



Effects of formal and informal land ownership systems on the economics of rice farming in Dakin kowa irrigarion scheme, Gombe State, Nigeria



Sani R M¹, Yaranduwa Y M¹ and Ayoola J B²

¹Department of Agricultural Economics, Faculty of Agriculture & Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi State, Nigeria.

²Department of Agricultural Economics, G. S. Tarka University of Agriculture Markurdi, Benue State, Nigeria.

Received: 22 April 2025 | Accepted: 14 November 2025

DOI: <https://doi.org/10.65791/cias.74>

ABSTRACT

This study examined the effects of formal and informal land ownership systems on the economics of rice farming in Dadin kowa irrigation scheme. A multi-stage sampling procedure was adopted in the study and 312 respondents were selected randomly. Data were collected using questionnaires and analyzed with descriptive statistics and stochastic frontier production model. The findings revealed a mean household size of 10 persons, mean farming experience of 19 years, mean irrigation experience of 11 years, farm size of less than 1 hectare for formal system and more than 5 hectares for informal system with a mean of 4 hectares and mean annual income of ₦78,093.25. The result further revealed the effect of land ownerships on the productivity of rice farming as, farm size ($P < 0.01$), family labor ($P < 0.01$), Hired labor ($P < 0.01$), agrochemicals ($P < 0.01$), organic fertilizer ($P < 0.01$), seed ($P < 0.01$) and rent ($P < 0.05$) significantly influence the technical efficiency of rice farmers and their output, while, for informal system, farm size ($P < 0.05$), Family labor ($P < 0.05$), Agrochemical ($P < 0.01$), Organic fertilizer ($P < 0.01$) and Seed ($P < 0.01$) significantly influences the technical inefficiency of rice farmers. The major constraints affecting rice production in the study area include; high cost of input (4.3), incident of pest and disease (3.4) and farmers/herders conflicts (3.2). It was concluded that rice production based on formal and informal systems is highly profitable. The study recommended that government and other relevant agencies should provide adequate security to cope the menace of farmers/herders clashes in the study area so as to allow farmers to maximize their productivity.

KEY WORDS: Rice farming; Irrigation; Land ownership; Gombe State.

1. Introduction

Land is a distinctive factor of production and is inclusive of all naturally occurring goods such as water, air, soil, minerals, flora and fauna that are used in the creation of products. Land is recognized as a primary source of wealth, social status, and power, the basis for shelter, food, and

economic activities (Ayoola *et al.*, 2023). It is an institutional framework within which decisions are taken about the use of land, embodying that legal or customary arrangement whereby individuals or groups or organizations gain access to economic and social opportunities through land

(Udo, 2003). The land system is also constituted by the rules and procedures which govern the right and responsibilities of both individuals and groups in the acquisition, use and control of land.

Nigeria has the ambition of diversifying her economy from crude petroleum dependency. The country also faces a looming food security crisis with a growing population that is increasingly dependent on imported foods. Insecure land tenure, scarcity of funds and credit, labour scarcity despite overall high unemployment and stagnant technology have crippled its further development. Until today, a wide range of policies, programmes and projects have had limited impact in ameliorating these problems. Given the choice, young people from the rural areas rather try their luck in urban centres. Climate change compounds the challenges confronting agriculture. The sector is dependent on the natural resource base and thus faces risks such as desertification, rising temperatures, changing rainfall patterns and sea level rise, leading to “degraded agriculture” and exacerbating conflict (Nwajiuba, 2020).

Rice (*Oryza sativa*) is a cereal which has become a staple food of considerable importance which is widely consumed in many countries of the world. In Nigeria, it one of the few food items whose consumption has no cultural, religious, ethnic or geographical boundary (Issa *et al.*, 2016). Rice accounts for over 20% of global calorie intake and has been an important food commodity for most people in Sub-Saharan Africa particularly, West African region. In Nigeria, rice has assumed a strategic position in the food basket of rural and urban households (Oyinbo *et al.*, 2013). As rice can provide a nation’s population with nationally required food security minimum of 2,400 calories per person per day (Bamidele *et al.*, 2010). Many local dishes are prepared with rice because of its

