable increase in rice production through efficient use of farm input resources.

Efficiency of production is central to raising production and productivity in African agriculture (Ajibefun, 2006). Optimizing output which implies efficiency is the main concern in the theory of production. It is the improvement in management decision to improve the productivity capacity of the farm. Ali and Chaudry (1990) observed that measurement of efficiency has remained an area of important research especially in developing countries where resources are meager and opportunities for developing and adopting better technologies are dwindling. While studies have been carried out to estimate the various factors that influence rice production in Cameroon (Bime *et al*., 2015; Goufo, 2008a; Goufo, 2008b; Molua, 2010; Ngome *et al.*, 2015; Yambare, 2016), none of the studies linked variation in efficiency to socio-economic and policy variables, by measuring the marginal effects of these variables. Those studies fail to give the marginal effects or magnitude of the effects of input variables on efficiency. These are the issues this study is set to address. The objective of this study is to determining the resource-use efficiency of rice producers in Ngoketunjia Division of Cameroon. Result from the study is important because it will provide practical tools for decision makers to apply production policies needed to improve rice production in the study area.

Methodology

The study was carried out in Ngoketunjia Division of the North-West Region of Cameroon. Ngoketunjia Division is located between latitude 5°37' N to 6°14' N of the equator and longitudes 10°23'E to 10°33'E (Ngome *et al*., 2015). The division share boundaries with Bui

Division to the north, Noun Division to the east, Mezam Division to the south and Boyo Division to the west. The division is made up of three sub-divisions: Ndop central, Balikumbat and Babessi subdivisions. According to Fonteh *et al*. (2013), Ngoketunjia division has a surface area of 17,910 km^2 with an altitude of 1150 meters above sea level. The climate is characterized by a dry season that start from November to mid March and the rainy season from mid March to October. Rainfall is the sub equatorial monsoon type with rainfall that varies between 1300–3000 mm annually with the mean at 2000 mm (Ngome *et al*., 2015). Rice is grown in the study area mainly on hydromorphic soils using continuous flooding methods as in most of sub-Saharan African countries. The minimum and maximum temperatures range from 15.5°C to 24.5°C respectively, with an annual average temperature of 21.3°C (Fonteh *et al.*, 2013). The population is estimated at 128.432 inhabitants of which 70% are involved in activities like agriculture, fishing and handicraft (Bime *et al.*, 2015). The division is well suited for production of arable crops such as rice, maize, cassava and yams. Vegetable crops grown in the area are crops like okra, peppers, onions, tomatoes, carrots, and cabbage. The upper Noun Valley Development Authority (UNVDA) intervenes in rice production in the study area by offering production services and some input resources.

Sampling technique and data collection

For this study, the selection of respondent farmers was two-stage and involved random and purposive sampling methods. In the first stage, the three administrative sub-divisions (Ndop Central, Balikumbat and Babessi subdivisions) were purposively selected for the study. Their selection was based on their relative importance in rice production. In the second stage, two villages each were randomly selected from the three subdivisions using the lottery method to give a total of six villages. The lottery method was also used to select 5% of the rice farmers from each of the six villages. A total of 165 respondents were selected as sample size from the 3315 registered rice farmers (Table 2). However, data from 160 farmers sampled were analyzed while 5 others were discarded for incompleteness. This represents 96.67% of the total data sampled. Random sampling was used because the rice farming field showed a very high degree of homogeneity in terms of their farming problems encountered, economic and social activities and their livelihood needs. Information was collected on output as well as inputs of each of the selected farms. Data were collected on socio-economic and policy variables. Such variables include farmers' age, level of education, household size, farming experience, gender and membership of cooperative society, farm size (hectare), seeds (kg), fertilizer (kg), herbicides (litres) and labour (man-days).

