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Factors Determining Fertilizer Utilization among Rice Farmers in Niger State of Nigeria

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Abstract

The research empirically identified the factors that determined inorganic fertilizer utilization among rice farmers in Niger State of Nigeria (9.0820°N, 8.6753°E) using field survey data of 2018 cropping season elicited from 184 rice farmers drawn through multi-stage sampling technique. The collected data were analysed using descriptive and inferential statistics. The results showed an economic active farming population which in a decade ahead if not replaced will threat the rice food security of the studied area due to decline in labor productivity as a result of an ageing situation. Furthermore, the identified idiosyncratic factors which had significant negative effects on fertilizer utilization among the rice farmers in the studied area were marital status, size of operational holding, farming experience and language spoken. Therefore, the study advised farmers to make efficient and effective use of their social capital to have effective access to credit in order to procure adequate agro-inputs, take advantage of bulk discount in purchase of inorganic fertilizer and should adopt farmer to farmer extension approach for dissemination of innovative farm practices especially fertilizer application to reach all the rice farmers in the study area. In addition, the study calls for social protection support for the farmers so as to encourage them to invest in riskier but more remunerative business along the rice value chain and other livelihood activities, thus reducing liquidity problems and supporting labor mobility.

Keywords: *Fertilizer; Utilization Intensity; Rice Farmers; Niger State; Nigeria*

Introduction

In sub-Saharan Africa, agricultural productivity over the last decade has continued to be on the decline [1] and the livelihood of the farming households has continued to worsen due to inadequate marketable surplus which has put most of the farming households in perpetual poverty. At present, the region agricultural productivity is lagging behind that of other regions in the globe, and as well less what is required to achieve food security and poverty reduction goals of sub-Saharan Africa [2]. The economic growth policy of the sub-Sahara region is adversely affected due to the decline in crop yield which many of its farmers are facing [3,4]. Wanyama., *et al*. [1] reported that the prominent constraint limiting higher productivity among farmers in the sub-Sahara Africa is "soil infertility" which is mainly related to the low nutrient status of the soils and continuous cultivation without planned replenishment of the depleted soil nutrients. In fact, IFDC [5] reported that Africa's soils are fragile and low in fertility and they are unable to support reasonable agricultural production [6,7]. Therefore, there is an urgent need to increase agricultural productivity in sub-Saharan Africa, especially in Nigeria with the fundamental means being the optimal use of improved agricultural technologies.

Idachaba [8] as cited in the running text of Nenna [7] identified some central elements which constitute the pivot upon which increase in productivity per unit of land revolves *viz.* high yield seed varieties that are fertilizer responsive and resistant to pests; capacity to domestically produce adequate quantities of inorganic fertilizer or to import them; extension agents to transmit knowledge on correct fertilizer application and related agronomic practices; efficient fertilizer marketing and distribution system; and, appropriate national

farm input policy. Besides, insufficient utilization of nutrients from fertilizers, fertilizer rates and types and appropriate application methods also contribute to the persistent low yield and economic low returns from the farmers' fields [7]. It is important to note that Nigeria cannot hope to produce enough food to feed her teeming population without using yield-increasing technologies, including inorganic fertilizer. Inorganic fertilizer is one of the most economical and reliable productivity-enhancing inputs available. However, most Nigerian farmers under-fertilize their farms, apparently due to unavailability of the commodity.

Continuous cropping coupled with low soil nutrient levels and poor nutrient conservation practices heightened by explosive population growth and use of agricultural land for many purposes which have led to land scarcity have caused excessive soil nutrient depletion in Niger State like most of the agrarian states in Nigeria. In Niger State, the intensive cropping practice has completely replaced the traditional shifting cultivation which is associated with a long period of land fallowing. Therefore, in sustainable agriculture, soil nutrient replenishment is very important as this would compensate nutrient depletion through harvested crops. Ogunmola [9] highlighted a decline in soil fertility as one of the major reasons slowing the growth rate pace of food production in Nigeria. Salimonu [10] potentially emphasized that the major cause of declining yield among smallholder farmers is increased cultivation on less productive lands. To reverse the declining yield trends, intensification through the use of inorganic fertilizers and other land-augmenting technologies is very essential. Olayide [11] noted that fertilizer is highly needed to reverse the declining soil fertility if the nutrient level of the soil is low.