relative ease in terms of storage and preparation. In terms of local production, rice is now one of the main cereals produced by Nigerian farmers; it is cultivated in virtually all the agro-ecological zones of Nigeria. It covers both the upland and the swamps, depending on the variety (Mohammed, 2013). There is therefore dearth of literatures on the effect of formal and informal land ownership systems on rice productivity in Dadin-kowa irrigation scheme which is one of the largest rice-producing irrigated areas in the North-eastern Nigeria. Hence, this study aimed to improve the productivity and technical efficiency of rice farmers in Dadin-kowa irrigation scheme and to address the effects of land ownership systems on the economic performance of rice farming in Dadin-kowa irrigation scheme area of Gombe State. Addressing these challenges would be a step towards improving productivity of rice farmers in this area.

The broad objective of the study is to analyze the effects of formal and Informal land ownership systems on the economics of rice farming in Dadin-kowa irrigation scheme in Gombe State. While the specific objectives are to describe the socio-economic characteristics of rice farmers in the Dadin-kowa irrigation scheme; to determine the effect of land ownership on productivity of rice farming and to identify the constraints affecting rice production in the study area.

2. Material and Methods

2.1 The study area

The study was conducted in Yamaltu-deba Local Government Area of Gombe State and Bayo Local government Area of Borno State. Gombe State lies between Latitude 10° 16' and 11° 00' North of the equator and Longitude 11° 00' and 11° 11' E of

the Greenwich meridian distance above the sea level within the Sudan Savannah ecological zone of Nigeria. It shares boundary with Bauchi in the west, Taraba and Adamawa in the south west, Borno in the east and Yobe in the north. Gombe State covers a land area of 158,998,569 m² with a population of 2,365,040 inhabitants based on 2006 National Population Commission (NPC) census with a 2.8 percent annual growth rate. The climatic condition of the State is characterized by two distinct season's dry and wet seasons. The wet season begins from April and ends in October, while the dry season starts in November and last up to March. The annual rainfall ranges from 600 mm to 1200 mm, with the minimum and maximum temperature of 22.7 °C and 33.5 °C, respectively. The major economic activities of the people are agriculture (farming and livestock production), trading and public service. Major irrigated vegetables grown in the State includes onion, spinach, amaranths, okra, tomatoes, pepper, pumpkins, cabbage, lettuce, water melon and sweet melon (DKIS, 2020).

2.2 Sampling procedure and sample size

A multistage sampling procedure was employed in the selection of rice farmers in Dadin-kowa irrigation scheme (**Table 1**). Stage 1: this involves the purposive selection of 2 Local Government

Areas (LGAs) 1 from the Gombe State and another from Borno State. This is based on their participation in irrigated rice production and prevalence of water in the area. Stage 2: These involve purposive selection of 6 villages based on the intensity of rice farmers in the area. Stage 3: involve random selection of 15% rice farmers from the sample frame as provided by GSADP to make a total sample of 320 rice farmers.

2.3 Data collection

Primary data were collected using structured questionnaires. The structured questionnaires were administered to 320 rice farmers with the help of enumerators. The enumerators were well trained and a pre-test analysis was conducted in other to test the reliability of the instrument for data collection. Out of 320 questionnaires that were distributed, the total number of 312 questionnaires were completed, retrieved and were subjected to analysis.

2.4 Data analysis

Data were analysed using descriptive statistics to describe the socio-economic characteristics of rice farmers and constraints affecting rice production; while, the inferential statistics used the Cobb-Douglas functional form to determine the effect of

Table 1: Sample size selection plan

State	LGA	Community(s)	Sample Frame	Sample size (15%)
Gombe	Yamaltu-Deba	Dadin-kowa	410	62
		Yaranduwa	375	56
		Hinna	345	52
Borno	Bayo	Biriyel	378	57
		Jauro garga	315	47
		Garin dala	310	46
Total	2	6	2133	320

Source: DKIS, (2020)

land ownership on productivity of rice farming.