Table 1: Distribution of Sample Size

Sub-division	Village	Sample frame	Sample size	Percentage
Ndop Central	Bamunka,	2007	100	60.62
	Bamali	60	3	1.82
Balikumbat	Bangolan,	440	22	13.33
	Bamukumbit	443	22	13.33
Babessi	Babungo	183	9	5.45
	Babessi	182	9	5.45
	Total	**3315**	**165**	**100.00**

Source: Field survey, 2017

Methods of data analyses

Descriptive statistics such as mean, frequency and percentages was used to describe the socio–economic characteristics of the respondents in the study area. The efficiency of resource-use in rice production was determined using multiple regression model. To obtain the marginal product of the inputs used in rice production, the production function was estimated using the ordinary least square (OLS) method. Data were fitted to four functional forms (comprising the linear, exponential, semi-log and the double-log function) using ordinary least square techniques (OLS). The estimated functions were evaluated vis-à-vis the statistical significance of R^2 as expressed by the F-ratio, the significance of the coefficients as attested to by the t-values, the plausible signs and magnitude of the coefficients and the magnitude of the standard errors. The *a priori* expectation of the independent variables was that their coefficients would carry positive signs. The form of the equations follows Taru *et al.* (2010) and is shown below as:

Linear function

$$Y = \delta_0+\delta_1X_1+\delta_2X_2+\delta_3X_3+\delta_4X_4+\delta_5X_5+\delta_6X_6+\delta_7X_7+\delta_8X_8+\delta_9X_9+\delta_{10}X_{10}+\delta_{11}X_{11}+U_i$$

Exponential Function

$$\text{Ln } Y = \delta_0+\delta_1X_1+\delta_2X_2+\delta_3X_3+\delta_4X_4+\delta_5X_5+\delta_6X_6+\delta_7X_7+\delta_8X_8+\delta_9X_9+\delta_{10}X_{10}+\delta_{11}X_{11}+U_i$$

Semi- logarithm function

$$Y=\ln\delta_0+\ln\delta_1X_1+\ln\delta_2X_2+\ln\delta_3X_3+\ln\delta_4X_4+\ln\delta_5X_5+\ln\delta_6X_6+\ln\delta_7X_7+\ln\delta_8X_8+\ln\delta_9X_9+\ln\delta_{10}X_{10}+ \ln\delta_{11}X_{11} + U_i$$

Double-log function

$\ln Y = \ln\delta_0 + \ln\delta_1 X_1 + \ln\delta_2 X_2 + \ln\delta_3 X_3 + \ln\delta_4 X_4 + \ln\delta_5 X_5 + \ln\delta_6 X_6 + \ln\delta_7 X_7 + \ln\delta_8 X_8 + \ln\delta_9 X_9 + \ln\delta_{10} X_{10} + \ln\delta_{11} X_{11} + U_i$

Where:

Y = Output of rice (Kg); f= a function of; X_1 = gender; X_2 = age (years); X_3 = educational level (years); X_4 = household size; X_5 = extension visits; X_6 = farming experience (years); X_7 = farm size (ha); X_8 = seeds quantity (kg); X_9 = labour use (man-hours); X_{10} = agrochemicals (Kg); X_{11} = off-farm income (FCFA); U_i= Error term; δ_0 = constant term; δ_1 to δ_{1n} = regression coefficients estimated. Having tested the effects of all the regressors on the regressand, the Cobb-Double-Log production function came out best for the estimation of resource use and was chosen as the lead equation.

Elasticity of rice production (E_p):

The elasticity of production measures the degree of responsiveness between input and output. Elasticity of coefficients was used to determine the effect of increased utilization of variable inputs to the total output for a double-log function. For a double-log functional form, elasticity of production is the coefficients of the different variable inputs used in the process of production. Return to scale was calculated as the sum of output elasticity of the various inputs (Ma'ule *et al*., 2015).

Marginal analysis of input utilization

According to Vitor *et al.* (2016), for farmers to be efficient in their use of production inputs, resources must be used in such a way that their marginal value product (MVP) be equal to their marginal factor cost (MFC) under perfect competition. Therefore, the resource use efficiency parameter was calculated using the ratio of MVP of inputs to the MFC. According to Taru *et al*. (2010) the efficiency of resource use is given as:

$$r = \frac{MVP}{MFC}$$

Where r = efficiency coefficient, MVP = marginal value product and MFC = marginal factor cost of inputs.

