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Productivity of New Rice for Africa under Different Contour Patterns in Northern Guinea Savanna of Kaduna State, Nigeria

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Abstract

This study investigated productive and profitability capacities of contour farming technologies in rice production in Barangwaje, Ikara Local Government Area and Dutsen Abba in Zaria Local Government Area of Kaduna State. In Barangwaje, 36 and 28 farmers from Dutsen Abba were selected based on interest for the trials. To compare the profitability, seeds, land preparation, fertilizer application and use of family labour, among others were used. Stochastic frontier model was employed to determine the efficiencies of contour rice farmers. Data were analysed using descriptive statistics, gross margin analysis and stochastic frontier model. The results showed that almost all (96%) of the respondents had annual income between ₦100, 000 and ₦150,000. High proportion (76%) of the respondents had extension contact and all the farmer had access to agricultural credit. In Barangwaje, the gross margin for one hectare of land cultivated was ₦420,253.75 for contour, ₦88,508.75 for contour + ridge-tie, ₦1,791.25 for flat land and ₦45,357.50 for farmer's practice (up-down slope). In Dutsen Abba, gross margin obtained shows that contour + ridge tie had ₦34,978.56, flat land had ₦26,132.06, contour had ₦2,313.00 and farmer's practice (up-down slope) had ₦114.31. Investment in rice cultivation was profitable as indicated by return per Naira invested. Stochastic frontier model shows that contour rice farmers were highly efficient as indicated by the value of gama (0.99), which implies that 99% of the variation of output from frontier was due to technical efficiency of the farmers. It concluded that rice production was highly profitable. Measures should be in place to reduce importation of rice in order to encourage local production. Constraints faced by farmers were not indicated in the abstract.

Keywords: Rice, contour, contour + tie, profitability, allocative, efficiency

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Introduction

Rice (*Oryza sativa*) is one of the world's most important food crops and staple. It is vastly important to the survival of the human race. Rice is the main source of sustenance for half the population of the earth (Okam, *e.al*., 2016). Growing rice occupies the entire lives of over thousands of people in Kaduna state Kaduna State Agricultural Development Programme (KADP, 2012). Rice is one of the primary sources of food and income for farmers in Kaduna State Ministry of Information (KDMOI, 2014). The demand for rice in Nigeria has assumed a steady rise in the last decades compared to other cereal crops such as sorghum and millet (Daramola, 2014). In Nigeria, the estimated annual rice demand is about 5 million metric tonnes, while local production is about 2.21 million metric tonnes (Hauser, 2013). The annual deficit of 2.79 million metric tonnes is bridged by importation of rice commodity. Good soil management such as contour practices should increase production of crops such as rice in Kaduna State and Nigeria in general.

Rice production in Northern Guinea Savanna is faced with a lot of challenges such as erosion, low soil fertility, erratic and low rainfall. Most cultivable areas in the Northern Guinea Savanna (NGS) have slopes ranging from 0 to over 6 %, have sandy loam, loamy sand to sandy surface soil textures, have low organic matter content and are very susceptible to erosion by wind and water (Okam, *e.al*., 2016). Consequently, arable lands are commonly degraded by erosion with sheet and rills occurring on the less eroded lands and gullies limiting/degrading most lands for use in cultivation (Onoja and Herbert 2012). Uncontrolled livestock grazing of farmlands have also contributed to predispose the land area to erosion in particular by wind. Rainfall intensity in the zones often exceeds the 20 $mmhr^{-1}$ threshold limit for erosive rains in the tropics and therefore causes serious erosion problems on cultivated lands (Jodha, Banskota and Partap, 2012).

Therefore, some adaptive strategies to reduce the effects of soil erosion such as contour farming, shifting cultivation, planting on raised mounds and avoidance of deep ploughing must be practiced to avoid crop failure (Horrigan, Lawrence and Walker, 2012). It was further revealed that farmers who successfully applied these methods improved upon their output levels per land area and the standards of living of their families.

