ICAE 2024
32nd International Conference of Agricultural Economists
2-7 August 2024 I New Delhi I India

Land Administration Practices and Effects on Allocative Efficiency of Irrigated Rice Farmers in North-East Nigeria: Implications for Sustainable Food Security

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Abstract

This paper analysed the effects of land administration on allocative efficiency of rice farmers in Dadinkowa Irrigation Scheme area, North-Eastern Nigeria. Primary data from a sample of 400 rice farmers were analysed using descriptive and inferential statistics. Results showed that land administration authorities in the area performed above average (0.67), with Large-scale PuBlic Authority (LPBA) significantly higher (0.74) than Large-scale PriVate Authority (LPVA), Small-scale PuBlic Authority (SPBA) and Local Authority (LA), being 0.67, 0.64, 0.6 respectively. Allocative efficiency of farmers ranged between 0.24 and 0.97 in LPBA, 0.39 and 0.98 in LPVA, 0.73 and 0.94 in SPBA and between 0.84 and 0.97 in LA; mean values being 0.86, 0.94, 0.85 and 0.93 respectively. Thus, large scale private authority achieved significantly higher allocative efficiency (F-cal 26.02) at 1% level. Farmers' perception of land administration service, land value, land use, non-farm income, household size and hired labor significantly influenced their allocative efficiency at 1% level. Public-private land administration reform that emphasize land tenure security, irrigation development and access to farm inputs would likely encourage long-term investment and efficient resource allocation; thereby promoting sustainable agricultural and food production, and contributing to national food security.

IAAE

JEL Codes: Q150, Q120, Q130

1.0 Introduction

In developing countries, agriculture is mostly dominated by low land productivity and low per capita food availability. Mutoko *et al.* (2015) observed that despite the persistent decrease in agricultural productivity over time, attempts to boost food productivity in Sub-Saharan Africa have always been centered on mechanization and fertilization, with little attention given to land administration. According to Norton *et al.* (2010), low productivity and wide variations in crop yields are due mostly to the challenges of land use distribution and the consequential farmland fragmentation and reallocation of productive resources among different small farms. Land as a productive resource is subject to intense competition as a result of population growth, unsustainable land use and climatic crisis; which may affect the proper use of land and alter the way farmers manage their resources. Land has become more and more a limiting factor and its administration is key to national development, yet, insecurity of land right is an important impediment that characterizes land administration and source of agricultural inefficiency (Gignoux *et al*., 2015). Nigeria has a total land area of around 924.768 square kilometer, with a population of 221 million, and an annual population growth rate of 2.8% (NPC, 2022). Hence, there is a concern of rising demand on land for agricultural production; while land tenure insecurity are frequently cited as major hindrance to agricultural production, economic growth and prosperity (Besley and Ghatak, 2010). This underscores the importance of land administration as a tool for sustainable development and food security.

The definition of land administration has taken different dimensions, depending on the development context; for instance, for the purpose of land record and tax reform, land administration was defined as *"the processes of recording and sharing information about the ownership, value and use of land and its associated resources"* (Simon-Hull *et al*, 2020). This include the management of a system of land rights, including procedure of land right allocation and recognition, definition and delimitation of boundaries between parcels, recording information about land rights, rights holders and parcels, as well as land transaction procedure (including sales, mortgages, leases and dispositions). Lengoiboni *et al.* (2019) also described land administration as institutions and processes of planning, controlling and monitoring of land use; land valuation and taxation procedures; resolution of uncertainty or adjudication of disputes concerning land rights and boundaries. In functional terms, Fisher and Whittal (2020) defined land administration as including four core functions; namely land tenure, land use, land value and land development.

Rice is the major staple food of more than half of the world population (Kadiri *et al.*, 2014) and Nigeria is the highest producer of rice in the West African Sub-region (Ahmad and Erhabor, 2012; Adesina *et al.*, 2018). The Dadin Kowa irrigation scheme area is an important zone for rice production in Nigeria, as it enables all-year rice production, but the pervasive low productivity in grain production reflects low level of technical, allocative and economic efficiency (Kolawole, 2006), and may be due to challenges of reallocation of productive resources among small farms (Norton *et al.*, 2010).

Empirical findings have shown the nature and dimensions of the effects of land administration on economic development in different contexts; for instance, Zakout *et al.*(2006) and Subedi (2016) argued that a good land administration system provides security to investors and permits government to raise taxes on the basis of the value of land and property, thereby promoting economic growth. Bugri (2008) and Markussen (2008) found a weak effect of land administration factors on agricultural production and economic growth. Lasisi *et al.* (2018) and Alarima *et al.* (2012) examined the effects of land tenure and land use, but did not take into account the other aspects of the core functions of land administration. There remains a wide knowledge gap about the theory of land administration and its effects on farmer efficiencies and implications for food security, particularly in the context of irrigation development. Hence, this study aimed at an assessment of the effects of land administration on allocative efficiency of rice farmers in the domain of Dadin Kowa irrigation scheme in Gombe and Borno States of Nigeria. Specifically, the study examined: (1) the existing land administration authorities in the study area, (2) the relative performance of land administration under the different land authorities in the study area, (3) the allocative efficiency of rice farmers under different land administration authorities in the study area, and (4) the effects of land administration and other factors on allocative efficiency of rice farmers in the study area, (5) finally drew implications of the findings for food security in Nigeria.

