RUFORUM Working Document Series (ISSN 1607-9345), 2023 No. 22:309-317.
Available from http://repository.ruforum.org

Research Application Summary

Analysis of land exchange practice and its effects on technical efficiency of rice farmers in north-eastern zone of Nigeria

Sani, M.[2], Ayoola, J.B.[1], Djomo, C.R.F[5], Ukpe, U.H.[6], Ayoola, G.B.[3] & Sani, R.M.[4]

[1]Institute of Food Security, Joseph SarwuanTarka University Makurdi, Benue State, Nigeria
[2]Department of Agricultural Economics, Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria
[3]Farm and Infrastructure Foundation (FIF)
[4]Department of Agricultural Economics, Abubakar Tafawa Balewa University, Bauchi, Nigeria
[5]Department of Agricultural Economics and Agribusiness, University of Buea, Cameroon
[6]Department of Agricultural Economics, University of Wukari, Taraba, Nigeria

Corresponding author: sanimohamadou47@gmail.com

Abstract

This study analyzed the practice of land exchange in Norther-Eastern zone of Nigeria. Four hundred (400) rice farmers under irrigation farming were selected using multi-stage sampling procedure to provide data by means of structured interviews. The results of the descriptive analysis showed that farmers exchange land (16.07%) in the study area through the means of land exchange for use (or farming purpose) and land exchange for property. Number of plots, reduction of distance among plots, practice of mechanization, reduction of production cost, and improvement of efficiency are factors influencing farmers to exchange land in the study area. The result revealed that farmers were technically efficient, and that efficiency could be increased given the level of technology and efficient use of available resources. The result of the beta regression showed that household size, rented land, and hired labor have positive effects on technical efficiency, whereas farmers' perceptions of land development have a negative effect on technical efficiency. However, it was found that the practice of land exchange did not affect the technical efficiency of rice farmers in the study area. It is therefore recommended that the government policy should clearly state rights related to the use of lands and encourage land transactions such as rent among farmers, the sale of rights of occupancy, or the transfer of leasehold rights so as to strengthen the land market and improve the efficient use of land.

Keywords: Beta regression, Land exchange, Nigeria, Rice, Technical efficiency.

Résumé

Cette étude a analysé la pratique de l'échange de terres dans la zone nord-est du Nigeria. Quatre cents (400) riziculteurs pratiquant l'agriculture irriguée ont été sélectionnés à l'aide d'une procédure d'échantillonnage en plusieurs étapes pour fournir des données par le biais d'entretiens structurés. Les résultats de l'analyse descriptive ont montré que les agriculteurs échangent des terres (16,07%) dans la zone d'étude par le biais d'échanges de terres à des fins d'utilisation (ou de culture) et d'échanges de terres à des fins de propriété. Le nombre de parcelles, la réduction de la distance entre les parcelles, la pratique de la mécanisation, la réduction des coûts de production et l'amélioration de l'efficacité sont des facteurs incitant les agriculteurs à échanger des terres dans la zone d'étude. Le résultat a révélé que les agriculteurs étaient techniquement efficaces et que l'efficacité pourrait être augmentée compte tenu du niveau de technologie et de l'utilisation efficiente des ressources disponibles. Les résultats de la

régression bêta ont montré que la taille du ménage, les terres louées et la main-d'œuvre salariée ont des effets positifs sur l'efficacité technique, tandis que les perceptions des agriculteurs concernant l'aménagement des terres ont un effet négatif sur l'efficacité technique. Cependant, il a été constaté que la pratique de l'échange de terres n'affectait pas l'efficacité technique des riziculteurs dans la zone d'étude. Il est donc recommandé que la politique gouvernementale définisse clairement les droits liés à l'utilisation des terres et encourage les transactions foncières telles que la location entre agriculteurs, la vente de droits d'occupation ou le transfert de droits de bail afin de renforcer le marché foncier et d'améliorer l'utilisation efficiente des terres.

Mots-clés: Régression bêta, Échange de terres, Nigeria, Riz, Efficacité technique.

Introduction

Nowadays, farmers exploit more and more fragmented lands necessitating additional time and effort to manage distance plots. Land fragmentation is said to hinder the efficient use of irrigation and the development of mechanical technologies (Demetriou, 2014). To this end, exchange of fragmented parcels seeks to increase access to distant plots (Len, 2017). Generally, land exchange is defined as an accord through which parties agree to exchange one or more parcels of land to improve conditions of exploitation (Bullard *et al.*, 2012). Land exchange is more specifically defined in the agricultural field as an agreement involving at least two landowners to exchange their lands to improve their agricultural productivity. Land exchange represents an important land tenure management tool to consolidate land ownership for more efficient management. It is also the preferred method for making rearrangements and readjustments of land ownership with government.