Contour farming is one of the oldest and sustainable human activities. It is a sustainable way of farming where farmers plant crops across slopes. Benefits of contour farming include maintenance of soil fertility by preventing downwash of the fertile topsoil of a farm and consequently enabling better yields. This method reduces erosion by more than 50%. In many parts of the World today hillsides are increasingly being cultivated (Gathagu, *et. al.,* 2018). The increased pressure for agricultural land use due to population growth calls for increased soil management practices to maximize its productivity.

To mitigate surface wash on cultivated farmlands on-farm trials involving contour-ridge-tying and contour ridging were carried out in Barangwaje and Dutsen Abba Local Government Area of Kaduna State, Nigeria to conserve soil against erosion using contour technology and store moisture for crop use in 2017 cropping season. The objectives of this study therefore, were to describe socioeconomic characteristics of rice farmers, compare profitability of rice production under different contour farming practices, and identify constraints of rice production in the area.

Methodology

The study was carried out in 2017 farming season in two communities in Northern Guinea Savanna of Kaduna State, namely Barangwage in Ikara LGA and Dutsen Abba in Zaria LGA and

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it adopted experimental research approach. There were 36 farmers from Barangwaje and 28 farmers from Dutsen Abba, a total of 64 farmers for the experiment. Pre-season training for resourceful farming was carried out to develop capacity and effective transfer of technology. The farmers were trained on the value of contour, planting of seeds of improved variety, fertilizer application in precise dose, weeding and harvesting at the right time. There were regular visits by the team of researchers (agronomists, breeders, soil scientists, crop protectionist, socio-economists and technicians) from the Institute for Agricultural Research, Ahmadu Bello University, Zaria during the field days (minor and major) were organized during the growing season to impart the technical aspects of the technique on the farmers. The field days provided the researchers and farmers the opportunity to discuss problems associated with contour farming techniques and their possible solutions.

In each of the communities, the standard size for the experiment was 0.25ha. There were 3 trials for each of the technologies i.e. contour, contour+ridge tie, flat land and farmer ridging practice in Barangwaje, Ikara LGA. The same was replicated at Dutsen Abba, Zaria LGA, thus, making a total of 24 experiments. Contour ridges were on treatment I, contour ridge + tie on treatment II, flat land was for treatment III and farmer's ridging practice was for treatment IV in the two communities. Ridges were made at a distance of 75cm apart, 25cm between hills, rice was transplanted at distance of approximately 1cm apart and New Rice for West Africa (NERICA) improved variety was used for the experiment. The entire plots were planted between 28/7/2017 and 31/7/2017. Fertilizers were applied in two split doses. The first was NPK 15:15:15 applied two weeks after transplanting. The second half was Urea (45%N) applied six weeks after transplanting by side placement method, 6cm – 8cm away from the plants. Weeds were controlled manually at 4^{th} week, 6^{th} week and 8^{th} week after transplanting.

Farm records were maintained for each plot with respect to operational costs and yield. This gave the opportunity to calculate the total costs of production (fertilizer, fungicide, sack, transportation and labour) and profit or loss at the end of production season. Data was collected on socio-economic characteristics of the farmers, farm production and marketing. The data collected was analysed using descriptive statistics, gross margin analysis and stochastic frontier model.

1. Gross margin analysis was used to determine the difference between the gross-farm income (GFI) and total variable cost (TVC).

GM = GFI – TVC……………………………………(1)

Where: GM = Gross Margin (Naira/hectare)

GFI = Gross Farm Income (₦/ha.)

TVC = Total Variable Cost (₦/ha.)

2. Stochastic Frontier production function model is expressed as:
$Y_I = f(X_{i;}\beta) + e_I$……………………………………..(2)

Where:

Y_I = quantity of agricultural output in specified unit,

X_i= is the vector of input quantities,

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B= is the vector of production function to estimated,

f(Xi; β) is a suitable functional form such as cob-Douglas.