2.0 Methodology and Analysis

The data for this study were obtained through a cross-sectional survey of registered farmer members of water users association in the Dadin Kowa irrigation scheme area of Gombe and Bornu States, Nigeria. Multi-stage sampling technique was used for sample selection; including one senatorial district from each State, two LGAs from each of the two Senatorial districts, three villages from each of the LGA, and random selection of farmer respondents after stratifying them into four land administration authorities namely large scale public DKIS authority, small scale public authority, private land administration authority, and local land administration authority. A total sample of 400 farmers were obtained by stratified randomization from a sample frame of 3988 registered farmers using Yamani (1973):

$$n = \frac{N}{1 + N(e^2)}$$

Where;

n = sample size; N = real or estimated size of the population; e = level of significance (5% or 0.05). Structured questionnaire was used as instrument for collecting data on the following variables:

The data were analysed using both descriptive and inferential statistics. Descriptive statistics; mean, frequency and percentage were used to describe the types and performance of land administration processes in the study area. Stochastic frontier regression model was used to determine the allocative efficiency scores of rice farmers under different land administration authorities. Beta regression model was used to assess the effects of land administration factors and other factors on the efficiencies of rice farmers in the study area.

2.1 Land Administration Index (LAI)

The land administration index for each farmer was calculated by multiplying the score of each factor (S_{fp}) by the corresponding weight (based on equal weight of the factor of land administration) of the factor (W_p) (in percentage), and summing for each farmer, as depicted in the equation function below;

$$LAI_p = \sum_{p=1}^{n} S_{fp} W_p$$

The value of land administration index for the study area was given by the average value of the land administration indexes. $L\bar{A}I = \frac{1}{n} \sum_{p=1}^{n} LAI_p$

if $L\bar{A}I < 50$, the land administration service does not perform well. Otherwise, if $L\bar{A}I \geq 50$,the land administration service has a good performance.

These land administration factors were:

S_1= Guarantee ownership and security of tenure; S_2= Equal access to property rights; S_3= Managing disputes regarding land rights and plot boundaries; S_4= Transferring property or use; S_5= Determining and allocating plot boundaries; S_6= Transparency of information on land; S_7=

Assessing the value of land; S_8= Assessing rental cost; S_9= Adopting planning policies and land use regulations.

2.2 Allocative efficiency model

The Cobb-Douglas stochastic cost frontier model used to estimate allocative efficiency scores was stated as:

$$\text{Ln } C_i = \alpha_0 + \alpha_1 \text{LnW}_1 + \alpha_2 \text{LnW}_2 + \alpha_3 \text{LnW}_3 + \alpha_4 \text{LnW}_4 + \alpha_5 \text{LnW}_5 + \alpha_6 \text{LnW}_6 + \alpha_7 \text{LnW}_7 + \delta_i - \varphi_i$$

Where;

Ln = Natural logarithm to base 10; C_i = the cost of producing rice for the ith farm (Naira/ha). α_i = The parameters to be estimated; W_1= price of seeds (Naira/kg); W_2= price of fertilizers (Naira/kg); W_3= price of herbicides (Naira/L); W_4= land rental cost (Naira/ha); W_5= price of pesticides (Naira/L); W_6=cost of labour (average payment per day and per ha); W_7= cost of water (Naira/day); δ_i = Random errors which are assumed to be independently and identically distributed; φ_i = Non-negative random variable associated with economic inefficiency. This is assumed to be independently distributed such that φ_i is obtained by truncation (at zero) of the normal distribution with variance δ'^2 and means φ .

The allocative inefficiency was modelled in terms of factors such as

$$\varphi_i = \sigma_0 + \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 + \sigma_4 Z_4 + \sigma_5 Z_5 + \sigma_6 Z_6 + \sigma_7 Z_7 + \sigma_8 Z_8$$

Where;

σ = a vector of unknown parameters to be estimated; Z_1= age of farmers in years; Z_2= Level of education measured in number of years spent in formal education; Z_3= experience in the cultivation of rice in years; Z_4= household size measured as number of family member living together in a house; Z_5= Number of land parcels; Z_6= Non-agricultural income (Naira).

2.3 Beta regression model

The effect of different factors on allocative efficiency was analysed using Beta regression model; a parametric approach which assummed that the dependent variable followed a Beta distribution with density function:

$$f(y;\mu,\varphi) = \frac{\pi(\varphi)}{\pi(\mu\varphi)\pi(1-\mu)\varphi} y^{\mu\varphi-1}(1-y)^{(1-\mu)(\varphi-1)}, 0 < y < 1$$

Where, $\mu = E(Y/X)$ is the expected conditional mean value of Y, φ is the precision parameter, and $\pi$is the gamma function, $VAR(Y) = \frac{V(\mu)}{1+\varphi} = \frac{\mu(1-\mu)}{1+\varphi}$

To relate the conditional mean μ to the predictor variables, the classical beta regression model assumes a predictor-response relationship given by: $n\left(\frac{\mu_i}{1-\mu_i}\right) = g(\mu_i) = x_i^T \beta$

Where:x_i^Tdenotes the vector of covariates, and β refers to the vector of regression coefficients. $g(.):(0;1) \rightarrow$ is a link function, which is strictly increasing and twice differentiable. Based on the added flexibility of the link model, four types of functions were used in order to choose the one that yields the best fit. These four functions are:

$$logit: g(\mu_i) = ln\left(\frac{\mu_i}{1-\mu_i}\right) \quad (1)$$

$$cloglog: g(\mu_i) = \ln\{-\ln(1-\mu_i)\} \quad (2)$$

$$probit: g(\mu_i) = ^{-1}(\mu_i) \quad (3)$$ with $(.)$is the standard normal distribution function.

$$loglog: g(\mu_i) = -\ln\{-\ln(\mu_i)\} \quad (4)$$

The model that minimized the Bayesian information criterion (BIC) was selected.

