Research Article

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Profitability of rice production in different production systems in Ebonyi State, Nigeria

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Abstract: Profitability of rice production in different production systems in Ebonyi State, Nigeria was evaluated. Rice is critical for food security in Nigeria, hence, farmers need to make appropriate choices of rice production systems to optimize production and ensure an adequate domestic supply. This study used 2015 survey data from rice farming households. Rice farmers in swamp, lowland and upland rice production systems showed variability in profit. Swamp production systems had the highest return per hectare (29.37%) followed by lowland production systems (20.10%) and upland production systems (13.03%). Poor access to production credit and climate change were constraints to rice production in the area. Rice production using the swamp production system is profitable and would ensure increased production and higher returns to the farmers. It is recommended that farmers should form cooperative groups to enable them to pool resources together to boost their production.

Keywords: Rice, Production systems, Profits, Ebonyi State

1 Introduction

Rice grows across all agro-ecological zones (AEZ) in Nigeria (African Rice Centre (AfricaRice), 2011). Longtau (2003) classified six rice-growing environments (RGEs) in Nigeria as; Upland, Hydromorphic, Rain-fed lowland, Irrigated lowland, Deep inland water, and Mangrove swamps. Farmers adopt a particular rice production system based on the topography, input, expected output and returns. However, growth in rice production in Sub-Saharan Africa (SSA) has been due to an expansion of the area under cultivation rather than to an increase in yield (Stryker 2010). Imolehin and Wada (2000) put potential hectares of rice production at 4.6 - 4.9 million ha and actual production at 1.7 million ha. The difference between potential and actual yields is very high. However, there is conflicting information on average yields from different sources. AfricaRice (2011) reports that in 2008 Nigeria had an increase in rice production of 31.2% over 2007 figures.

Rice is critical for food security throughout Africa, and especially in Nigeria. For many decades, rice had the fastest growing consumption rate among all staple crops, determined in large part by huge growth in demand in urban centres (AfricaRice 2011). Consumers are exhibiting a shift in preference from traditional staples (such as cassava, maize and yams) to rice (Nigerian National Food Reserve Agency, Federal Ministry of Agriculture and Water Resources, Japan International Cooperation Agency, 2009). There is a demand of 5 million MT of rice yearly in Nigeria. However, only about 3.2 million MT are produced locally (Federal Ministry of Agriculture and Rural Development, FMARD, 2012) with a demand gap of 1.8 million metric tons. The inability to meet rice consumption needs through local production makes the country import-dependent (Onyenweaku and Ohajianya 2008; Akinbile 2010). Nigeria spends about N356 billion annually for about 2 million MT of milled rice (FMARD, 2011).

Relying on the import of expensive food on global markets not only stimulates domestic inflation, but also hurts Nigerian farmers, displacing local production and fuelling rising unemployment (FMARD, 2012). In 2016, the price of rice doubled over 2015 prices, owing largely to foreign exchange rates and fluctuations in government policy on rice importation. Yet, domestic demand for rice is still high. United States Department of Agriculture (USDA) 2014/2015 estimates showed that of 6.4 million MT domestic demand of milled rice in Nigeria, only 2.84 million MT was produced locally (Live Rice Index [LRI], 2016).

Nigeria is ecologically endowed to attain self-sufficiency in paddy rice production with potential land

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area for rice production of between 4.6 million and 4.9 million ha (FMARD, 2012; Ezedinma 2005). However, in spite of the immense untapped potential of rice production in Nigeria, only 1.8 million ha of Nigeria's total land mass suitable for rice production is cropped to rice (Coalition for African Rice Development [CARD], 2009). In spite of the very favourable ecologies for rice production in Nigeria, production of paddy rice remains low. Oyinbo, Damisa and Rekwot (2013) reported that less than 10% of the potential 3.4 million hectares are currently irrigated. The choice of a balanced approach to the use of rice production systems presents an opportunity to be exploited (Macauley 2015).