The explicit form of the model is as follows;

$$\ln Y_{ij} = \beta_0 + \beta_1 \ln X_{1ij} + \beta_2 \ln X_{2ij} + \beta_3 \ln X_{3ij} + \beta_4 \ln X_{4ij} + \beta_5 \ln X_{5ij} + \beta_6 \ln X_{6ij} + V_{ij} - U_{ij} \dots\dots\dots (1)$$

where;

$\ln$ = Logarithm to base e

Y_{ij} = Output of rice (kg)

X_1 = farm size (hectare)

X_2 = Family labor (mandays)

X_3 = Hired labor (mandays)

X_4 = Agrochemical (Litre/hectare)

X_5 = Inorganic fertilizer (kg/hectare)

X_6 = Seeds (kg/hectare)

X_7 = Cost of rent per season (₦)

3. Results and Discussion

3.1 Socio-economic characteristics of rice farmers

The result from **Table 2** revealed that the households had a minimum number of 2 persons and the maximum number of 44 persons with the mean of 10 persons. The large household size may serve as a source of cheap and readily available farm labor supply depending on the compaction and very likely increased output (Ndanitsa *et al.*, 2021). The finding agrees with Mustapha *et al.* (2012) and Olumba (2014) who reported that large family size could be as a result of polygamous nature of the rural farmers. He further opined that this could be linked to the fact that most rural farmers look at large household size as a good and economical way of maximizing farm returns by using family labor.

The result also revealed that the household had a minimum and maximum farming experience

between 1 and 60 years, respectively, and had a mean of 19 years. Gomina (2015) and Ndanitsa *et al.* (2021) posited that farming experience is used as a measure of efficiency in management *i.e.* the more experience a farmer was, the more s/he had the ability to manage farm resources effectively and efficiency, which is expected to translate in to higher returns for entrepreneurs. The result further shows that majority of the farmers had mean experience of 11 years. The rice farmers in the study had a minimum and maximum irrigation experience between 1 and 60 years, respectively. The years of irrigation experience were reflected in more effective production capacity and high output level of rice. This finding is similar to that of Issa *et al.* (2016) who found high irrigation experience of 10 years and above among maize farmers.

The result of the analysis depicts that the minimum and maximum farm size used by rice farmers were 0.5 and 15 hectares with a mean of approximately 4 hectares. This implies that rice production in the study area is mainly practiced by small-scale farmers under formal system. The average farm size for formal land ownership system was less than 1 hectare, while for the informal land ownership system was 15 hectares. This result is in line with Mohammed (2015), Tijjani and Bakari, (2014) who reported that 85 percent of the farmers in the area are small-scale farmers cultivating less than five hectares of land. Similarly, the result revealed the minimum and maximum annual income of formal and informal rice farmers to be ₦100,000 and ₦1,100,000, respectively with an annual mean of ₦78,096.25. This implies that farmers earned low annual farm income which could be as a result of

Table 2: Descriptive statistics of socio-economic variables of rice farmers (n=312)

Variables	Minimum	Maximum	Mean	Std. Deviation
Household size	2	44	10.18	5.927
Farming experience	1	60	18.87	10.804
Irrigation experience	1	60	11.34	8.745
Farm size	0.5	15	3.76	1.950
Annual Income	100,000	1,100,000	78,096.25	835468.540

Source: Field survey, (2021).

constraints that associated with rice farming such as high cost of fertilizer, pest and disease, high cost of transportation, lack of improved seed varieties.

3.2 Effects of formal and informal land ownership on productivity of rice farming

The result of maximum likelihood estimate on efficiency of rice farmers revealed that for the formal system, farm size ($P<0.01$), family labor ($P<0.01$), Hired labor ($P<0.01$), agrochemical ($P<0.01$), organic fertilizer ($P<0.01$), seed ($P<0.01$) and rent ($P<0.05$) significantly influences the technical efficiency of rice farmers (Table 3). The coefficient of farm size was positive and statistically significant related to technical efficiency at ($P<0.01$), this implies that increase in farm size by 1%, the output of rice related to technical efficiency will increase by 0.9850. This implies that increase in farm size will increase the output of rice farmers.