$MFC = P_x$

Where P_{xi} = unit price of input, say x and P_y is the unit price of rice output.

$MVP = MPP_x * P_y$

$$MPP_x = \frac{\delta Y}{\delta Y} = \beta_x \frac{Y}{x}$$

MPP_x = Marginal Physical Product of Input X,

Therefore,

$$MPP_x = \frac{\delta Y}{\delta Y} \times P_y = \beta_x \frac{Y}{x} \times P_y$$

Marginal value product (MVP) of a particular input is therefore calculated by the product of output elasticity of that input, the ratio of mean output to mean input values and the unit output price. On the other hand, marginal factor cost (MFC) of an input was obtained from the data collected on the unit price of that input. To decide whether or not an input was used efficiently, the following convention was followed in this study. If $r = 1$, it implies the input was used efficiently. $r > 1$, it implies the input was underutilized and therefore both output and profit would be increased if more of that input is employed. $r < 1$, it implies the input is over-utilized and therefore both output and profit would be maximized if less of that input is employed.

Results and discussion

Socioeconomic analysis of rice producers in the study area

The socio-economic characteristics of rice farmers in the study area are shown in Table 2. The table shows that the respondents whose age ranged from 20-30 years made up 26.3% while those from 31-50 years constituted 61.9% of the farmers. About 11.9% of the respondents were above 50 years of age. The results show that majority of the farmers were within their active age. The results are in line with the study of Mokgalabone (2015) who had simillar results and opinned that as farmers become older, they tend to have more experience in farming. The results also showed that there were 56.4% female farmers while male farmers made up 43.8% of the total population of the respondents. Theses results are as expected since rice production tasks like transplanting, weeding and harvesting are done mainly by female farmers. The results for marital status showed that 71.9% of the farmers were married, 6.2% were widowers while 21.9% were single. The significance of marital status on rice production can be explained in terms of

Results from the study further revealed that 91.2% of the respondents attained formal education and 8.8% had no formal education. The literacy level in the study area was high. Oluyole and Usman (2006) had similar results and posited that education predisposes an individual towards change, enhances skill and hence increases output. The result also shows that 51.9% respondents were visited by extension workers while 48.1 were not meaning that extension services were not well developed in the study area. Agricultural extension teaching helps farmers to adopt and implement new farming methods and relay information concerning new technologies. The results also showed that 41.4% of the respondents had farm sizes between 1 and 10 hectares, 29.3% between 11 and 20 hectares while 29.3% had farm sizes greater than 21 hectares. These results agree with the findings of Byiringiro (1995), who found that large farms were allocatively more efficient with respect to the use of input resources than smaller farms.

Table 2: Socio-economic characteristics of respondents

Variable		Frequency	Percentage
Age (years)			
Youths	20-30	42	26.3
Middle age	31-50	99	61.9
Adults	51-80	19	11.8
Gender	Male	70	43.8
	female	90	56.2
Marital status	Married	115	71.9
	Single	35	21.9
	Widow	10	6.2
Education	Primary	75	46.8
	Secondary	34	21.2
	High	24	15.0
	University	10	6.3
	Post graduate studies	3	1.9
	No formal education	14	8.8
Extension visits	Visits	83	51.9
	No visits	77	48.1
Farm size (ha)	1-10	66	41.4
	11-25	47	29.3
	26- above	47	29.3

Source: Field survey, 2017

Production function estimates

A total of eleven input variables were included in the Cobb-Douglas regression model. The regression results are shown in Table 3. The overall significance of a regression was assessed by the F-statistic value. The F-statistic value of 475.2 at 1% level indicated that the socio-economic characteristics of producers significantly influenced their output. The R^2 value of 0.89 implies that 89% of variation in rice output is explained by the 11 predictors with farm size exerting the highest significant influence on production output.