Despite consistent efforts by the state government and supportive agencies in collaboration with Federal government of Nigeria in ensuring availability of inorganic fertilizer at a subsidized rate to farmers, this has not yielded the intended objectives given the present low yield among rice farmers in the State. However, Sanders and Ahmed (2001) as stated by Olayide [11] reported that successes in substantially raising sorghum and maize yields in South-Africa and Sudan; and Mali, Burkina Faso and Ghana respectively were attributed to fertilizer.

Therefore, in view of the current situations of low growth rate of rice crop outputs, rapid population growth and unintended objective from the highly publicized fertilizer subsidy programme in the state, it become imperative to unearth the idiosyncratic factors which could hinder optimum used of inorganic fertilizer among rice farmers in Niger State as the bulk of the farmers are small-scale farmers who possess only social capital and lack economic capital. It was against this background that the present research made an attempt to determine the factors influencing fertilizer utilization intensity among rice farmers in Niger State of Nigeria. The specific objectives were to describe the socio-economic profile of the rice farmers in the study area and to determine the factors influencing fertilizer utilization intensity among the rice farmers in the study area.

Research Methodology

Multi-stage sampling technique was used for the study. Firstly, the study adopts the stratification of Niger State done by Niger State Agricultural Development Authority into three (3) agricultural zones *viz.* Bida (Zone A), Shiroro (Zone B) and Kontagora (Zone C). Then, random selection of two Local Government Areas (LGAs) from each of the three zones *viz.* Katcha and Lapai; Shiroro and Gurara; and, Wushishi and Mariga for Zone A, Zone B and Zone C respectively. Thereafter, two villages were randomly selected from each of the chosen LGA using Default Microsoft Excel random sampling tool. Two registered Co-operative associations were randomly selected from each of the selected villages using the Default Microsoft Excel random sampling tool. Cochran's formula was used to determine the representative sample size using the sampling frame gotten from Niger State Agricultural Mechanization and Development Authority (NAMDA), thus a total of 184 rice farmers were selected *viz.* simple random sampling technique. Structured questionnaire complemented with interview schedule was used to elicit information from the respondents during the 2018 production season. Objective 1 and 2 were achieved using descriptive statistics and multiple regression model (OLS) respectively. The Cochran's formula used is shown below:

$$n_a = \frac{n_r}{(n_r - 1)} \quad \text{..... (1)}$$

$$n_r = \frac{(1.96)^2 pq}{e^2} \quad \text{..... (2)}$$

Where:

n_a= Adjusted sample size for finite population

n_r= Sample size for infinite population

N = Population size

p= Proportion of population having a particular characteristic

q= 1 - p

e^2= error gap

Thus, p = 0.40 and q = 1 - 0.40 = 0.60

Zones	LGAs	Villages	Co-opt. memb	Population	Sample size
Bida (A)	Katcha	Kangi Toga	KTFC	20	10
			KTYC	15	8
		Sheshi Dama	SDFC	18	9
			SMFC	15	8
	Lapai	Gbage	GYFCS	15	8
			GRFCS	20	10
		Puzhi	PSFCS	12	6
			PFCS	18	9
Shiroro (B)	Shiroro	Farin-doki	AMDA	20	10
			FYFCS	15	7
		Zhikuchi	GFCSL	10	5
			ZRFCS	12	6
	Gurara	Tufa	YMCA	19	10
			ARFA	10	5
		Lambatta	LRFCM	15	8
			BDA	14	7
Kontagora (C)	Wushi-shi	Gwarijiko	GFC	16	8
			KCFG	10	5
		Fugangi	FFC	13	6
			FYFCS	10	5
	Mariga	Kahigo	KUCS	17	8
			YFCMS	20	10
		Bobi	RCACM	13	6
			BHICS	20	10
Total	6	12	24	367	184

Table 1: *Sampling frame of the rice farmers in the study area.*

Source: NAMDA, 2018.