The coefficient of family labor was positive and statistically significant related to technical efficiency at ($P<0.01$), this implies that the technical efficiency of rice farmers who used family labor is efficient to increase the output of rice farmers. This means that family labor was enough to boost rice production because they are adequate. This result disagrees with the findings

of Kareem (2016); Shittu (2014) and Abaoba (2020) who reported that households are inefficient in terms of labor use. Similarly, the coefficient of hired labor was positive and statistically significant related to technical efficiency at ($P<0.01$), this indicated that the technical efficiency of rice farmers who also used hired labor tends to increase the output of rice farmers by 0.8097. This implies that increase in number of hired labor would increase the output of rice farmers. This means that, hired labor influences the yield of rice production as compare with family labor.

The coefficient of agrochemical was positive and statistically significant related to technical efficiency at ($P<0.01$), this implies that if the quantity of agrochemical increases by 1%, the output of rice farmers will increase by 0.1894 related to technical efficiency. This is so because insect pest infestation and weed were serious challenges facing rice farmers and efforts to eliminate insect pests and weed chemically will increase the output of rice farmers. This result emphasizes the importance of agrochemical in agricultural production and this is consistence with the finding of Aboaba (2020) who reported that there exist a relationship between agrochemical and the output of rice in Ogun State. The coefficient of organic fertilizer was positive and statistically significant related to technical

Table 3: Effect of formal and informal land ownership on the productivity of rice farming

Variables	Parameter	Formal		Informal	
		Coefficient	t-value	Coefficient	t-value
Constant	α_0	-11.2177	-20.7***	-21.473	-32.002***
Farm size	α_1	0.9850	6.0***	-0.702	-1.939**
Family labor	α_2	0.5560	5.1***	-0.123	-2.280**
Hired labor	α_3	0.8097	3.3***	-0.457	-0.637
Agrochemicals	α_4	0.1894	3.5***	-0.713	-4.130***
Organic fertilizer	α_5	0.9503	8.6***	-0.811	-5.465***
Seed	α_6	0.7727	2.9***	-0.511	-5.159***
Rent	α_7	-0.2446	-2.1**	-0.177	-1.193

Source: Field survey, (2021). Notes: ** and *** = 5% and 1% level of significance.

efficiency at ($P < 0.01$), this implies that if the quantity of organic fertilizer increases by 1%, the output of rice farmers will increase by 0.9503. This indicated that the higher the quantity of organic fertilizer, the higher will be the output of rice farmers. The coefficient of seed was positive and statistically significant related to technical efficiency at ($P < 0.01$), this implies that if the quantity of seed increases by 1%, the output of rice farmers will increase by 0.7727. This indicated that the higher the quantity of seed sown, the higher the output of rice. This result is in line with the findings of Ambali *et al.* (2012) and Okello *et al.* (2019) who reported a positive relationship between the quantity of seed and the output of rice. The coefficient of rent was negative and statistically significant related to technical efficiency at ($P < 0.05$), this implies that if land rent cost increases by 1%, the total cost of land rent will decrease by 0.2446. This is so because land is a particularly vital resource used in production and any attempt to raise its rental cost will decrease the total production cost.

Furthermore, the result of maximum likelihood estimate on efficiency of rice farmers for informal system revealed that farm size ($P < 0.05$), Family

labor ($P < 0.05$), Agrochemical ($P < 0.01$), Organic fertilizer ($P < 0.01$) and Seed ($P < 0.01$) influences the output of rice farmers. The coefficient of farm size was negative and statistically significant at ($P < 0.05$), this implies that 1% increase in the area under cultivation of rice will result in decreased output of rice by 1.939. This indicated that as the size of the farm increases, output of rice decreases and this result disagree with Ndanitsa *et al.* (2021) and Abdulahi (2021) who reported that farm size significantly determines the output of water melon and maize respectively at ($P < 0.01$) in Niger and Katsina States, respectively. The coefficient of family labor was negatively significant at ($P < 0.05$), this implies that 1% increase in family labor; the output of rice will decrease by 2.280. This means that, family labor was insufficient in production process of rice thereby decreasing the output of rice. The coefficient of agrochemical was negative and statistically significant at ($P < 0.01$), this implies that 1% increase in agrochemical will result to decrease in output of rice by 4.130. This indicated that, increase in level of agrochemical in rice farms will lead to decrease in output of rice there by affecting the technical efficiency of rice farmers. The coefficient of organic fertilizer was negative and statistically