Land exchange has been promoted in many regions as instrument for solving the issues of land fragmentation. In the Netherland, before the Second World War, farmers exchanged their lands without any law in order to improve their farmland. That exchange of land was based on private initiative and was defined legally as a process involving at least three landowners (Yimer, 2014). After the Second World War, the objective of land exchange in the Netherlands was local agricultural development through the re-allotment of parcels and the improvement of rural infrastructure.

In many Sub-Saharan African countries, legal framework establishes that all land is owned by the State on behalf of people. Thus, land must not be sold and land market is illegal. However, people are exchanging land for money without relying on public acknowledgement of terms of sales and purchase, and any legal proof of purchase or ownership (Knight, 2010). It is what Benjaminsen and Lund (2003) described by the term “informal formalization”. Although these transactions appear more regular and common, we cannot consider them legal. The importance of land exchange on economic development has been debated upon by authors. According to some authors, land exchange is an important factor to ensure agricultural development using land. For instance, Len (2017) argued that the exchange of fragmented parcels seeks to overcome the problem of fragmented distant plots to achieve plots that are as large as possible. And according to Hartvigsen (2015), land exchange is a very important tool for land consolidation, and used by individual farmers, based on private initiative to improve their agricultural productivity. Past studies conducted in the study area focused on the effect of rainfall variability on rice yield (Noel, 2020); assessment of Dadin-kowa irrigation scheme (Hassan *et al.* 2015); resource use efficiency of rice production

(Barau *et al.,* 1999; Tijjani *et al.,* 2013), and the comparison of technical efficiency of rice farmers under different land administration authorities (Sani *et al.,* 2023). More recently, the study of Ayoola *et al.* (2022), has attempted to explain why farmers exchange land in the study area. However, the study did not explain the process of land exchange and its effect on technical efficiency of rice farmers. This has created a knowledge vacuum that needs to be filled to understand why farmers are exchanging their land. It is based on this backdrop that this study aimed at an analysis of land exchange practice and its effect on technical efficiency of rice farmers in Dadin-Kowa irrigation scheme area of Gombe and Borno States of Nigeria. Specifically, the study aimed to: (1) analyse the practice of land exchange in the study area, (2) identify factors influencing farmers to exchange land in the study area, (3) estimate the scores of technical efficiencies among rice farmers and (4) assess the effect of land exchange on technical efficiency of rice farmers in the study area.

Methodology

This study adopted a cross-sectional survey design using questionnaires to obtain information. The study was carried out in Borno and Gombe States of Nigeria, two of the 36 States of the country. These two neighboring States are characterized by good climatic and soil condition that support rice production. Gombe State is located within the latitude 10°15 N and longitude 11.10°E in the Northeastern part of Nigeria. Its Headquarter is Gombe. The state has an area of 20,265 km² and a population of around 2,365,000 people (NPC, 2006). Borno is located within the latitude 11°N and longitude 13.5°E in northeastern part of Nigeria. Its Headquarter is Maiduguri. The state has an area of 57,799 km² and a population of around 4,171,104 people (NBS, 2006). The population of the study comprised rice farmers of Gombe and Borno States that are involved in the Dadin-Kowa Irrigation Project (DKIP) and those that were not but were practicing irrigation farming (Figure 1).