The coefficient for age (0.7534) of the household head was positively correlated with rice output and statistically significant at 1% level of probability. This implies that the farmers (the majority who were in their middle-ages), were more energetic and likely to generate bigger output than younger ones. The reason could be that these farmers might have accumulated resources with which to risk investing in rice production outfits and thus turn out bigger outputs. This result did not agree with the studies of Ajibefun and Abdulkadri (2004) who observed that age of farming household heads had an inverse relationship with the productivity of the farmers.

The coefficient obtained for level of education (0.2529) was positive and significant at 1% level. This result follows *a priori* expectation, given that educational is an important factor in agricultural productivity. Educated farmers were expected to be receptive to improved farming techniques and therefore should have a higher level of technical efficiency than farmers with less education. The positive coefficient of education is in line with the findings of previous studies by Oni *et al.* (2009), Fon and Fonchi (2016) that education has a positive effect on output.

The coefficient for household size (0.2725) was positive and significant at 1% level. Thus a unit increase in household size increased output by 0.2725%. The plausible explanation could be that the large household size enhanced the availability of family labour which might had removed any labour constraint. Oni *et al.* (2009) in their study had similar results and remarked that benefits associated with household size increase may shrink any loan given to farmers as a result of high commitment on the need of the household members.

The coefficient for the experience of household head was positive and significant at 1% level confirming *a priori* expectation. This result showed that, perhaps, farmers who were more experienced in rice farming were more ready to adopt new technology. Their resource use efficiency and productivity are positively affected. Thus the farmers were likely to be market oriented under current production system where productivity and efficiency were improving.

Farm size was positively related to output and statistically significant at 1% level with a coefficient of 0.9488 which conformed to *a prior* expectation. Thus, a unit increase in farm size would lead to an increase in output level by 0.9488%. Ogisi *et al.* (2014) in their study had similar results. The positive sign and significance of this coefficient explains the importance of farm size as fixed assets on rice production.

The coefficient (0.3569) for labour was positive and significant at 1% level showing that a unit increase in labour increased output by 0.3569%. The increased productivity of labour was probably due to high managerial ability through better employment and use of labour by the farmers. The results were in line with the study of Vitor (2016) who observed that when the available labour is efficiently managed, redundancy and diminishing returns to labour is avoided.

Table 3: Summary of regression analysis

	Functional forms			
Variables	**Linear**	**#Double-log**	**Semi-log**	**Exponential**
Intercept	-8414.3	3.4888***	-5466.8	3.5695***
	(1.817)	(7.358)	(-0.326)	(26.51)
Gender	-1267.1	-0.0243	-15435.4**	0.0439
	(-0.985)	(-0.197)	(-2.526)	(1.173)
Age	-124.35**	0.7534***	-2080.4	-0.0046**
	(-2.005)	(6.702)	(-0.282)	(-2.562)
Education	163.79	0.2529***	-6292.3**	0.0168***
	(1.164)	(4.548)	(-2.1439)	(4.110)
Household size	-477.11	0.2725***	-8113.5	0.0096
	(-1.627)	(2.823)	(-1.6242)	(1.127)
Extension visits	696.4264	-0.0334	2560.2	-0.0007
	(0.5464)	(0.281)	(0.4337)	(-0.0200
Experience	-44.8343	0.1499***	1443.2	-0.0004
	(-0.667)	(3.085)	(0.572)	(-0.208)
Farm size	964.44***	0.9488***	47987.9***	0.0106**
	(5.339)	(3.793)	(3.869)	(2.012)
Seeds	94.58863	-0.1732	127.82	0.0094
	(0.393)	(0.798)	(-0.012)	1.396
Labour	-0.1112	0.3569***	-2603.9	7.03E-06**
	(-0.952)	(6.758)	(-0.80469)	(2.068)
Agro-chemicals	15.1823	0.0201	-1360.1	0.0003
	(1.985)**	(0.657)	(-0.894)	(1.639)
Off-farm income	-0.0318	0.0075	-167.51	-1E-06
	(-1.634)	(0.892)	(-0.398)	(-1.772)*
R^2	0.87	0.89	0.73	0.78
Adjusted R^2	0.86	0.88	0.71	0.77
F-ratio	88.09***	475.2***	34.6***	45.38***
Observations	160	160	160	160