significant at ($P < 0.01$), this implies that 1% increase in organic fertilizer will decrease the output of rice by 5.465. This means that organic fertilizer decreases the level of rice output if it is applied in abundant, it will destroy the rice plant thereby reducing the yield. The coefficient of seed was negative and significant at ($P < 0.01$), this indicated that 1% increase in the quantity of seed sown will lead to decrease in output of rice. This implies that if the quantity of seed sown increases there will be overpopulation among the crops, competition will arise in terms of sunlight, air, water and fertilizer thereby harboring pests and diseases which will lead to decrease in output and yield of rice in the area. This will greatly affect the technical efficiency of rice output in the area.

3.3 Constraints affecting rice production

Table 4 shows the constraints affecting rice production in Dadin-kowa irrigation scheme. The result revealed that high cost of input, incident of pest and diseases and farmers/herders conflicts were the major challenges faced by rice farmers in the study area. Others include inadequate extension services, land fragmentation, inadequate storage facilities, land encroachment and high cost

of labor were also some the challenges faced by rice farmers. These constraints are believed to have serious negative implication on farmer's production efforts and farm income due to their discouraging effects.

4. Conclusion

The study concluded that the major constraints affecting rice production in the Dadin-kowa irrigation scheme were the high cost of farm inputs, incidence of pests and diseases, and farmers–herders conflicts. Other challenges identified by farmers included inadequate extension services, land fragmentation, inadequate storage facilities, land encroachment, and high labor costs, all of which negatively affected production efforts and farm income. These constraints discouraged farmers and limited their productivity and standard of living.

Based on the findings, the study recommended that the government and relevant agencies should provide adequate security to address farmers–herders clashes in the study area, thereby enabling farmers to maximize productivity. It also recommended exploring alternative methods of

Table 4: Distribution of farmers according to constraints affecting rice production

Constraints	SA	A	UD	D	SD	Total	Mean
High cost of input	187	94	8	18	13	1384	4.3
Incident of pests and diseases	67	67	116	58	12	1079	3.4
Farmers/herders conflict	120	60	15	25	100	1035	3.2
Inadequate extension services	35	88	12	170	15	918	2.9
Land fragmentation	74	6	35	185	20	889	2.8
Inadequate storage facilities	60	83	13	50	114	885	2.8
Land encroachment	8	57	181	27	10	875	2.7
High cost of labor	70	37	50	29	134	840	2.6
Lack of access to credit facilities	14	45	32	179	50	754	2.4
Lack of processing facilities	52	36	45	32	155	758	2.4

Source: Field Survey, (2021).

land acquisition beyond inheritance to increase land available for rice cultivation and expand production. In addition, improving farmers' technical efficiency through credit facilities was suggested as a means of sustaining rice production. Finally, the study emphasized the need for timely provision of farm inputs and supplies such as machinery, improved seeds, agrochemicals, and fertilizers at affordable prices to enhance productivity, income, and the overall standard of living of farmers.

5. Acknowledgement

This is to acknowledge the financial support of Transforming Irrigation Management in Nigeria Project (TRIMING) to the conduct of this research. We equally, acknowledge the support and encouragement of the Research Panel of Experts (RPOEs) that lead to the successful completion of the study.