The model is specified as:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots\ldots\ldots + \beta_{17} X_{17i} + \beta_{18} X_{18i} + \rho_i$$

With, $Y_i = AE_i$

β_0 = intercept, the value of AE_i when others variables are null.

β_i = are the parameters to be estimate; X_1= age (years); X_2= distance to Home (km); X_3= experience (years); X_4=Off-farm income (Naira); X_5= Household size; X_6= inheritance (1=yes; 0=no); X_7= purchase (1=yes; 0=no); X_8= rent (1=yes; 0=no); X_9= individual lease (1=yes; 0=no); X_{10}= gift (1=yes; 0=no); X_{11}= government allocation (1=yes; 0=no); X_{12}= land administration service index (LASI); X_{13}= land value (soil quality); X_{14}= land use (Herfindahl index); X_{15}= land development index (quality of infrastructures); X_{16}= land exchange practice (1=yes; 0=no); X_{17}= land fragmentation (Simpson's Index); X_{18}= hired labor force (man-day).

ρ_i is an error term which is assumed to be independent and identically distributed.

2.4 ANOVA test

The analysis of variance (ANOVA) F statistic for testing the equality of several means was used to test the statistical significance of the differences of land administration service index among groups. It was stated as follows:

$$F(observed) = \frac{variation\ between\ groups}{variation\ withi\ groups}$$

If F(observed)>the critical F value, we reject the null hypothesis that all the group means are the same, and support that at least one group mean differs from other group means.

3.0 Results and Discussion

3.1 Existing land administration authorities and land acquisition practices

The results in Table 1 showed four categories of land administration authorities in the domain of Dadin Kowa irrigation scheme; namely Large-scale PuBlic Authority (LPBA) significantly higher (0.74) than Large-scale PriVate Authority (LPVA), Small-scale PuBlic Authority (SPBA) and Local Authority (LA). About 60%, 82.3%, and 77.1% of farmers acquired land mainly through formal lease from LPBA, LPVA and SPBA respectively. Fewer farmers acquired land informally through inheritance (26.2%, 11% and 8.6% respectively for LPBA, LPVA and SPBA) and rent (13.1%, 5.5% and 17.6% respectively for LPBA, LPVA and SPBA). Whereas, under local authority (LA), land is mainly acquired through inheritance (50.6%), rent (33.8%), purchase (7.8%) and informal lease (6.8%). This indicates that informal land transaction still prevails in the area in deviance from the Nigeria Land Use Act, which confers right on the government to hold land in trust for the people. This finding is in tandem with Oluwatayo *et al.* (2019) that the bulk of the land transactions are carried out informally under customary laws in rural Nigeria, as a result of which documentation of land transactions is either poor or completely absent. Table 1 also shows that documentation of land transactions in LPBA, LPVA and SPBA is through the issuance of receipt conferring right of occupancy to farmers as indicated by 92.5%, 95% and 94.2% of the farmers respectively, while 53.8% of farmers in local authority (LA) only had customary title.

Results also revealed that farmers have right to transfer land on lease (79.4%, 71.3% and 45.7%), rent (70.1%, 49.2% and 34.9%) and lend (33.6%, 16.6%, and 20%); while 67.1% of farmers in local authority (LA) perceived that they had the right to sell their land respectively for LPBA, LPVA and SPBA (Table 1). This result agrees Boudreaux and Sacks (2009), who found that despite that government is the holder of land in some African countries like Nigeria and Ethiopia, it is a common practice for individuals to informally hold unto rights to transfer their rights of land use to another. Farmers have been using their land for a period of 8 - 13 years, which is an indication of tenure security of land use in the area.

Table 1: Land administration authorities, acquisition methods, rights and documentation

VARIABLES	LPBA	LPVA	SPBA	LA
Land acquisition				
Inheritance	26.2	11	8.6	50.6
Purchase	0.9	0	2.6	7.8
Rent	13.1	5.5	17.6	33.8
Lease	0	0.6	0.5	6.8
Gift	0	0	0	0.3
Community lease	0	0.6	0	0.3
Government allocation	59.8	82.3	77.1	0.4
Land right				
Sell	-	-	-	67.1
Rent	70.1	49.2	34.9	98.4
Transfer (lease)	79.4	71.3	45.7	97.1
Lend	33.6	16.6	20	98.4
Transaction document				
None	7.4	5	5.8	41.9
Deed	0	0	0	2.6
Right of occupancy	92.5	95	94.2	1.7
Customary title	0.1	0	0	53.8
Duration (mean years)	12.72	11.73	7.54	8.57