Source: Computed from field survey data, 2017.
Note: Figures in parenthesis are calculated t-ratios
***: Indicate significance at 1% level
**: Indicates significance at 5% level
*: Indicates significance at 10% level
#: Indicates a lead equation

Elasticity of rice Production

Elasticity of production is the percentage change in output when a variable input is varied. It measures the sensitivity of the dependent variable to changes in independent variables. Elasticity indicates what would happen to output of rice if all inputs were to increase simultaneously. The sum of elasticities was 1.809 showing increasing returns to scale for rice farmers in the study area (Table 4). This implies that production was in stage one of the production function which is an irrational stage of production. The result showed that a unit increase in factor inputs would lead to a more than a unit increase in rice output. Therefore, rice farmers could benefit from the results of increasing returns if they continued to increase input use. The results are in line with the findings of Ajibefun (2002) in his study on traditional agricultural production in Nigeria.

Table 4. Elasticities of factor inputs

Factor	Elasticity
Farm size	0.9488
Seeds	-0.1732
Labour	0.3569
Agro-chemicals	0.0201
Off-farm income	0.6570
Total (Return to Scale)	1.8096

Source: Field survey, 2017

Resource use efficiency

With regard to allocative efficiency of rice farmers in the study area, the ratio of marginal value product (MVP) to marginal factor cost (MFC) showed that farm size, seed, labour, agrochemicals and off-farm income had values of 0.004, 0.005, 1.919, 0.005 and 0.054 respectively (Table 5). The results showed that within the limits of statistical error, none of the inputs was efficiently allocated by the rice farmers. According to the ratio obtained, farm land was over used. The overuse of farm land may be as a result of the customary land tenure system practiced in the area where people gain access to land as a social right granted by virtue of their membership to the community. With easy access to land, the farmers tend to allocate more land for use than their level of resources. The results agree with the view of Eze *et al.* (2011) in their study in South-Eastern Nigeria that farm size was greatly influenced by the system of land tenure prevalent in the area. The results further indicated that the farmers over-utilized rice seeds. This was expected since farmers in the area combined *NERICA* (improved rice) seeds with locally produced seeds from previous harvest. This practice may be as a result of poor access to extensive services offered in the study area that could direct the farmers on efficient selection and use of seeds as well as the type of seeds to use.

The results also showed that labour was-under used. Labour may be under-used in agriculture when crude implements are used to execute specialized tasks and farm sizes are more than available labour. Nossal and Lim (2011) showed that farmer's educational attainment has a positive and significant impact on labour use by the farmers in terms of innovativeness and number of new practices. As such, the demand for farm labour will increase as farm business seeks to capture the benefits of improved technology to raise productivity

Agrochemicals could be used to control weed, insects and as fertilizer. However, this input was over-used in the study area. Over-use of the resource may be the result of inadequate training of the farmers by extension agents. Rahman and Debnath (2015) had similar results in their study of agrochemical use in Bangladesh and posited that indiscriminate use of agrochemicals by untrained farmers was to get rapid and huge returns from their farms.

The results show that off-farm income was over-used. Off-farm income has a significant positive effect on agricultural land productivity. Although non-farm activities do withdraw labour out of agriculture and dampening land productivity, the negative effect that is caused is negligible compared to land productivity improvement brought by non-farm income.