The technical and allocative inefficiency effects *Ui* is affected by;

$Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$……..(3)

Z_1 = age of farmer (year),

Z_2 = education (year),

Z_3 = household size (number),

Z_4 = farming experience (year),

Z_5 = membership of association (year),

Z_6 = amount of credit received (₦),

Z_7 = extension contact (number).

$Z_1 – Z_7$ = are the scalar parameters to be estimated.

The stochastic cost function which is the basis for estimating the allocative efficiency of the farms is specified as follows:

$C_1 = g(Pi; \alpha) \exp (vi + Ui)$…………………………(4)

Where:

C_1 = represents the total input cost of the i^{th} farm,

g = suitable functional form,

Pi = represents input prices employed by the i^{th}farm,

α = parameters to be estimated,

vi and Ui are the random error terms.

The Cobb-Douglas cost frontier function for the rice farms is specified as follows:

$LnC = \alpha_0 + LnP_0 + \alpha_1 + LnP_1 + \alpha_2 + LnP_2 + \alpha_3 + LnP_3 + \alpha_4 + LnP_4 + vi + Ui$….(5).

C = total input of production of the rice farm (₦), α_0 = intercept or constant.

$\alpha_1 – \alpha_5$= parameters to be to estimated, Ln = logarithm to base e, P_1 = cost of land (₦).

P_2 = cost of labour (₦), P_3 = average cost of seed (₦), P_4 = average cost of fertilizer (₦), P_5 = average cost of agrochemical (₦).

Results and Discussion

Socioeconomic Characteristics of the Participating Rice Farmers

Table 1 shows the distribution of socioeconomic characteristics of contour rice farmers in the area. There were more (82%) male and few (18%) female respondents with the mean age of 43 years. This result agrees with Anjaneyulu *et al.* (2015) who reported that productive farmers are generally young. Education shows high level informal education (84%), ranging from no any form of education to quaranic education. However, very few (3%) of the respondents had tertiary education. This result is in agreement with Afolami *et al.* (2012) who found that farmers in Nigeria were mostly illiterate. Household size distribution revealed that the respondents had a mean of large (11) persons in their households. This result is in agreement with Onumadu, *et al.* (2014) who stated that large household size has the potentials for labour and access to information. Farm size designated to rice cultivation by the respondents shows an average (2.1 ha) size. This result agrees with Saleh and Oyinbo (2017) who found that rice cultivation is profitable in northern Nigeria. Farming experience had an average of 29 years and this finding supported Akande (2002) who discovered that farming experience is not only length of time but also its intensity and consistency which farmers had exhibited. Land acquisition in the study area is mostly by inheritance (83%) in the area. The result of annual income revealed that less than half (37%) of the respondents had between ₦250, 001-300,000 per annum being the highest and very few (7%) had above ₦300, 001 being the lowest. This finding is supported by (Okeleye *et al.,* 2012) who reported that high income has positive influence on adoption of agricultural technologies. There were high proportion (73%) of the respondents who had access to extension services and very few (2%) reported no contact at all. Membership of farmers' association indicates that more than half (65%) of the respondents belonged to two farmers' associations, few (21%) of them were members of only one association.

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Table 1: Distribution of socioeconomic characteristics of contour rice farmers

Characteristic	Percent
Male	82
Female	18
Age (year)	
21-30	10
31-40	40
41-50	35
51-60	4
Above 60	11
Level of Education (year)	
No formal education	54
Primary education	30
Secondary education	13
Tertiary education	3
Household Size (person)	
1-5	37
6-10	53
11-15	4
Above 15	6
Farm Size (ha.)	
0.5-1	1
1.1-2	8
2.1-3	34
3.1-4	46
Above 4.1	11
Farming Experience (year)	
1-10	14
11-20	37
21-30	44
31-40	3
Above 40	2
Method of Land Acquisition (1=gift,2=inheritance,3=rent,4=purchase)	
Gift	4
Inheritance	83
Rent (Lease)	1
Purchase	12
Annual income (₦)	
50,000-100,000	1
100,001-150,000	10
150,001-200,000	11
200,001-250,000	34
250,001-300,000	37
Above 300,001	7
Extension contact	
No contact	2
Weekly	24
Fortnightly	73
Monthly	1
Membership of association (number of association one belongs)	
Not a member of any association	13
One association	21
Two associations	65
More than two associations	1