Source: Field survey, 2021

Figure 1 shows that about 22% of farmers in LPBA, 25% in LPVA, 20% in SPBA and 17% in LA have experienced conflicts over land due to herdsmen activities. This conforms with Adisa (2012), who asserted that farmer-herdsmen conflicts over the use of agricultural land is persistent in Nigeria, with grave consequences for rural development. Other sources of conflict were problem of inheritance in local land authority area, boundary conflict, discriminatory and duplicated land allocation, dispute over the payment of land duties, and eviction by land authorities or owners in the study area. Also, about 24% of farmers in LPBA, 35% in LPVA, 31% in SPBA and 30% in LA expressed dissatisfaction with the land administration process in the area; for reasons of water competition, partiality of agents, lack of land development, conflict over land and high allocation cost. FAO (2014) attributed water competition to population pressure, especially where countries experiencing the fastest population growth are those where land and water resources are least abundant, making the pressure on irrigation water extremely high.

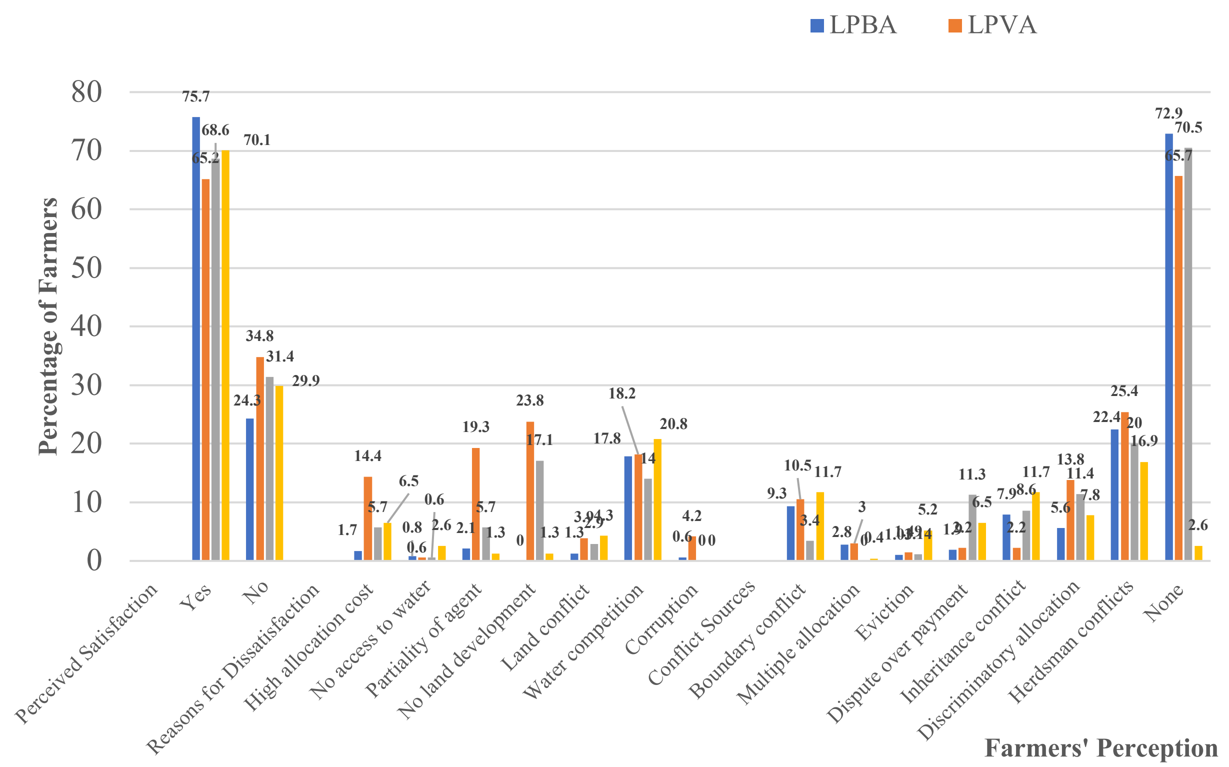

Fig. 1: Distribution of Farmers' Perception about Land Administration By Different Land Administration Authorities

Source: Field survey, 2021

3.2 Performance of Land Administration in the Study Area

The mean land administration service index (LASI) as presented in Figure 2 was 0.67. Being greater than 0.5 (LASI>0.5), this implies that farmers' perception of the performance of land administration factors in the study area was above average. Relatively, the result also revealed that the land administration service in LSPA was most effective being the highest index (0.74), followed by PA (0.67), SPLA (0.64) and LA being the least effective (0.6). This farmers' assessment was based on the following factors in their order of importance, namely; guarantee ownership and security of tenure, equal access to property rights, managing disputes regarding land rights and plot boundaries, transparency of information on land, plot allocation and boundary determination, transferring land use, valuation of land quality, determining rental cost, as well as adopting planning policies and land use regulations. This classification showed the importance of land tenure security. equity and fairness in land transaction, and conflict management in terms of assessing the performance of land administration; which is consistent with Byamugisha (2013) that the performance of land administration in some Sub-Saharan African countries is largely influenced by inefficient land transaction procedure and fraudulent practices that give way to land conflicts and social instability.