Estimates indicate that over 90 percent of domestic rice production comes from resource-poor and weakly organized smallholders (USAID 2009; Cadoni and Angelucci 2013). These smallholders apply a low-input strategy to agriculture, with minimum input requirements and low output (International Fund for Agricultural Development [IFAD], 2009). The livelihood of these smallholder farmers have been constrained by a host of challenges: low productivity; paucity of opportunities for value addition; limited access to productive assets and inputs; inadequate support services (extension and research); inadequate market and rural infrastructure; post-harvest losses and a constrained enabling environment (IFAD, 2012). More so, a huge proportion of domestic rice in Nigeria is not tailored to meet market needs. This has also limited the market share of the domestic rice producers.

Ebonyi State, Nigeria is one of the major rice producing areas and market for locally produced rice. This makes it a reference point for rice production in Nigeria. There is prevalence of rice farmers adopting different production systems in the State. However, there is inadequate information on the profit margins in different rice production systems in the State and constrains limiting farmers from investing more in rice production. Moreover, with the economic downturn experienced by the nation in recent years, there is a need to guide rice farmers on best production system to adopt for optimum yield, increased income and food security for their families, as well as, higher output for the market. It is not known empirically, which production system ensures higher profits. The objectives of this study were to examine the socio-economic characteristics of the farmers in different rice production systems in the study area; ascertain the production systems, rice varieties cultivated and the sowing methods; determine the costs and return of the farmers in different production systems; and identify the factors that constrain farmers in different production systems. It was hypothesized that there were no significant differences in the profits earned by rice farmers in different production systems. The results of the study have important policy implications on financing rice farmers for increased rice production.

2 Materials and methods

2.1 Study area

The study area is Ebonyi State which is located in South-East Nigeria. The state lies in the humid tropical agro-ecological zone of Nigeria within Longitudes 7^0 30'E and 8^0 30'E and Latitudes 5^0 40'N and 6^0 45'N (Okereke 2012). It has a land area of 5,935 km^2 (ebonyistate.gov.ng, accessed 17/04/2017) with a projected population of 2,253,140 persons in 2016 using a growth rate of 3.5% (National Population Commission, 2016). The State shares boundaries on the North by Benue State, to the West by Enugu State, to the East by Cross River State and to the South by Imo and Abia State (*ebonyistate.gov.ng, accessed 17/04/17*). The climate of Ebonyi State is that of a humid tropical climatic region. The mean annual temperature stands at 28^0C with an average rainfall of 1200mm - 2500mm [Ebonyi Agricultural Development Programme (EBADEP), 2005]. It has a luxuriant vegetation of tropical rainforest. The soil of Ebonyi State is basically clayey and loamy soil. The clayey swampy soil is suitable for rice farming.

Figure 1: Map of Ebonyi State showing location of study area

2.2 Sampling procedure

A multi-stage sampling procedure was adopted in the selection of respondents. Ebonyi State was purposively selected for this study because it has the highest output of paddy rice in southeast Nigeria (National Bureau of Satistics, 2012). In the first stage, four Local Government Areas (LGAs) namely; Ikwo (Ebonyi Central), Izzi (Ebonyi North), Afikpo South and Ohaozara (Ebonyi South) were purposively selected based on the dominance of rice farming in the LGA's and their representation of the three agricultural zones. From each selected LGAs, three communities were purposively selected for the same reason to give a total of twelve communities. Lists of rice farmers in the communities were obtained from the Agricultural Development Programme (ADP) office in the LGA and these lists formed the sample frame of 765 farmers. A proportionate sampling technique was used to select farmers from the twelve communities to give a sample size of 180 respondents.

Data were collected from primary sources. The instrument of primary data collection was a well-structured questionnaire which was administered through personal interview. In this research, efforts to increase the reliability of recall information provided by the sampled households included; pretesting of the questionnaire, use of key informants, including ADP extension agents, IFAD staff, Executives of Abakaliki Rice Mill Industry, and, focus group discussions to triangulate information provided by households. Pretesting provided an opportunity to train enumerators in detecting and responding to errors (inconsistencies) in reporting. The assessment period covered the 2015 rice production year. The data were collected between May and October 2015.