Model specification

The equation of the fertilizer utilization intensity (FUI) fitted into the OLS estimated exponential functional form estimated is specified below:

$Y_i = f(X_1, X_2, X_3 \ldots \ldots \ldots \ldots \ldots \ldots \ldots X_n)$ ..... (3)

$Y_{it} = \beta_0 + \beta X_{it} + \varepsilon_i$ ..... (4)

Where:

Y_{it} = *Total inorganic fertilizer (kg)used by ith farm/Total farm size (ha)*

X_{it} = Vector of explanatory variables

X_1 = Unit price of fertilizer (₦)

X_2 = Unit price of output (₦)

X_3 = Yield (kg)

X_4 = Marital status (married =1, otherwise = 0)

X_5 = Education (years)

X_6 = Sickness of household member (number)

X_7 = Extension visit (number)

X_8 = Access to credit (yes = 1, otherwise = 0)

X_9 = Seed variety (improved = 1, local =0)

X_{10} = Gender (male = 1, otherwise = 0)

X_{11} = Age (year)

X_{12} = Household size (number)

X_{13} = Annual income (₦)

X_{14} = Farm size (hectare)

X_{15} = Farming Experience (year)

X_{16} = Non-farm income (yes =1, otherwise = 0)

X_{17} = language spoken (number)

X_{18} = Security threat (yes = 1, no = 0)

β_0 = Intercept

β_{1-n} = Vector of parameters to be estimated

ε_i = Stochastic term

Results and Discussion

Socio-economic characteristics of the rice farmers in the study area

A cursory review of the results (Table 2) showed that the farmers acquired various form of formal education but the majority had formal education beyond the secondary school level as indicated by the mean and the wide standard deviation values of 8.6 and 5.12. Therefore, the implication is that the adoption of innovation in the study area will face apprehension or skepticism given that the level of education acquired place majority of the farmers in the adoption category of early majority. The mean value of implies that majority of the farmers were small-scale farmers and consequently this will not permit them to undertake mechanize rice farming even if given credit support under CBN Anchor borrowing programme. The mean value of 40.748.20 is an indication that the majority of the farmers were economically active, as they possessed the physical strength required to perform manual operations involved in rice production. In addition, it shows that the farming population is interested in rice production not only as a way of life but as a business enterprise. However, there is the tendency of food security threat in a decade ahead in the studied area if the present farming population is not replaced by a youthful population as the present farming population would have age by then. Therefore, the teeming youthful population in the studied area should be encouraged to actively engage in rice production in order to sustain and enhance rice food security in the studied area.