The study revealed that there was significant difference in the performance of land administration under different land administration authorities in the study area as indicated by the F cal (17.55) at 1% level (Table 2). This implies that the performance of land administration service under large scale public authority (LPBA) was significantly better than other land administration authorities in the area, including LPVA, SPBA and LA in descending order of quality of performance.

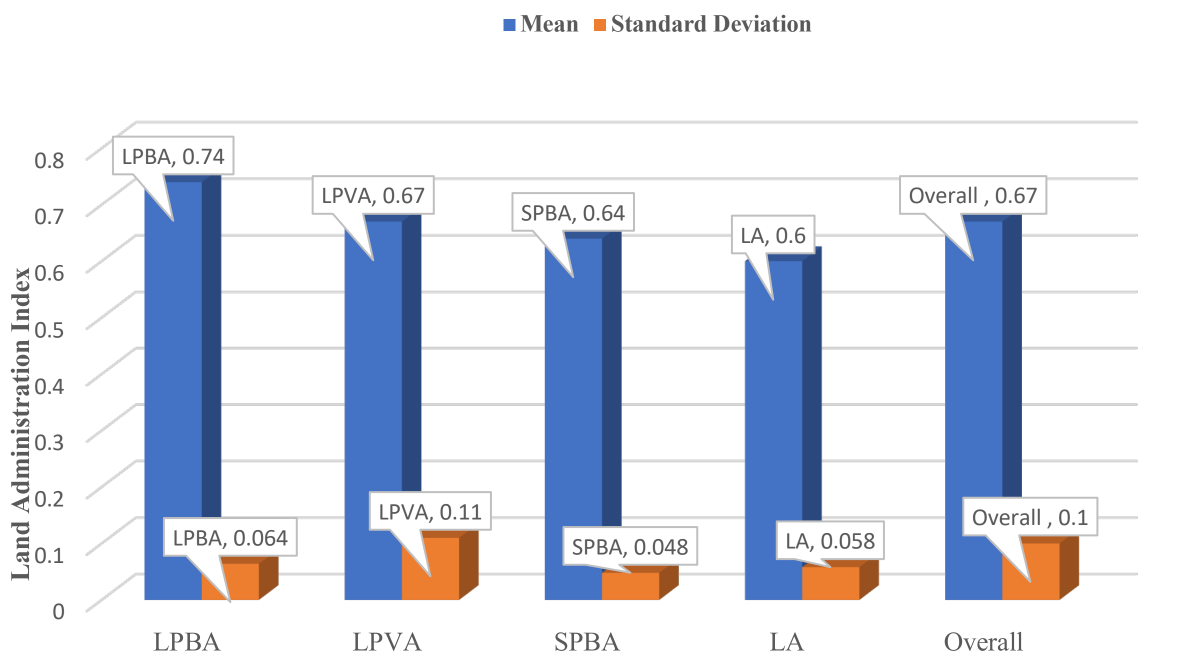

Fig.2 Distribution of Land Administration Indexes Across Administration Authorities
Source: Field survey, 2021

Table 2: ANOVA Test of Difference of land Administration Service Index Among the Land Administration Authorities

Land Allocation Service Index	Sum of Square	Df	Mean	F	Sig.
Between groups	0.419	3	0.139	17.55	0.000
Within groups	3.15	395	0.0079		
Total	3.56	398	0.0089		

F tab at 1% is 3.78; F tab at 5% is 2.60; F tab at 10% is 2.08

Source: Field survey, 2021

3.3 Allocative Efficiency of Rice Farmers Across Land Administration Authorities

The analysis of the cost function revealed that there were allocative inefficiency effects as shown by the gamma value of 0.98, 0.64, 0.89 and 0.97 for LPBA, LPVA, SPBA and LA respectively, which were significant at 1% level (Table 3). This implies that about 98%, 64%, 89% and 97% of total variation in the maximum cost were due to the inefficiency rather than random variability. The estimated sigma squared was significant at 1% level except for PA that was 5% level. This indicated a good fit and correctness of the specified distribution assumption of the model. All the coefficient of the variables examined in the cost function have positive signs and conformed with a priori expectation indicating that the estimated cost function is an increasing function.

The result showed that in LPBA, cost of labor ($p<0.01$), price of seed ($p<0.05$), price of fertilizer ($p<0.01$), rental cost ($p<0.05$) and price of pesticide ($p<0.05$), positively increase the total cost of rice production. The coefficient of the labor showed that one percent increase in the cost of labor used for rice production is likely to increase cost of producing rice by 0.46%, compared with 0.48% obtained by Okello *et al.* (2019) in Northern Uganda. The price of seed is positively and significantly related to allocative efficiency. This means that if the price of seed increases by 1%, the total cost will be reduced by 0.38%. The coefficient of price of fertilizer revealed that if the price of fertilizer increases by 1%, the total cost will be increased by 1.12%. This is in conformity with Laniyan *et al.* (2018) for Oyo State, Nigeria, while contradicting Aboaba (2020), who found a negative and significant relationship between cost of fertilizer and total production cost in Ogun State, Nigeria. The coefficient of land rental cost revealed that an increase of land rental cost by 1% will increase the total cost by 0.28%, which implies that an attempt to raise land rent in the area will increase the total production cost, corroborating the findings of Gela *et al.* (2019).