Data were analyzed using descriptive statistics, econometric as well as farm budgeting techniques. Descriptive statistics such as frequencies, percentages and mean were used to achieve objectives ii and vii. The budgetary analysis and Return on Investment (ROI) were used to achieve Objective iv. The budgetary analysis used was a Net Returns (NR) model as used by Hardwick and Keyser (2010) and it was modified and specified as follows:

$$GM = TR - TVC \quad (1)$$

$$TC = TVC + TFC \quad (2)$$

$$NR_i = GM - TFC \quad (3)$$

$$TC_i = TVC + TFC \quad (4)$$

Where,

i = 1, 2 and 3
1= Upland production system
2= Lowland production system
3 = Swamp production system
GM= Gross Margin (per tonne)
TR= Total Returns
TVC= Total Variable Cost
TC = Total Cost
NR = Net Return (per tonne)
TFC= Total Fixed cost
FC= Fixed Cost

Interest on operating capital reflects the amount of money tied up in the production of the crop. It reflects the amount of money borrowed or the amount that could have been

Table 1: Proportionate sampling of rice farmers in the study area

LGA	No of Registered Rice Farmers	Proportionate sampling	Sample size	Pre-selected Communities (No. of respondents)
Ikwo	280	$\frac{280}{765} \times 180$	66	A (22) B (22) C (22)
Ohaozara	204	$\frac{204}{765} \times 180$	48	A (16) B (16) C (16)
Izzi	166	$\frac{166}{765} \times 180$	39	A (13) B (13) C (13)
Afikpo South	115	$\frac{115}{765} \times 180$	27	A (9) B (9) C (9)
Total	**765**		**180**	**12**

earned if it had been invested in alternative uses in the market. The interest on operating capital was calculated using the formula as described by Etaferahu (accessed 15/01/2019):

Interest on operating capital = Eit

Where,

E = Total cash operating expense

I = Interest rate (i.e., 17 per cent); and

t= length of the production period (5month)

The hypothesis which stated that there were no significant differences in the profits earned by rice farmers in different production systems was tested using Analysis of Variance (ANOVA). The hypothesis is stated in the form;

H_0: $\mu_1 = \mu_2 = \mu_3$

H_1: $\mu_1 \neq \mu_2 \neq \mu_3$

The ANOVA model was specified as follows (Anyanwu, et al., 2016);

$$F = \frac{MSSB}{MSSW} = \frac{SSB/(k-1)}{SSW/(N-k)} \quad (5)$$

TSS (Total Sum of Square) = SSB + SSW (6)

SSB (Sum of Square Between group) = $\frac{\sum_{j=1}^{k} n_j (\bar{X}j - \bar{\bar{X}})^2}{K-1}$ (7)

SSW (Sum of Square Within group) = $\frac{\sum_{j=1}^{k} \sum_{i=1}^{nk} (\bar{X}_{ji} - \bar{\bar{X}}_j)^2}{N-k}$ (8)

Where,

F = value by which the statistical significance of the mean differences was judged

$\bar{\bar{X}}$ = Mean profit of rice farmers

$\bar{\bar{X}}$ = Grand mean profit of rice farmers in Ebonyi State

MSSB = Mean sum of squared deviations between the levels of profit of the rice farmers

MSSW = Mean sum of squared deviations within the levels of profit of the rice farmers

N = Sample size of rice farmers in Ebonyi State

K = number of production systems

k-1 = numerator degrees of freedom

N-k = denominator degrees of freedom

Ethical approval: The conducted research is not related to either human or animal use.

3 Results and discussion

3.1 Demographic characteristics of the rice farmers

The demographic characteristics of the rice farmers were presented and discussed according to their age, sex, education, marital status, household size, years of farming experience and farm size.