Table 5; Resource use efficiency indicators

Resource	MVP	MFC		Description
Farm size	21.64	5000	0.004	Over used
Seeds	2.797	500	0.005	Over used
Labour	3838	2000	1.919	Under used
Agro-chemicals	2.435	500	0.005	Over used.
Off-farm income	109.27	2000	0.054	Over used

Source: Field survey, 2017

Conclusion and recommendation

The study estimated the input use efficiency of rice in Ngoketunjia division of Cameroon. The major findings revealed that majority of the farmers fall within the active age and most of the farmers were married, experienced and had attained formal education. The results of the multiple regression analysis showed that rice output in the study area was positive and significantly influenced by age, education, household size, experience, farm size and labour. The estimation of input use efficiency showed that resources were not appropriately used. While farm size, seeds, agrochemicals and off-farm income were over-used, labour was under-used. Rice output could be improved by adjusting the use of farm size, seeds rate, and amount of agrochemicals, off-farm income and the use of labour. Based on the findings, it was recommended that the socio-economic characteristic of rice farmers should be taken into consideration when formulating policies to improve rice production. Farmers should be assisted to form cooperatives and farmers' groups. This will solve the problem of farm size, and appropriate use of farm input resources. In addition, farmers need to adjust the usage of the resources through farmer education.

References

Adedeji, I. A., S.A. Faseyi, B.O. Ajiboye, S.A. Abolusoro, and Y. Abdulfatah (2015). Application of stochastic frontier production function to cocoa production In Surulere Local Government Area of Oyo State, Nigeria. **In**: Haruna, U., Izge, A. U., Abdulhamid, A., Iliyasu, Y., Abdurrahman, S. L. and Katanga, Y. N. (Eds.). Agriculture: A renewed focus for economic development in Nigeria. Proceedings of the 29 annual conference of the farm management association of Nigeria, Faculty of Agriculture, Federal University Dutse, Jigawa state, Nigeria from 23 to 26 November, pp 642.

Ajibefun, I. A. (2006). Linking socio-economic and policy variables to technical efficiency of traditional agricultural production: Empirical evidence from Nigeria. Poster paper presentation at the International Association of Agricultural Economics Conference, Gold Coast, Australia, August 12-18, 2006, pp 16.

Ajibefun, I. A. (2002). Analysis of policy issues in technical efficiency of small scale farmers using the stochastic frontier production function. With application to Nigerian farmers. Paper prepared for presentation at the International Farm Management Association congress, Wageningen, Netherland, July 2002. pp 16.

Ajibefun, I.A. and O.A. Abdullahi (2004), Impact of size of farm operation on resource use efficiency in small scale farming: Evidence from southwestern Nigeria, Food, Agriculture and Environment 2(1): 359-364

Ali M. and M.A. Chaudri, (1990). Inter-regional farm efficiency in Pakistan's Punjah: A frontier production function study. *Journal of Agricultural Economics.* (41): 62-74

Bime, M.J., N.M. Ngala, A.F. Jaza, and M.L. Mawo, (2015). An analysis of the pre and post harvest management techniques in rice production?: The case of UNVDA Ndop, North West Region, Cameroon. *International Journal of Sustainable Agricultural Research*, *2*(4): 120–132. http://doi.org/10.18488/journal.70/2015.2.4/70.4.120.132. Retrieve on 2 /2/2017

Byiringiro, F.U. (1995). Determinants of farm productivity and the size-productivity relationship under land constraints. An unpublished M.Sc. thesis submitted to the department of Agricultural Economics, Mitchigan State University, pp 86

Eze, C.C., S.O. Konkwo, J.S Orebiyi and F.A. Kadiri (2011), Land tenure system, farm size, innovation and agricultural productivity in South-East Nigeria. A contributed paper for the Agricultural Economics Society's 85th annual conference held at university of Warwick from 18th – 20th April, pp 19

Fani, D.C.R., U.I. Odoemenem, and C. Biam, (2016), Analysis of technical efficiency of small scale rice farmers in the West Region of Cameroon: A stochastic frontier approach. *International Journal of African and Asian Studies.* 21(2016):1-6

Fon, D. E., and D. Fonchi, (2016). Rice consumption in Cameroon? A need for policy change. *International Journal of Agricultural Policy and Research*, 4(11): 242–248.

Fonjong, L. N. (2007). The fortunes and misfortunes of women rice producers in Ndop, Cameroon and the implications for gender roles. *Journal of International Women's Studies Article 8*(4): 133–147.