Most of the farmers were likely to adopt rice innovative practices given that majority of them had extension contact during the last production with at least 4 visits as indicated by the mean values of 0.89 (approximately 89%) and 4 visits respectively. However, this adequate contact with extension agents should have enabled the farmers to be able to obtain the potential yield level of 6 to 7 tons but paucity of capital due to poor access to credit (mean value of 0.30, approximately 30%) by most of the farmers affected the possibility of getting the potential yield level as evidenced by the yield mean value of 2428.10kg. *Ceteris paribus*, with the standard rice cost of cultivation of ₦400000 for an average of 7 tons (₦4285.71 as a cost of production for a bag of 75kg weight) in comparison with the output price of ₦10230 per bag, the rice business is profitable as a farmer will make a profit of ₦5944.29 per bag. Furthermore, this translates into a Return on Capital Invested (RCI) index of 1.39, implying that for every ₦1 invested in rice production, ₦1 is returned and a profit of 39 kobo is made. The mean value of 9 persons (SD 3.45) is an indication that most of the farmers have a large household size which may perhaps be for the purpose of having access to free family labor required to perform farm operations. However, in the situation where the farm household has a high dependency ratio, this human asset will become a liability as the farmer will be left to contend with outrageous high household expenditure due to too many mouths to cater for. Also, it was observed that most of the farmers have accumulated experience in rice production (mean experience of 19.95 years) which will have given them the opportunities to correct observed errors in the past, thus the tendency of the farmers been rational and efficient in taking decisions on allocation of their resources in rice production in the studied area. The results showed that most of the farming household had at least three of their household members been sick during the last production season as indicated by the mean value of 2.795 persons. This is likely to affect the farm labor quantity released and also the slim capital base of the farmers due to medic expenditure all in an effort to revive the sick ones. Most of the farmers diversified their income base as evident by the non-farm income mean value of 0.713 (approximately 71.30%), an indication that they engaged in non-farm income activities in order to insulate themselves against unforeseen future shocks from risks and uncertainty. It was observed that rice enterprise in the studied area is dominated by male farmers (mean value of 0.9405, approximately 94.05%) which may be as a result of adequate access to productive resources as compared to their female counterparts whom religious and cultural barrier limit their access to productive resources. Despite women farmers reported to account for a substantial percentage of contribution to agricultural output in sub-Saharan Africa, this jinx remained unbroken in the studied area owing to the fact that women are seen to be limited to procreation, household choir and upbringing of young ones in farming household. Thus, there is need for adequate gender sensitization on the importance of women contribution in the food security of the studied area and also saving them from the grip of poverty vicious cycle given their crucial roles in household responsibility typical of African agrarian setting which is polygamous characterized. It was observed that on an average (mean value of 2.43), most of the farmers can speak at least two languages, an indication of good integration into the global farming world in the studied area. The ability of most of the farmers to be able to communicate in more than one language will to large extent ease and enhance diffusion of any farm innovation in the studied area. It was observed that most of the farmers were married, thus were responsible household heads that were into rice farming to meet-up with their family expenditure as indicated by the marital status mean value of 0.827 (approximately 82.7%). In addition, married farmers are likely to benefit from social and economic capitals as monetary benefits are handed over to the groom from the bride's parents as customs demand in the studied area coupled with the fact that two good heads are better than one. Security of lives and properties is under threat *viz.* farmers/herders clash as indicated by the mean value of 0.195 (approximately 19.5%), thus putting the rice food security and human capital at risk. Therefore, urgent action should be taken to avert the loss of lives and properties by providing range reserves for the nomads given that agricultural land is indispensable for both sub-sectors and the contribution of both sub-sectors is very important not only for food security of the nation but also the national GDP. Both parties should learn to tolerate each other as they have been operating side by side since time immemorial and should be very wary of third parties. In addition, stakeholders should know that pastoralism/nomadism is a tradition whose replacement with the modern way has to be gradual and not in a rush. The results showed that all the farmers in the studied area pool their social capital together by participating in co-operative organizations (co-operative membership mean value of 1.00, approximately 100%) in order to benefit from pecuniary advantages *viz*. effective access to credit facilities, bulk discount in input purchase, bargaining power in output marketing, efficient educative and moral interactions. Unfortunately, most of these farmers are poor as they can hardly keep up with their family expenditures given that their per capita daily income of $4.03 can hardly sustain a household of an average of 8 persons as it

translates to per capita daily income of $0.50 per household member which is far below the international threshold per capita daily income of $1.90 recommended by World Bank for people living in sub-Saharan Africa [12]. This result indicates a problem of food insecurity among the rice farmers in the studied area as this amount has put the farmers in a booby trap of inability to meet-up with the recommended minimum daily calorie intake of 2250Kcal required per head per day. It was observed that most of the farmers used local variety seed of rice which may be attributed to the high cost of the improved and hybrid seed varieties in the studied area as the cost of 1 kg of improved paddy rice seed cost ₦350 and approximately 30 kg and 50 kg is required to cultivate 1 hectare using direct and indirect sowing respectively, thus translating to ₦10500 and ₦17500 respectively.

Variables	Mean	Standard deviation
Unit price of fertilizer (₦)	117.81	34.538
Unit price of output (₦)	10230	1243.5
Yield	2428.1	631.90
Marital status	0.82703	0.37925
Educational level	8.5946	5.1217
Sickness of household member	2.7946	1.7134
Extension contact	0.800	0.40109
Extension visit	3.8324	3.2099
Access to credit	0.29730	0.45831
Seed variety	0.35135	0.47869
Gender	0.94054	0.23712
Age	40.735	8.2019
Household size	8.6703	3.4475
Annual income (₦)	447210	276080
Farm size	1.2478	0.53084
Farming experience	19.946	8.1125
Co-operative membership	1.000	0.0000
Non-farm income	0.71351	0.45335
Language spoken	2.4324	0.68922
Security threat	0.1946	0.39696

Table 2: *Socio-economic characteristics of the rice farmers.*

Source: Field survey, 2018.