In LPVA, only labor cost increases the total cost, showing that 1% increase in labor cost will increase the total production cost by 0.56%. In SPBA, price of seeds, price of herbicide and rental cost increase the total cost; while in LA, labor cost, price of seeds and cost of water increase the total cost. The coefficient of the cost of water revealed that 1% increase in expenditure for water would increase the total cost by 0.46%, indicating that farmers in the LA seem to spend more to access irrigation water than those in the public and private authorities.

The inefficiency model showed that in LPBA and LPVA, non-farm income had positive and significant effect on the cost inefficiency. This means that farmers' allocative efficiency decreases with increase in non-farm income, which agreed with Laniyan *et al.* (2018) in the case of rice farmers in Oyo State, Nigeria. In SPBA, the inefficiency increase with age, indicating that the older the farmer the more difficult was for him to manage efficiently his production costs. In LA, farmers' allocative efficiency increases with age and experience, implying that the older the farmer the more experienced and more allocatively efficient as this represents advantage in decision making to reduce the production costs; corroborating the findings of Akinbode (2011).

Table 3: Maximum Likelihood Estimates of the Parameters in the Stochastic Cost Frontier Analysis (allocative efficiency)

	LPBA		LPVA		SPBA		LA	
Variables	Coeff	t-ratio	coeff	t-ratio	coeff	t-ratio	coeff	t-ratio
Constant	0.66	0.52	3.772	2.04**	5.82	7.98***	-1.069	-0.75
Labor cost	0.461	4.01***	0.5609	2.95***	0.1502	1.48	0.4891	3.13***
Price of seeds	0.3801	1.981**	0.069	0.57	0.1702	4.54***	0.1701	2.350**
Price of fertilizer	1.121	3.5301***	0.91	0.86	0.018	0.066	-0.085	-0.13
Price of herbicide	-0.072	-0.48	-0.244	-1.11	0.421	2.55**	-0.105	-1.08
Rental cost	0.2761	2.4**	-0.512	-0.47	0.711	2.231**	1.0311	1.46
Price of pesticide	0.3061	2.26**	-0.007	-0.065	-0.097	-1.2	0.002	0.024
Water cost	0.045	0.41	-0.376	-1.63	-0.39	-0.54	0.4601	2.981***
Inefficiency model								
Constant	-1.46	0.177	4.47	0.81	-18.76	-1.62	0.487	0.67
Age	-0.312	-1.25	-0.27	-0.64	0.31	1.75*	-0.3009	-2.22**
Education	-.249	-0.19	-0.82	-0.29	0.357	1.24	0.034	1.46
Experience	-.137	-0.57	-0.15	-0.36	-0.178	-1.13	-0.2701	-3.89***
Household size	0.157	0.53	-0.12	-0.28	-0.25	-0.86	-0.022	-1.08
Non-farm income	5.70e-6	1.99**	3.66e-6	2.02**	-1.2e-6	-0.49	-0.0001	-0.67
Number of plots	0.065	0.072	-0.33	0.81	0.537	0.61	-0.034	-0.98
Sigma-square	0.4811	54.4***	0.3809	2.14**	0.532	5.53***	0.7809	5.97***
Gamma	0.9821	6.19***	0.6432	11.09***	0.89	5.14***	0.9708	10.9***
LR test	59.27		79.13		178.92		89.05	

Source: Field survey, 2021

Figure 3 shows the distribution of allocative efficiency values for farmers in the different land administration authorities. The estimated allocative efficiency of the farmers ranged between 0.24 and 0.97 in LPBA, 0.39 and 0.98 in LPVA, 0.73 and 0.94 in SPBA and between 0.84 and 0.97 in LA. The mean values were 0.86, 0.94, 0.85 and 0.93 for LPBA, LPVA, SPBA and LA respectively. This implies that if the average farmer is to achieve the allocative efficiency of his most efficient counterpart, the average farmer could realize a 11%, 4%, 9% and 4% cost saving for LPBA, LPVA, SPBA and LA respectively. This also implies a cost increase of 75.2%, 60.2%, 22.3%, and 13.4 % for the most allocatively inefficient farmer in LPBA, LPVA, SPBA and LA respectively.