Fonteh, M. F., F.O. Tabi, A.M. Wariba and J. Zie, (2013). Effective water management practices in irrigated rice to ensure food security and mitigate climate change in a tropical climate. *Agriculture and Biology Journal of North America*, pp 284–290.

Goufo, P. (2008a), Rice production in Cameroon: A review. *Research Journal of Agriculture and Biological Sciences*, 4(6): 745-756

Goufo, P. (2008b). Evaluating the constraints and opportunities for sustainable rice production in Cameroon. *Research Journal of Agriculture and Biological Sciences*, *4*(6): 734–744.

Ma'ule U.M., R.M Sani and M.H. Sani (2015). Production costs and returns of water melon farmers participating in Fadama II in Misau Local Government Area, Bauchi State, Nigeria, **In**: Haruna, U., I.U. Izge, A. Abdulhamid, Y. Iliyasu, S.L. Abdurrahman, and Y. Katanga (Eds.). Agriculture: A renewed focus for economic development in Nigeria. Proceedings of the 29 annual conference of the farm management association of Nigeria, Faculty of Agriculture, Federal University Dutse, Jigawa state, Nigeria from Nov. 23-26, pp 642.

Mokgalabone, M.S. (2015). Analyzing the technical and allocative efficiency of small-scale maize farmers in Tzaneen municipality of Mopani district: A Cobb-Douglas and logistic regression approach. An unpublished M.Sc. thesis submittted to the Department of Agricultural Economics and Animal Production, Faculty of Science and Agriculture, University of Limpopo. pp 184

Molua, E.L. (2010), Price and non-price determinants and acreage response of rice in Cameroon. *Journal of Agricultural and Biological Science* 5(3):1-6

Ngome, F.A., D. Mepiemfu-Lamare, P.I. Tata and C. Suh, (2015). Assessing biotic and abiotic constraints to upland rice cultivation in Cameroon. *Journal of Agriculture and Ecology Research International*, *3*(1): 33–40.

Nossal, K and K. Lim, (2011), Innovation and productivity in the Australian grains industry, research report 11.06, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, pp 56

Ogisi, O.D., T. Begho and S.A. Ewolor, (2014). Resource use efficiency and profitability of fluted pumpkin production in Ukwuani Local Government Area of Delta State, Nigeria. *American Journal of Agriculture and Forestry*, 2(4): 129-134.

Oluyole, K.A. and J.M. Usman (2006). Assessment of economic activities of cocoa licenced buying agents (LBAs) in Odeda Local Government Area of Ogun state, Nigeria. *Akoka. Journal of Technology and Science Education*, 3(1): 130-140.

Oni, *O., E. Nkony*a, J. Pender, P. Dayo, and K. Edward, (2009). Trends and drivers of agricultural productivity in Nigeria. The Nigeria strategy support program. *International Food Policy Research Institute. pp 48.*

Rahman, K.M.A. and Debnath, S.C. (2015). Agrochemical use, environmental and health hazards in Bangladesh, International Research Journal of Interdisciplinary and Multidisciplinary Studies (IRJIMS), 1(7): 75-79.

Taru, V.B., G. E. Nkwi, A. I. Medugu and J. Reuben, (2010). Economics of broiler production in Meme Division of Cameroon. *Journal of Agricultural Science*, 1(2): 83-87

Vitor, D. A., C.A. Wongnaa and R. Aidoo, (2016). Resource use efficiency among maize farmers in Ghana. *Agriculture and Food Security*, *5*(8): 1–10. http://doi.org/ 10.1186/ s400 66-016-0076-2. Retrieved on 25/2/2017

Wang Y., C. Wang, and S. Pan (2011), The impact of non-farm activities on agricultural productivity in rural China. Paper presentation at the Agricultural and Applied Economics Association's AAEA and NAREA joint annual meeting, Pittsburgh, Pennsylvania, July 24-26 pp 22

Yambare, A. (2016), Agricultural technology and living conditions of rice farmers in Cameroon: Case of the Northwest Region (unpublished)