The distribution of the farmers by age showed that the mean age for farmers was 49 years. This implies that the rice farming populations were still within their productive age and can still engage efficiently in rice production. Rice farming is a labour intensive occupation and exerts energy for land preparation, nursery, planting, weeding and harvesting. The findings are similar to those of Nwaobiala and Adesope (2015) who found out that the mean age of upland rice farmers and swamp rice farmers in Ebonyi State were 37.3 years and 39.2 years respectively. This is encouraging as an active age implies increased productivity and enables the farmers engage in other value adding activities like rice processing. The results of the investigation on distribution by sex showed that 59.4% of the farmers were male and 40.6% were female. This shows that rice farming activities is carried out by both male and female. The mean number of years spent in school was 9 years. These results imply that the farmers in Ebonyi State were enlightened. Educational enlightenment, and also imply that the rice farmers will be more receptive to information from extension agents and other means on the adoption of best practices for improved yield and harvesting techniques that would harness the quality of rice. Findings on the marital status of the rice farmers showed that about 86.7 % of the farmers were married. The distribution of rice farmers according to years of experience showed that rice farming has been a long time

Table 2: Distribution of rice farmers by demographic characteristics

Variables	Sample mean	Standard deviation	Minimum	Maximum
Age	49 years	12.4	21	70
Sex	-	-	0 (Female 40.6%)	1 (Male 59.4%)
Education (years)	9 years	5.3	0 (No formal Education)	16 (Tertiary Education)
Household size	8 persons	4.4	1	18
Marital status	-	-	0 (Single 13.3%)	1 (Married 86.7%)
Farming experience (years)	21 years	21.6	2	45
Farm size (Ha)	0.75	1.3	0.1	3.0

Source: Own computation based on field survey (2015) data.

practice among farmers in the study area with a mean of 21 years.

The investigation on farm size revealed that the mean farm size was 0.75 hectares with 53.33% of the rice farmers having farm holdings of 0.6 -1.0 hectares. The size of the farm holdings confirm that these rice farmers are smallholder and produce on a small scale. This is consistent with the findings of Nwinya, Obienusi and Onuoha (2014) who found that rice farmers in Izzi Local Government Area of Ebonyi State on average owned less than a hectare of land.

3.2 Production systems, rice varieties and sowing methods

3.2.1 Production systems

The distribution of the farmers on production system is presented on Figure 2. The distribution of the farmers on production systems used for rice cultivation revealed the majority of the respondents (62.2%) adopted the swamp production system, while 21.2% and 16.7% percent used lowland and upland production systems respectively.

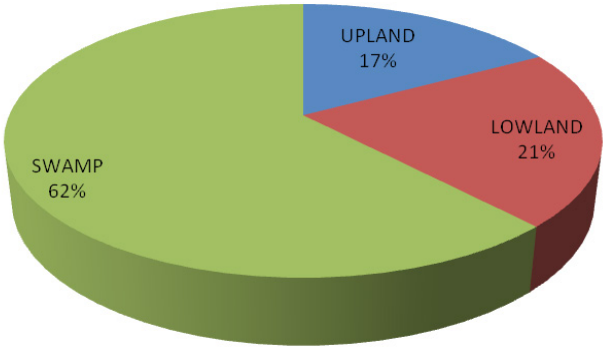

Figure 2: Distribution of rice farmers by production system. Source: Own computation based on field survey (2015) data.

The choice of swamp production system may be because of water availability and suitability of the land for rice production. This is consistent with the findings of Epundu (2010) and UNEP (2005). The upland rice system is the least preferred. It suggests that the risk of drought is higher in the upland rice system than in the others and hence farmers would prefer the swamp and lowland production systems because of the dependence on rain fall. However, the choice of a production system is based mainly on the topography, geography as well as technology and input use (Erenstein, et al. 2003).

3.2.2 Rice varieties

The different varieties of rice cultivated by the farmers were identified and presented in Table 3. The variety planted by the majority (63.33%) of the farmers was Faro 44. Faro 44 is an improved local semi-dwarf cultivar of rice grown in Nigeria. It thrives under different production systems. It is the most preferred cultivar available to farmers as it is of better quality with an output and production success significantly and above most local cultivars (AgroNigeria, 2015).