Cost, Return and Profitability of Contour Farming Technologies

The technologies evaluated in this study were contour, contour +ridge tie, planting on flat land and farmer's ridging practice (up-down slope). The result shows that costs and returns analysis indicated that labour and fertilizer inputs accounted for greater parts of the total variable costs incurred in all the treatments, labour amounted to variable cost of ₦173,346.25, ₦162,091.25, ₦167,608.75 and ₦173,042.50 for contour, contour + ridge tie, flat land and farmer's practice

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respectively in Barangwaje and ₦187,987.00, ₦161,021.44, ₦159,067.94 and ₦153,885.69 for contour, contour + ridge tie, flat land and farmer's practice respectively in Dutsen Abba. While fertilizer accounted to ₦2040, 000 in each of the 2 locations, giving rise to a total cost of ₦408, 000.

. The gross margin analysis of contour farming practices for Barangwaje is shown in Table 2. The result indicated that contour had the highest gross revenue and total variable costs/ha., while flat land had the least. The reason for high gross revenue and total variable costs may be attributed to the following: first, contour farming maintains soil fertility by preventing downwash of the fertile topsoil of a farm and consequently enabling high yields per hectare. The result agrees with Horrigan, *et al.* (2012) who found that contour technology reduces erosion by more than 50%. Secondly, contour ploughing increases the soil's water retention ability to ensure that enough water soaks into the soil for good health of the plants. The low gross revenue and total variable costs in the flat land may be attributed to rainwater washing farming fertilizers downstream and consequently, reduced soil fertility. The contour recorded the highest return per Naira invested, while flat land recorded the least. However, the reasons could be the difference in total variable costs involved by two groups of farmers.

Table 2: Costs and returns analysis of contour farming practices in maize production

			Location A: Barangwaje					
			Treatment					
Costs/Returns Items	**Contour (₦)**	**%**	**Contour+ridge tie (₦)**	**%**	**Flat Land (₦)**	**%**	**Farmer's Practice (₦)**	**%**
(1) Cost/ha (₦)								
Seed	8,000.00	4.62	8,000.00	4.94	8,000.00	4.77	8,000.00	4.62
Fertilizer	40,800.00	23.54	40,800.00	25.17	40,800.00	24.34	40,800.00	23.58
Fungicide	1,250.00	0.72	1,250.00	0.77	1,250.00	0.75	1,250.00	0.72
Bag (Sacks)	1,360.00	0.78	1,440.00	0.89	1,040.00	0.62	1,280.00	0.74
Labour								
Land Preparation	35,888.67	20.70	35,888.67	22.14	35,888.67	21.41	35,888.67	20.74
Planting	11,718.75	6.76	11,718.75	7.23	11,718.75	7.18	18,750.00	10.84
Fertilizer Application	14,648.44	8.45	14,648.44	9.04	14,648.44	7.00	14,648.44	8.47
Weeding	30,517.58	17.61	30,517.58	18.83	30,517.58	18.21	30,517.58	17.64
Harvesting	12,695.31	7.32	12,695.31	7.83	12,695.31	7.57	12,695.31	7.34
Threshing	15,637.50	9.02	15,637.50	9.65	10,530.00	6.28	8,572.50	4.95
Transportation	830.00	0.48	895.00	0.55	520.00	0.31	640.00	0.37
Total Variable Cost (TVC)	**₦173,346.25**		**₦162,091.25**		**₦167,608.75**		**₦173,042.50**	
(2) Returns								
Average yield (kg/ha)	4240.00		1790.00		1210.00		1560.00	
Average Price (kg/ha)	140.00		140.00		140.00		140.00	
Gross Revenue (₦ /ha)	**593,600.00**		**250,600.00**		**169,400.00**		**218,400.00**	
Gross Margin (GR – TVC) (₦ /ha)	**420,253.75**		**88,508.75**		**1,791.25**		**45,357.50**	
Return/Naira Invested	**2.42**		**0.55**		**0.01**		**0.26**	