6. Reference

- Abaoba, K. O. (2020). Economic Efficiency of Rice Farming: A Stochastic Frontier Analysis Approach. *Journal of Agribusiness and Rural Development*, 4(58): 423-435. <http://dx.doi.org/10.17306/J.JARD.2020.01377>
- Abdulahi, Z. (2021). Profitability and Technical Efficiency of Melon Egusi Production under Sole and Mixed Cropping System in Niger State, Nigeria. Unpublished M. Sc. Thesis submitted to the Department of Agricultural Economics and Farm management, Federal University of Technology, Minna, Niger State, Nigeria
- Ambali, O.I., Adegbite, D.A., Ayinde, I.A., Awotide, D.O. (2012). Analysis of production efficiency of food crop farmers in Ogun State, Nigeria. *ARPJ. Agric. Biol. Sci.*, 7(9): 680–688.
- Ayoola, J. B., Sani, R. M., Ayoola, G. B., Dzever, D. D., Zaman, E. Y., Sani, M., Adoka, T., Moses, A.U., Yunusa, M. Y., Abu, G. A., and Abu, O. (2023). Variability of Land Tenure, Land Rights and Land Acquisition Methods among Male and Female Farmers in Irrigation Sector of Gombe and Bornu States, Nigeria. *Research Square*. pp.1-19.
- Bamidele, F. S., Abayomi, O. O. and Esther, O. A. (2010). 'Economic Analysis of Rice Consumption Patterns in Nigeria', *Journal of Agricultural Science Technology*, 12: 1–11.
- Dadin-kowa Irrigation Scheme [DKIS], (2020). Progress Report. 2020.
- Gomina, A. (2015). Impact of savings on credit cooperative societies in combating poverty among crop farmers in three Local Government Areas of Niger State, Nigeria. PhD. Dissertation, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria. pp. 76-80.
- Issa, F. O., Kagbu, J. H. and Abdulkadir, S. A. (2016). Analysis of Socio-Economic Factors Influencing Farmers' Adoption of Improved Maize Production Practices in Ikara Local Government Area of Kaduna State, Nigeria. *Agroresearch*, 16(2): 15-24.
- Kareem, O. I. (2016). European Union's Standards and Food Exports from Africa: Implications of the Comprehensive Africa Agricultural Development Programme for Coffee and Fish. *Journal of African Development*, 18: 83–97.

- Mohammed, A. I. (2013). Economic Analysis of the Structure, Integration and Performance of Rice Markets in Dekina Local Government Area of Kogi State, Nigeria. *Journal of Agriculture, Forestry and the Social Sciences (JOAFSS)*, 11 (1): 88-93.
- Mohammed, U. A. (2015) 'Response of some rice cultivars to Abiotic stress', 5(1): 375–380.
- Mustapha, S. B, Undiandeye U.C., A. M. Sanusi, A. M. and Bakari S. (2012): Analysis of adoption of improved rice production technologies in Jeer local government area of Borno state, Nigeria; *International Journal of Development and Sustainability*, 1(3): 1112-1120.
- Ndanitsa, M. A., Sallawu, H., Bako, R. U., Oseghale, A. I., Jibrin, S., Mohammed, D. and Ndako, N. (2021). Economic Analysis and Technical Efficiency of Watermelon Production in Niger State of Nigeria. *Journal of Agripreneurship and Sustainable Development (JASD)*, 4(4): 64-80.
- NPC, (2006). National Population Census Figures Abuja, Nigeria.
- Nwajiuba, E. C. (2020). Food Insecurity in Nigeria: Food supply matters. Available from www.elibrary.imf.org. retrieved on 25th June, 2022.
- Okello, M. D., Bonabana-Wabb, J. and Mugonola, B. (2019). Farm level allocative efficiency of rice production in Gulu and Amuru districts, Northern Uganda. *Agric. Food Econ.*, 7(19), <https://doi.org/10.1186/s40100-019-0140-x>
- Olumba, C. C. (2014). Productivity of improved plantain technologies in Anambra State, Nigeria. *African Journal of Agricultural Research*, 9(29): 2196-2204.
- Oyinbo, O., Damisa, M. A., and Rekwot, G. Z. (2013). Growth trend of rice demand and supply in Nigeria: Opportunity for youth and women empowerment. *Russian Journal of Agricultural and Socio-economic Sciences*, 4(6), 31-34.
- Shittu, A. (2014). Off-farm labor supply and production efficiency of farm household in rural Southwest Nigeria. *Agric. Food Econ.*, 2(4).
- Tijjani, T. and Bakari, T. (2014). Impact of Participatory Development Projects on Social Capital: Evidence from Farmland Consolidation Projects in Paddy Areas of Japan *JARO*, 52(3): 273-283.
- Udo, G. O. (2003). *Model Building in Property Valuation*. Enugu: Institute for Development Studies, University of Nigeria.