Determinants of fertilizer utilization intensity among the rice farmers

The results of the OLS estimates showed the exponential regression function form to be the best fit for the specified equation as indicated by the diagnostic test statistics *viz*. homoscedasticity, normality and collinearity tests. The results showed the variance and distribution of the residual variable to be constant i.e. homoscedasticity and not heteroscedasticity and normally skewed or normally distributed respectively, as indicated by the non-significance of the Breusch-Pagan (robust variant) Langrage Multiplier (LM) and Chi^2 tests at 10% degree of freedom. Also, the covariance was not found to exist between the predictor variables as evident by the variance inflation factors for the predictor variables which were less than the VIF benchmark of 10.0 (Table 3).

Variables	Coefficients	t-stat	Elasticity	VIF
Constant	5.243 (0.412)	12.72***	-	
Unit price of fert. (₦)	0.005 (0.001)	5.273***	0.11883	1.378
Unit price of output (₦)	-1.420E5 (2.64E5)	0.538^{NS}	-0.02795	1.228
Yield	0.0001 (5.74E5)	1.756*	0.04675	1.497
Marital status	-0.171 (0.100)	1.706*	-0.02711	1.648
Educational level	-0.006 (0.007)	0.801^{NS}	-0.00915	1.421
Sickness	0.0027 (0.024)	0.113^{NS}	0.00146	1.965
Extension visit	0.0021 (0.0121)	0.175^{NS}	0.00155	1.720
Access to credit	0.211 (0.077)	2.754***	0.01196	1.409
Seed variety	-0.063 (0.066)	0.945^{NS}	-0.00432	1.149
Gender	0.302 (0.146)	2.067**	0.05458	1.370
Age	-0.002 (0.006)	0.276^{NS}	-0.01189	2.310
Household size	0.002 (0.013)	0.134^{NS}	0.00287	2.241
Annual income (₦)	2.35E8 (1.247E7)	0.188^{NS}	0.00204	1.351
Farm size	-0.252 (0.073)	3.438***	-0.06118	1.727
Farming experience	-0.012 (0.006)	2.108**	-0.04513	2.299
Non-farm income	-0.011 (0.069)	0.159^{NS}	-0.00152	1.125
Language spoken	-0.119 (0.049)	2.438**	-0.05641	1.310
Security threat	-0.083 (0.095)	0.874^{NS}	-0.00321	1.634
R^2	0.379			
Adjusted R^2	0.312			
F-Stat	5.635***			
Heteroscedasticity test	23.93 [0.157]^{NS}			
Normality test	3.010 [0.221$^{]NS}$			

Table 3: *Determinants of FUI among rice farmers in the study area.*

Source: Field survey, 2018.

*Note: ***. **. * and NS means significant at 1%, 5%, 10% and non-significant respectively.*

The values in ( ) and [] are standard error and probability value respectively.

Furthermore, the control variables found to have significant influence on fertilizer utilization among the rice farmers in the studied area were the fertilizer unit price, yield, marital status, access to credit, gender, farm size, farming experience and number of languages spoken as indicated by the significance of their respective estimated coefficients at less or equal to 10% probability level. The direct relationship of the significant fertilizer price coefficient with the fertilizer utilization intensity (FUI) in the studied area clearly depicts that fertilizer is a necessity as indicated by the inelastic of the estimated parameter. This shows that the rice farmers in the studied area are favorable dispose to the use of inorganic fertilizer which may be attributed to the fact that there is no suitable alternative or substitute as an organic fertilizer is seen to have a less relative advantage when compared to the former. In addition, low or poor fertility of their farmlands coupled with poor enlightenment on the use of integrated pest management for soil fertility enhancement contributed in making inorganic fertilizer a necessity in rice production among the farmers in the studied area. Therefore, the marginal and elasticity implications of ₦1 increase in the price of inorganic fertilizer will lead to an increase in the intensity of fertilizer usage by 0.0053 kg and 0.119% respectively. The positive significance of yield coefficient shows how favorable marketable surplus due to increase rice productivity has a direct influence in encouraging farmers to increase their consumption of inorganic fertilizer in rice production in the studied area. Thus, the marginal and elasticity implication of a 1 kg increase in rice yield will result in an increase in FUI among the rice farmers