Table 3: Rice varieties

Rice varieties	Frequency	Percentage *
Faro 44	114	63.33
R8	15	8.33
Faro 15	18	10.00
Faro 52	12	6.67
Faro 150	27	15.00

Source: Own computation based on field survey (2015) data

*Multiple responses recorded, hence > 100%

3.2.3 Sowing methods

Two sowing methods were identified among rice farmers using the different production systems and the results were presented in Table 4. The results showed that the majority of the farmers (81.67%) used nurseries in seeding, while 18.33% of the farmers used broadcasting (direct seeding) methods. Direct sowing of rice is reported to reduce labour cost by 30% and overall production cost by 40% (Mahmood 2002). However, farmers reported that sowing rice in nurseries and further transplanting, though more costly yields better result. This may be because, the farmer is certain of transplanting only viable seedlings.

Table 4: Sowing methods

Sowing methods	Frequency	Percentage
Nursery	147	81.67
Broadcasting	33	18.33
Total	180	100

Source: Own computation based on field survey (2015) data.

3.2.4 Profitability of rice production in different production systems

The result of the profitability of rice production in different production systems is presented in Table 5. The result showed that the swamp production system had the highest net return of $276.64 per hectare with a return on investment of 29.37% indicating a 29.37 return on every $1 spent in rice farming using the Swamp production system. The net return of the farmers using the lowland and upland production system was $183.55 and $103.02 per hectare respectively. In addition, the return on investment was 20.10% and 13.03% for both lowland and upland production systems respectively. This indicated a $20.10 return for every $1 spent in rice farming using lowland production system and $13.03 return for every $1 spent in upland rice faming.

The result of the return on investment for rice farming

Table 5: Profitability (per cycle) of 1ha of rice production in Ebonyi State

Item	Unit price $	UPLAND		LOWLAND		SWAMP	
		Quantity	Amount $/Ha	Quantity	Amount $/Ha	Quantity	Amount $/Ha
A. Revenue (R)	406.09/MT	2.2 MT	893.40	2.7 MT	1,096.45	3.0 MT	1,218.27
B. Variable Cost							
I. Capital Operating Inputs							
Seed	0.50/Kg	30Kg	15.00	30Kg	15.00	30Kg	15.00
Agrochemicals							
a) Herbicide	10.15/Litre	4L	40.6	4L	40.6	4L	40.6
b) Insecticide	5.07/Litre	1L	5.07	2L	10.14	2L	10.14
Fertilizer	30.46/50Kg	200Kg	121.84	200Kg	121.84	200Kg	121.84
Total Capital Operating Cost (TCOC)			**182.51**		**187.58**		**187.58**
II. Labour (Man-days)							
Land clearing	4.06	15	60.90	10	40.60	6	24.36
Land preparation	5.07	12	60.84	17	86.19	20	101.40
Nursery	2.54	10	25.40	10	25.40	10	25.40
Planting/transplanting	5.07	14	70.98	25	126.75	32	162.24
Application of herbicides/Pesticide	5.07	4	20.28	4	20.28	2	10.14
Application of fertilizer	5.07	4	20.28	4	20.28	3	15.21
Weeding	2.54	10	25.40	8	20.32	5	12.70
Bird scaring	15.23	2	30.46	2	30.46	2	30.46
Harvesting	1.52	70	109.44	85	129.20	95	144.40
Threshing/winnowing	5.07	8	40.56	10	50.70	10	50.70
Others (bagging)	5.07	3	15.21	3	15.21	3	15.21
Total Labour Input (TLI)			479.75		565.39		592.22
C. Total Variable Cost (TVC= TCOC+TLI)			**662.26**		**752.97**		**779.80**
D. Gross Margin (R-TVC)			**231.14**		**343.48**		**438.47**
E. Fixed cost							
Depreciation on equipment			30.45		30.45		30.45
Rent on land			50.76		76.14		76.14
Interest on operating capital (17%)			46.91		53.34		55.24
F. Total Fixed Cost			**128.12**		**159.93**		**161.83**
G. Total Cost (TC = TVC+TFC)			**790.38**		**912.90**		**941.63**
H. Net Return (R - TC)			**103.02**		**183.55**		**276.64**
I. Return on investment (H/G)			**13.03%**		**20.10%**		**29.37%**