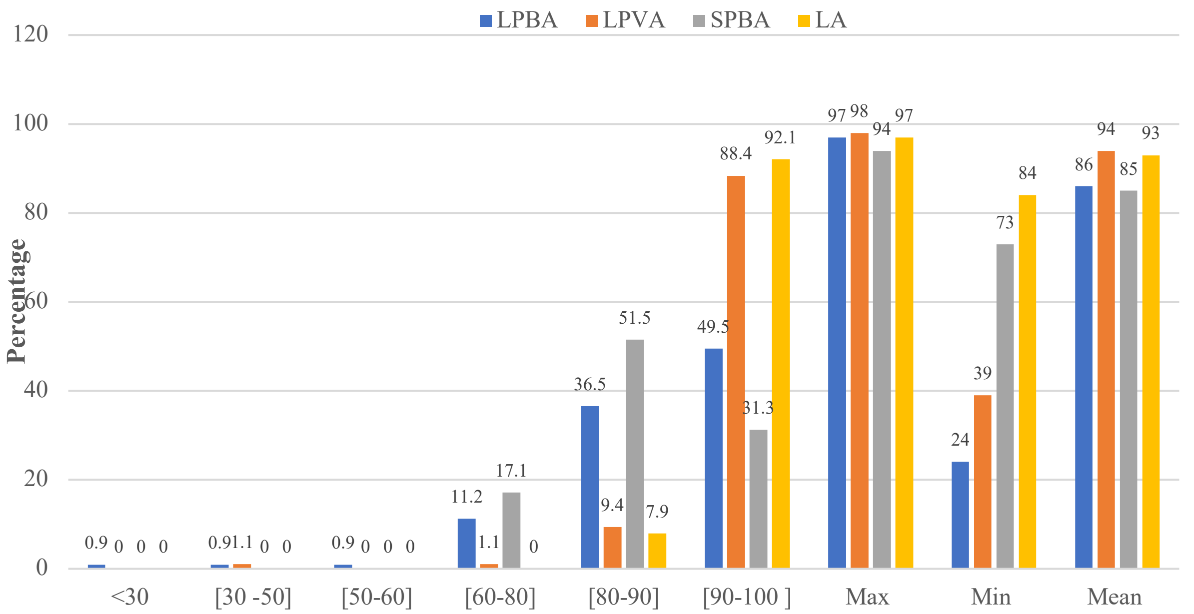

Fig. 3: Distribution of Farmers' Allocative Efficiency By the Land Administration Authorities
Source: Field Survey, 2021

The test of the difference of allocative efficiency among the four groups of farmers (4 land administration authorities) shows F cal of 26.02, which is significant at 1% level (Table 4). Hence, the null hypothesis of no significant difference is rejected and the alternative hypothesis is accepted. This implies that farmers in the private authority (PA) achieved significantly higher allocative efficiency and able to reduce cost of production much more than those in the other land administration authorities.

Table 4 : ANOVA test of difference of allocative efficiency among groups

Allocative efficiency	Sum of Square	Df	Mean	F	Sig.
Between groups	0.43332643	3	0.144442143	26.02	0.000
Within groups	2.19305229	395	0.005552031		
Total	2.62637872	398	0.006598942		

F tab at 1% is 3.78, 5% is 2.60, 10% is 2.08

3.4 Effects of Land Administration and Other Factors on Efficiencies of Rice Farmers

Table 5 shows the effects of land administration and other factors on the efficiencies of rice farmers under irrigation farming in the study area. The beta regression estimates show the likelihood ratio chi-squares of 38.07 with p-value of 0.0038 for allocative efficiency scores, revealing the fitness of the model at 1% ($p < 0.01$) level of significance.

The results showed that off-farm income, household size, land administration service index, and land value were the factors affecting the allocative efficiency score of rice farmers in the study area. Off-farm income negatively affects the allocative efficiency score at 10% significance level ($p<0.1$), meaning that having an off-farm income would result in a decline in the allocative efficiency of 1.25E-08. According to Madududu *et al.* (2022), farmers with other permanent sources of income outside farming will have limited time to commit themselves to farming, hence, their farming activities will be more subsistent and allocatively inefficient. Contrarily, the coefficient of household size was found to be positive and statistically significant at 5% level of probability, indicating that an increase in the size of households by one person would increase the allocative efficiency score of rice farmers by 0.13%. This implies that households with more members are allocatively more efficient compared to smaller households, which is inconsistent with the findings of Aboaba (2020) in Oyo State, Nigeria.

The results also showed that the land administration service index affects the allocative efficiency score of rice farmers in the study area. The coefficient of the land administration service index was negative and statistically significant at 1%. Thus, the result suggests that a unit increase in the land administration index would decrease the allocative efficiency of farmers by 8.6%. That is to say that the more farmers perceive improvements in land administration services, the less their resource use efficiency for production. According to

Shimelles *et al.* (2009), this situation may be explained by the anxiety and uncertainty of farmers over land, discouraging them from engaging in long term investment or efficiently allocating resources for production.

At 1% level of probability ($p<0.01$), land value has a positive effect on the allocative efficiency of rice farmers in the study area. That is to say that a unit increase in land value (soil quality) would result in an increase in the allocative efficiency score of rice farmers by 2.6%. The increase in demand for land in rural areas, in tandem with the increasing pressure over land, causes an increase in land value, which constrains farmers to adopt an efficient use of land as a resource of production. The more land has value (good soil quality), the more farmers are willing to allocate adequate resources for production.

The coefficient of land use showed negative and significance at 10% level, indicating that when the farmer intensifies the use of land, his allocative efficiency would decrease by 2.9%. That is to say that the increasing frequency of cropping in irrigation rice farming requires more use of fertilizer and other chemical inputs, which are not efficiently allocated, probably due to lack of financial resources and inadequacy between the increasing frequency of cropping and the required resources. According to Couper (1995), agricultural intensification could be sustainable only if the land management practices used by the farmers could compensate for nutrient loss. The findings are in line with Oladeebo and Adekilekun (2013), who found that land use intensity decreases the efficiency of farmers involved in food crop production in Osun State, Nigeria.