In Dutsen Abba, Table 3 shows that the gross margin analysis for the treatments shows that contour + ridge tie had the highest gross revenue, while farmer's ridging practice had the lowest. The reason for the high gross revenue may be attributed to maintenance of soil fertility by water retention as a result ridge tie as against other practice that did not use extra technology such as ridge tie. Also, contour + ridge tie recorded highest return per Naira invested in the farming, while contour and farmer's ridging practice recorded lowest return per Naira invested. The reasons for the high return could be attributed to less variable costs or good management practices by farmers in the group. However, reasons for low return per Naira invested by contour farmers may

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be attributed to high total variable costs incurred. Farmers who practiced farmer's ridging practices recorded less return per Naira invested. This may also be attributed to less total variable costs involved in the farming which might have reduced high profit that could be made in the business.

Table 3: Costs and returns analysis contour farming practices in maize production

Location B : Dutsen Abba								
				Treatment				
Costs/Returns Items	**Contour (₦)**	**%**	**Contour + ridge tie (₦)**	**%**	**Plant on Flat Land (₦)**	**%**	**Farmer Ridging Practice (₦)**	**%**
(1) Cost/ha (₦)								
Seed	8,000.00	4.26	8,000.00	4.97	8,000.00	5.03	8,000.00	5.20
Fertilizer	40,800.00	21.70	40,800.00	25.34	40,800.00	25.65	40,800.00	26.51
Fungicide	1,250.00	0.64	1,250.00	0.78	1,250.00	0.79	1,250.00	0.81
Bag (Sacks)	1,120.00	0.60	1,120.00	0.70	960.00	0.60	1,140.00	0.74
Labour								
Land Preparation	40,000.00	21.28	35,888.67	22.29	35,888.67	22.56	35,888.67	23.31
Planting	30,000.00	15.96	11,718.75	7.28	11,718.75	7.34	18,750.00	12.18
Fertilizer Application	10,000.00	5.32	14,648.44	9.10	14,648.44	9.21	14,648.44	9.52
Weeding	40,000.00	21.23	30,517.58	18.95	30,517.58	19.19	30,517.58	19.83
Harvesting	10,000.00	5.32	10,000.00	6.21	10,000.00	6.29	10,000.00	6.49
Threshing	5,697.00	3.03	5,958.00	3.70	4,324.50	2.72	5,211.00	3.38
Transportation	1,120.00	0.60	1,120.00	0.70	960.00	0.43	880.00	0.57
Total Variable Cost (TVC)	**187,987.00**		**161,021.44**		**159,067.94**		**153,885.69**	
(2) Returns								
Average yield (kg/ha)	1360.00		1400.00		1130.00		1100.00	
Average Price (kg/ha)	140.00		140.00		140.00		140.00	
Gross Revenue (₦ /ha)	**190,400.00**		**196,000.00**		**185,200.00**		**154,000.00**	
Gross Margin (GR –TVC) (₦) /ha)	**2,313.00**		**34,978.56**		**26,132.06**		**114.31**	
Return/Naira Invested	**1.00**		**1.20**		**1.16**		**1.00**	

Technical Efficiency of Rice Production in the Treatments in the Study Area

Maximum Likelihood Estimates (MLEs) for the production frontier are presented in Table 4. The sigma square (δ^2) and gama (γ) were estimated to be 0.36 and 0.99 respectively and were significant at 10% and 1% levels of probability respectively. The value obtained for sigma square was significant at 1% level of probability, indicating a good fit and the correctness of the specified assumption. The value of gama (0.99) implies 99% of the variation of output from the frontier, meaning technical inefficiency of the contour rice farmers.