Source: Own computation based on field survey (2015) data

$1 = N197

in the different production systems showed that Swamp rice farmers had a higher return on investment, followed by Lowland and then Upland production systems. This implied that rice farming using the Swamp and Lowland production systems had a higher profit than rice farming using Upland production system. The results are similar to the findings of Fakayode (2009) who reported that Lowland rice production systems were more profitable than Upland rice production systems. Agrifood Consulting International (2002) in a study of rice value chain in Viet Nam found that different production systems had different gross margin and this is attributed to the difference in cost of labour operations utilized in different production systems.

Labour was a significant component of the input cost, composing about 72.44%, 75.08% and 75.94% of the total cost for upland, lowland and swamp production systems respectively. In this respect, one important finding of the costs analysis was that labour costs are high in Ebonyi State compared to other variable cost items and this reduces the overall profitability. This is in line with the findings of Ohajianya and Onyenweaku (2003) who found that labour constituted the highest cost component of total variable costs (59.9% and 67.9%) for large and small scale rice farmers respectively) in Ebonyi State. The high cost of labour can be attributed to the use of paid manual labour in major operations in rice production (e.g. land clearing, nursery, weeding, etc), inefficiency in labour utilization in agricultural productions and high labour rates due to rural to urban migration in Nigeria (Obasi et al. 2013; Ehirim et al. 2012, Ogundele and Okoruwa 2006). Rice farmers depend on family labour for activities like weeding to reduce the cost of hired labour (Longtau 2003).

3.3 Constraints

The results of the constraints of the farmers in rice production in Ebonyi State are presented in Table 6. From the findings, about 80.55% of the respondents identified poor access to credit for production and climate change as a constraint. Production credit facilitates production by enabling farmers to purchase the inputs needed and in adequate quantities. Production credit can be sourced from both formal and informal institutions. However, the inherent risk in agricultural production has been reported to affect the ability of farmers to obtain credit from formal institutions. Climate change affects crop production and output. Nwalieji and Uzuegbunam (2012) reported that the negative effects of climate change on rice production includes; reduction in crop yield and grain quality, destruction of farm land by flood, high incidence of weeds, pests and diseases, decrease in soil fertility, etc.

About 70.56% of the farmers stated that they were constrained by lack of timely access to improved rice seed and other inputs. The Federal Government through the Ministry of Agriculture provides seeds, fertilizers and other inputs to rice farmers to increase rice production. However, the late supply of these inputs hampers production and yield. This is because, to achieve optimum

Table 6: Factors constraining rice farmers in Ebonyi State (n=180)

Constraints	Frequency	Percentages *	Rank
Low productivity	125	69.44	11th
Pests and diseases	52	28.89	15th
Inadequate post-harvest knowledge and handling	130	72.22	7th
Inadequate storage facilities	70	38.89	14th
Variability in prices of rice	127	70.56	9th
Poor access to markets	132	73.33	5th
Poor access to production credit	145	80.55	1st
Unavailability of irrigation facilities	129	71.67	8th
Poor market information	96	53.33	12th
Competition from imported brands	139	77.22	3rd
Unavailability of modern and affordable processing facilities	131	72.78	6th
Climate change that affects crop production/output	145	80.55	1st
Poor access roads	81	45.00	13th
Lack of favourable government policy	137	76.11	4th
Lack of timely access to improved rice seed and other input	127	70.56	9th

Source: Own computation based on field survey (2015) data.

*Multiple responses recorded, hence > 100%

yield, planting and other production activities are carried out during specific periods. This is in line with the findings of Longtau (2003) that farmers in Ebonyi State are faced with the problem of late arrival of input for paddy production.