by 0.0001kg and 0.047% respectively. The inverse relationship of the significant coefficient of the marital status with the FUI indicates that married farmers used less inorganic fertilizer when compared to their counterparts who are single in rice production and they may be attributed to too many mouths in the household to carter for i.e. high family expenditure as the mean household size of 8 persons is large for a small-scale farmer with average farm size of 1.25 living on a per capita daily income of ₦1242.25 ($4.03). Consequently, this can hardly sustain an average farming household of 8 persons as it translates to $0.50 per household member which is far below the FAO recommended $1.90 per day for an individual in sub-Saharan Africa to be food secure. Therefore, the marginal and elasticity implications of a farmer being married will lead to a decrease in FUI among the farmers by 0.171 kg and 0.0271% respectively. The catalytic effect of credit support on timely procurement of farm inputs had a strong direct effect on the consumption of inorganic fertilizer among the rice farmers in the studied area as indicated by the positive significance of the access to credit estimated coefficient. Thus, the marginal and elasticity implications of farmers with access to credit will result in an increase in inorganic fertilizer utilization among the rice farmers by 0.211 kg and 0.012% respectively. The implication of male farmers having adequate access to farm resources as compared to their female counterparts whom religion and cultural barriers limit their access to farm resources makes the former to utilize inorganic fertilizer more in rice production in the studied area. Thus, the marginal and elasticity implications of being a male farmer will lead to an increase in FUI by 0.302 kg and 0.055% respectively. Diseconomies of scale due to the nature of the farmers operating on small-scale affect consumption of inorganic fertilizer among the farmers in rice production in the studied area as indicated by the negative significance of the estimated farm size coefficient. Therefore, the marginal and elasticity implications of a unit increase in the operational holding will lead to a decrease in the FUI in rice production among the farmers by 0.252 kg and 0.061% respectively. Accumulated experience and opportunities of been able to address or correct past observed errors have made the rice farmers in the studied area to be meticulous in fertilizer utilization in rice production as shown by the negative significance of the estimated farming experience coefficient. In addition, an average of 19.95 years of acquired farming experience in rice production will make a farmer be rational and efficient in the allocation of his scare farm resources keeping in view cost implication in order to optimize profit in rice farming. This shows that the experience rice farmers in the studied area give due consideration to the cost implications involved in operating rice farming as a business and not as a way of life only. Therefore, the marginal and elasticity implications of an additional year of farming experience in rice production will lead to a decrease in the fertilizer to be utilized in rice production. Communication diversity of the farmers makes them to be informed on the importance of integrated pest management in enhancing and sustaining the fertility of their farmland due to the consequence of nitrogen loading, leaching, volatility, high pest and disease infestation caused by stereotype type of the inorganic fertilizer in use in the studied area as indicated by the negative significance of the estimated coefficient for the number of language(s) spoken by a farmer. Therefore, the marginal and elasticity implications of a farmer speaking more than one language will lead to a decrease in the FUI in rice production by 0.12 kg and 0.056% respectively.

Conclusion and Recommendations

Based on these findings despite the fact that rice farming is been dominated by economically viable labor force who are interested in the enterprise as a business and not just a way of living, it is obvious that the studied area in a future decade ahead will face imminent food insecurity if no attempt is made to replace the existing active farming population which by them will become obsolete in terms of labor productivity. In addition, most of the farmers were very poor with very slim income to sustain the large household size and keep the farm business going concern. Also, due to the paucity of capital as a result of poor access to credit, most of the farmers had small operational holdings of less than 2 hectares. Furthermore, the identified idiosyncratic factors which affect fertilizer utilization among the rice farmers were marital status, farm size, farming experience and language spoken. Therefore, the following recommendations were made based on the findings: The study advised farmers to make efficient and effective use of their social capital to have effective access to credit in order to procure adequate agro-inputs, take advantage of bulk discount in purchase of inorganic fertilizer, enlighten members on the importance of sustainable household size for better livelihood and should adopt farmer to farmer extension approach for dissemination of innovative farm practices especially fertilizer application to reach everybody in the farming community. In addition, the co-operative organizations should go into co-operate farming in order to maximize economies of scale. The study calls on both the government and non-governmental agencies to support/provide farmers with social protection so as to encourage them to invest in riskier but more remunerative business along the rice value chain and other livelihood activities, thus reducing liquidity constraints and supporting labor mobility.

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