The coefficient obtained for farm size (0.702) was positive and significant at 1% level of probability, implying that any increase in farm size would lead to an increase in output of rice cultivated. The parameter estimate for seed was positive and significant at 1% level of probability, which implies that an increase in quantity of seed would also increase the output of farmers. The coefficient obtained for labour was also positive and significant at 1% level of probability. The estimated coefficients obtained for fertilizers and agro - chemicals were positive and significant at 1%.

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Table 4: Maximum likelihood parameter estimates of stochastic frontier production function

Variable	Coefficient	Std Error	t-ratio
Constant (β_0)	2.515	0.159	15.79***
Farm size (β_1) (Pi)	0.702	0.059	11.985***
Seed (β_2)	0.154	0.026	59 239***
Labour (β_2)	0.128	0.044	29.000**
Fertilizer (β_3)	0.085	0.035	24.273**
Agro-Chemicals (β_5)	(3s) 0.053	0.055	96.141***
Sigma (δ^2)	0.362	0.211	1.712
Gamma	0.998	0.001	82.140***

*** P≤0.01, **P P≤0.05

Determinants of Technical Inefficiency in Rice Production

Table 5 shows the determinants of technical inefficiency in rice production in contour farming in the study area. The coefficient of age was found to be negative and significant at 10% level. This means that as age of the farmer increases, the technical inefficiency decreases. The coefficient obtained for education was negative and shows a significant relationship with technical inefficiency at 5% level of probability. The negative coefficient of education reveals that a high level of education results in a reduction in technical inefficiency of contour rice farmers. The coefficient of household size was also negative and significant at 5%. This implies that as family size increases, the technical inefficiency decreases. This is because farmers who have large household sizes are more technically efficient. Size of the household is associated with labour availability and timely access of farmers to labour may reduce inefficiency in farm operations. The estimated parameter for the amount of credit received was negative and significant at 1% level of probability. The negative sign of this variable indicates that an increase in the amount of credit received decreases the technical inefficiency.

Table 5: Estimated determinants of technical inefficiency

Variable Coefficient	Coefficient	Std Error	t-ratio
Constant	1.066	0.478	2.230**
Age	-0.045	0.028	-1.644
Education	-0.129	0.075	-1.739
Household size	-0.026	0.025	-1.036
Farming experience	0.014	0.011	1.297
Membership of cooperative	0.018	0.022	0.796
Access to credit	-0.088	0.027	-3 059***
Extension contact	0.0016	0.0049	0.339

*** P P≤0.01, ** P P≤0.05

Constraints Faced by Rice Farmers in Contour Farming.
Table 6 shows the major constraints identified by the respondents. The results show that high cost of fertilizer was the most important constraint (97.93%), followed by lack of finance (63.44%) and inadequate farm land (40.49%). Other problems included; lack of herbicides (31.03%), inadequate market for rice (24.14%), soil fertility problem (23.45%) and high cost of hired labour (17.24%). The result agrees with the finding of Samarpitha *et al.* (2016) that access to fertilizer and institutional credit, source to major markets and adequate land for rice cultivation Access to institutional credit is identified are the key factors in improving rice production. World Food Summit (2016) also reported that availability and access to adequate, timely and low cost inputs are of great importance especially to small and marginal farmers. Easy access to financial services at affordable cost positively affects the productivity, asset formation, income and food security of the farmers. Credit access is important because of its ability to create access to other production factors,

Table 6: Constraints faced by rice farmers under contour farming

Problems	*Percentage	Rank
High cost of fertilizer	97.93	1st
Financial assistance	63.44	2nd
Inadequate farm land	40.49	3rd
Lack of herbicides	31.03	4th
Inadequate market for rice	24.14	5th
Soil fertility problem	23.45	6th
Inadequate/high cost hired labour	17.24	7th
Inadequate extension	2.07	9th

***multiple responses**

Conclusion and Recommendations
Rice production is highly profitable under contour technology in Northern Guinea Savanna of Kaduna State. Improvements should be made by extending technical, allocative and economic efficiencies for adoption by farmers in the study area. Age, education, household size, access to credit, membership of cooperative and farming experience were the socio-economic characteristics influencing the technical and allocative inefficiencies of the farmers.