Only about 28.89% reported the incidence of pests and diseases as a constraint in rice production. This may imply that majority of the farmers use insecticide and pesticides and hence do not suffer any major setback from pest and disease attack. Rice requires prompt application of agrochemicals such as insecticides and herbicides to check the menace of pests and diseases infestation that may occur as a result of overgrowth of weeds. Pests and diseases attack the rice plant and reduce the value of the paddy rice.

3.4 Differences in profits earned by rice farmers in different production systems

The hypothesis which stated that there were no significant differences in profits earned by rice farmers in different production systems was tested using Analysis of Variance and the results were presented in Tables 7 and 8.

The result of the one-way ANOVA of difference in profits earned by farmers in different rice production systems in Ebonyi State indicates a significant mean difference in the profits of farmers using swamp, lowland and upland production systems, (F (2, 177) = 13.747, $\rho <$ 0.01). The multiple comparison of mean difference in different production systems using a Turkey post-hoc test is presented in Table 8. It showed a significant difference between the upland and lowland farmers' profit, as well as a significant difference in the profit between the upland and swamp farmers profit. However, the difference between the profit of lowland and swamp farmers did not differ significantly. This indicates that farmers using upland production systems differ in the profits obtained from rice production compared to farmers using lowland and swamp production systems.

The results for the comparison between the lowland and swamp production systems indicate that the profits of farmers in both production systems were not significant and hence farmers can adopt either of these production systems. It further implies a wide yield gap from rice production using upland production system compared to lowland and swamp production systems, and hence the difference in the profits. This is consistent with the findings of Erenstein et al. (2003), that yields differ according to production system and technology used.

Table 7: ANOVA result for differences in profits earned by rice farmers in different production systems

Sources of variance	Sum of squares	df	Mean square	F	P value
Between Groups	112787606974.405	2	56393803487.203	13.747***	<0.01
Within Groups	726090990525.595	177	4102208986.020		
Total	838878597500.000	179			

Source: Own computation based on field survey (2015) data.

*** Significant at the 0.01 level

Table 8: Post Hoc comparison of mean difference in profits earned by rice farmers in different production systems Dependent Variable: Revenue

	(I)PRDSYST	(J) PRDSYST	Mean Difference (I-J)	Std. Error	Sig.
Turkey HSD	Upland	Lowland	33670.17375*	12144.84990	0.017
		Swamp	64633.29493*	12998.31482	0.000
	Lowland	Upland	-33670.17375*	12144.84990	0.017
		Swamp	30963.12119	15594.86567	0.119
	Swamp	Upland	-64633.29493*	12998.31482	0.000
		Lowland	-30963.12119	15594.86567	0.119

Source: Own computation based on field survey (2015) data.

* The mean difference is significant at the 0.05 level

4 Conclusion

Returns to farmers confirmed that rice farming using the Swamp production system was profitable, followed by Lowland and Upland rice production systems. Rice farmers in Ebonyi State were constrained by poor access to production credit, poor access to markets, low productivity and lack of timely access to improved rice seed and other inputs. Farmer's using the Upland production systems differ in the profits compared to farmers using either Lowland or Swamp production systems.

4.1 Recommendation matrix

The profitability of rice farmers using recommended production systems would increase rice production as well as meet the goal for food sufficiency in the nation. A set of recommendations for further research and policy intervention is suggested by the researcher and presented in the form of a recommendation matrix (Table 9).

Conflict of interest: Authors declare no conflict of interest.

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Table 9: Recommendation matrix indicating issues that needed further research, extension and policy intervention

Facts of consideration	Recommendations		
	Research needed	Extension needed	Policy intervention needed
Farmers adoption of swamp production system for optimal production		√	
Accessibility of farmers to institutional credit			√
Education on climate change and adaptation measures	√	√	√
Formation of cooperative groups to ensure improved access to affordable production credit and sale of product of members		√	√
Provision and availability of agricultural inputs at the time required		√	√
Ensure market access and protection of local farmers from competition from imported brands			√
Providing farmers' access to modern and affordable processing facilities to reduce post-harvest loss	√		√

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