The coefficient of hired labor was statistically significant at 5% level ($p<0.05$), revealing that an increase in hired labor decreases the allocative efficiency score of rice farmers by 0.8%; which is similar to the reports of Okello *et al.* (2019) . This result implies that the absence of effective supervision of hired labor may result in poor quality and quantity of work done, thereby increasing the cost of production relative to output, and consequent loss in allocative efficiency.

Table 5: Effects of Land Administration and Other Factors on Efficiencies

Variables	Coefficient	Z-statistics	(dy dx)
Age	-0.001	-0.77	-0.0003
Distance to Home	-0.002	-0.46	-0.0004
Experience	-0.0024	-1.34	-0.0005
Off farm Income	-5.59e-08*	-1.68	-1.25e-08
Household size	0.006**	2.32	0.0013
Inheritance	0.045	0.68	0.01
Purchase	0.027	0.34	0.006
Rent	0.019	0.30	0.004
Lease	0.101	0.97	0.023
Gift	0.413	1.61	0.092
Government allocation	-0.045	-0.71	-0.01
LASI	-0.387***	-3.15	-0.086
Land value	0.118***	2.70	0.026
Land use	-0.13*	-1.67	-0.029
Land development	0.029	0.53	0.0065
Hired labor	-0.037**	-1.97	-0.008
Constant	-0.67		
LR Chi2	38.07		
Prob > chi2	0.0038		
Log likelihood	615.966		
BIC	-1112.15		

***, ** and* significant at 1, 5 and 10% respectively. Bayesian information criterion (BIC)
Source: Field survey, 2021

3.5 Implications for sustainable food security

Irrigation scheme is a global and national strategy towards boosting all-year round agricultural production and promoting food security, which has remained underutilised over time, specifically as in the case of the Dadin Kowa irrigation scheme. According to Takayama *et al.* (2021), economies of scale are not achieved by farmers in the domain of the irrigation scheme due to the land administration system, which promotes excessive farmland fragmentation, and thereby hindering the potential to deliver all-year round production of crops in the area. Findings from this study showed that land administration, land value, intensity of land use, hired labor, off-farm income sources and household size of farmers significantly influence their allocative efficiency. This implies that these factors either enhances or reduces farmers' ability to distribute farm resources optimally to ensure a marginal cost that enables maximum output to meet the market demand for food crops. Effective land administration that ensures security of land tenure, less fragmented and more economically feasible plot size may promote allocation efficiency of farmers and boost agricultural productivity in the area. Where the intensity of land use is not accompanied by adequate inputs, there will likely be a loss of allocative efficiency. The increasing value of land as a result of soil quality or higher pressure over land may entice farmers to invest in land or force them to adopt an efficient use of land to improve their allocative efficiency. The lack of land development in the study area explains the farmers' bad perception of the reliability of infrastructure, thus having a non-significant negative effect on the technical efficiency of rice farmers. Farmers' perception of the performance of land administration service could deter them from efficiently allocating resources for production because of uncertainty of land tenure security, thereby discouraging them from engaging in long-term investment or efficiently allocating resources for production, which may have negative consequence on food crop output and food security.

According to Gachot (2014), appropriate land administration confers security on the land use and determines the level of involvement in agriculture in an agrarian society. Hilhorst and Meunier (2015) reported that implementation of innovative land administration processes in Lithuania, the Republic of Korea, Rwanda and the United Kingdom, were found to have promoted sustainable transformation of irrigation scheme, economically feasible farm sizes, increased farm output, land productivity, income and food security in the stated study areas. Therefore, land administration process that prioritizes development of irrigation infrastructure and protect land from degradation and excessive fragmentation, may promote efficient allocation of land for irrigation farming and aid all-year agricultural productivity and food production, thereby contribute to meeting national food security needs.

4. Conclusion and Recommendations

The study concludes that the most common formal acquisition of land was through government allocation, but farmers also acquired land informally, especially through inheritance, rent and individual lease. Farmers on formalized land administration authorities (LPBA, LPVA and SPBA) exercised the right to rent or lease only; while farmers under local authority (LA) have rights to sell, rent, lend, and transfer their land. Conflict over land was mainly due to farmers-herdsmen crisis, as well as disagreement over land boundary. The study also concluded that land administration service performance under the four administration authorities was above average: large scale public (LPBA), large scale private (LPVA), small scale public (SPBA) and local authorities (LA), with large scale public authority having the best performance index. Finally, farmers were allocatively efficient, but there is large room for improvement in the optimal distribution of their production resources to enhance farm productivity and reduce production cost. The land administration factors that promote allocative efficiency of rice farmers were household size and land value, while off-farm income land administration service index, hired labor and land use could undermine efficient allocation of farm resources in the area.

Government policy should clearly state rights related to the use of public land especially in aid of agricultural production; including transfer of leasehold rights or rent among farmers so as to strengthen the land market and improve the efficient use of land. Through public-private partnership in land administration, the development of land and irrigation infrastructure should be accelerated in the area so as to improve land value, thereby serving as incentive for farmers to engage in long-term investment decisions on land and encourage them to more efficiently allocate land and other farm resources.

Acknowledgment

The fund for this study was provided by the Federal Government and the World Bank, through the "Transforming Irrigation Management in Nigeria (TRIMING) project. The governments of Gombe and Borno States, Yamaltu/Deba and Bayo local governments, Traditional leaders, water users association and farmers are also acknowledged.

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