Inputs should be made available in time and at affordable prices to the farmers. Extension should be available to enhance farmers' educational capacity in the study area. Farmers should be assisted to obtain credit facilities by reducing the bottlenecks associated with bank loans.

Reference

Afolami, C.A., Obayelu, A.E., Agbonlahor, M.U., Lawal-Adebowale, O.A. (2012). Socioeconomic analysis of rice farmers and effects of group formation on rice production in Ekiti and Ogun States of South-West Nigeria. *Journal of Agricultural Science.* 2012;4(4): 233-244.

Anjaneyulu M. Economics of paddy cultivation: A study in Andhra Pradesh (2015). *International Journal of Scientific Research.* 4(8):603-604.

Daramola, B. (2014). Competitiveness of Nigerian Agriculture in a Global Economy: Any Dividends of Democracy? Inaugural Lecture Series 36, Federal University of Technology, Akure.

Gathagu, J. N., Mourad, K.A. and Sang J. (2018). Effectiveness of Contour Farming and Filter Strips on Ecosystem Services. *International Journal of Environment, 2012(4) 99–106.*

Hauser, E. (2013). The WTO Food Security and Poverty Reduction: A Contradiction in Ternf. 2nd Edn. Agriculture and Rural Development, pp: 8 - 11.

Horrigan, L., Lawrence, R. S. and Walker, P. (2012). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental health perspectives*, *110*(5), 445.

Jodha, N. S., Banskota, M., &Partap, T. (2012). Strategies for the sustainable development of mountain agriculture: An overview. *Sustainable Mountain Agriculture (2 volumes). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd*.

Kaduna State Agricultural Development Programme (KADP). (2012). Highlights on the activities and achievements of Kaduna state agricultural development programme.

Kaduna State Ministry of Information (KTMOI) (2014). Diary. A Publication of the Ministry of Information, Katsina.

Okam, C.Y., Yusuf, O., Abdulrahman, S. and Suleiman A. D. (2016). Comparative Analysis of Profitability of Rice Production among Men and Women Farmers in Ebonyi State, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology*, 10(1): 1-7

Okeleye, K.A., A.A. Oyekanmi, O.I. Ariyo and T.O. Tayo, (2012). Performance of rice variaties under upland and lowland rainfed ecologies of southwestern Nigeria. *ASSET Ser. A,* 2: 127-140.

Onoja, A. O and Herbert, B.C. (2012). Econometric Evaluation of Rice Profitability Determinants in Kogi State, Nigeria. *Journal of Agricultural Extension and Rural Development.*Vol. 4(5) 107 - 114.

Onumadu, F.N. and Osahon, E.E. (2014). Socioeconomic determinants of adoption of improved rice technology by farmers in Ayamelum local government area of Anambra State, Nigeria. *International Journal of Scientific and Technology Research*. 2014;3(1):308-314.

Saleh, M.K. and Oyinbo, O. (2017) Rice Production under Different Weed Management Technologies Adopted by Rice Farmers in Katsina State, Nigeria. *Journal of Agricultural Extension,* 21 (1): 151 - 166.

Samarpitha, A., Vasudev N. and Suhasini, K. (2016). Socio-economic Characteristics of Rice Farmers in the Combined State of Andhra Pradesh, *Asian Journal of Agricultural Extension, Economics and Sociology, 13(1): 1-9*

World Food Summit, (2016). World Food Summit Plan of Action, FAO. Rome. 13th-17th November, 2016.