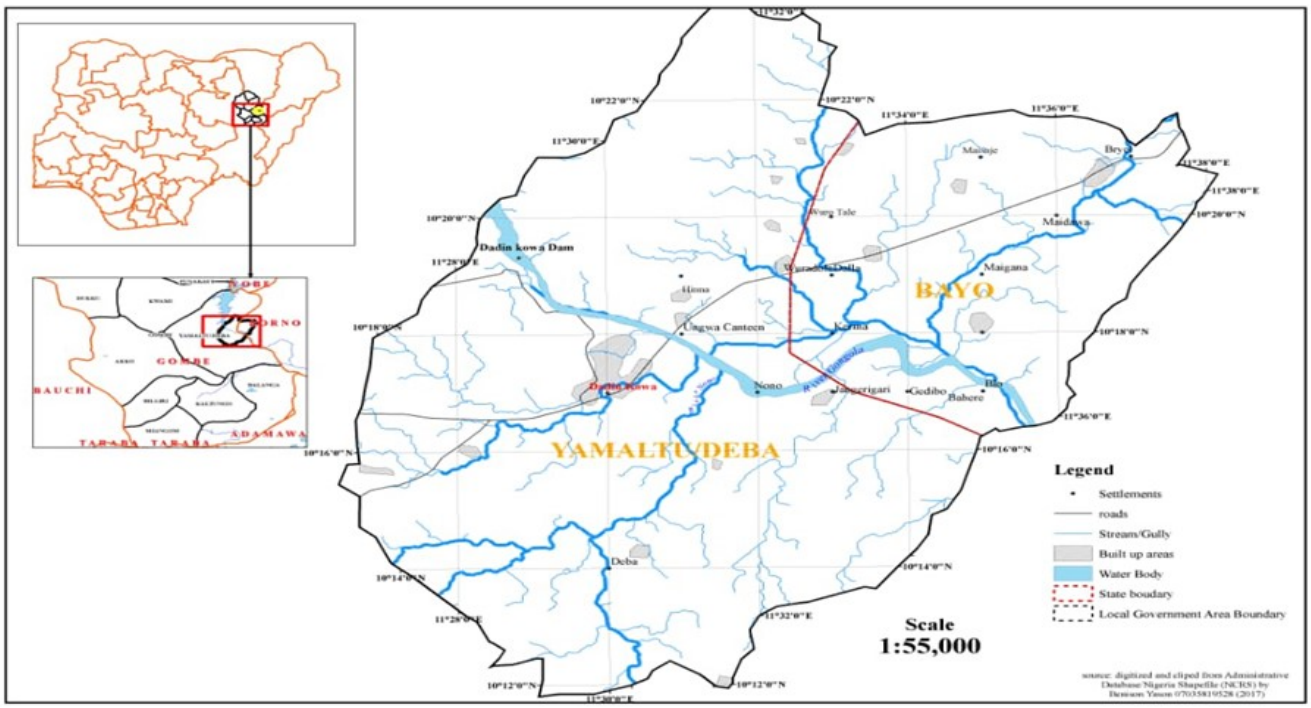

Figure 1. Map showing the location of Dadin-Kowa Irrigation Project area and the Irrigation canal in Borno and Gombe States. Source: Upper Benue River Basin Gombe, 2019.

Multi-stage sampling technique was used for sample selection. Firstly, based on proximity to the DKIS and UBRBDA, one senatorial district was purposively selected from each State, and two (2) LGAs were further purposively selected from each of the two Senatorial districts. Secondly, three (3) villages were selected from each of the LGA selected using random sampling technique. Finally, from each village, respondents were randomly selected after stratifying them into four (4) land administration authorities: Dadinkowa Irrigation Scheme (DKIS); Integrated Savanna Vegetables and Fruits Canning Factory (VEGFRU); National Institute of Horticultural Research and Training (NIHORT) and College of Horticulture (CoH) (NIHORT/CoH); and Local authority.

The sample sizes of the various strata were obtained by randomization to get the number of respondents for the various strata using Taro Yamani (1973) formula from a population frame of 3691 registered farmers practicing irrigation farming.

The formula is expressed as follows:

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

Where: n = sample size; N = real or estimated size of the population; e = level of significance (5% or 0.05).

In terms of model specification, the approach involved the use of binary logistic regression model to identify factors influencing. The Cobb-Douglas stochastic production frontier model was used to estimate technical efficiency scores and to determine the effects of different factors on technical, allocative, and economic efficiencies, Beta regression model was used.

Results and Discussion

Land exchange practice. The result of the descriptive analysis of land exchange, showed that farmers had information about the practice of land exchange (66.4, 60.2, 71.4 and 66.2% for DKIS, VEGFRU, NIHORT/CoH and Local authority respectively). In the same way, most of farmers affirmed that land was exchanged in their area (50.5, 42, 60 and 54.5% for DKIS, VEGFRU, NIHORT/CoH and Local authority respectively). From the result,16.07% of respondents had exchanged land in the study area. This means that few farmers in the study area had experience in land exchange. This result is in conformity with Alemu *et al.* (2019), who revealed a serious problem of limited comprehensive experience of farmers on land exchange, since 68% of farmers interviewed did not have any experience of land exchange practice in order to concentrate their land holding and improve their efficiency.

The practice of land exchange was more important in Local land (19.5%), DKIS (17.8%), NIHORT (17.1%), while VEGFRU had the lowest percentage (9.9%). However, the practice of land exchange was done informally among farmers and only 6.4% had practiced formal land exchange. The land exchange approaches practiced in the study area were: land exchange for use (or farming purpose) (13.2%) and exchange of property (2.87%). Land exchange for use is more important in DKIS (16.7%), follows by NIHORT/CoH (14.2%), Local authority (12.9%) and VEGFRU (8.9%). This result showed the importance of land exchange for use in the study area, as also indicated by Ito *et al.* (2016) in the case of Japanese agriculture during the agricultural stagnation period in the late 1980s. Their study confirmed the improvement in farmland use efficiency by facilitating land rights transfers from farm households that had ceased farming or reduced their farm operational size, holding this land

temporarily, and subsequently selling or renting it out to farm households that intended to enlarge their farm size. However, exchange of propriety is more important in Local authority (6.6%), follows by NIHORT/CoH (2.9%), DKIS (1.1%) and VEGFRU (1%). The result showed that farmers in local lands were very few to exchange their propriety. It means that farmers did not want to lose the control over their land. The major right related to a land acquired through land exchange is the right of farming (17.8, 9.9, 17.1 and 19.4% for DKIS, VEGFRU, NIHORT/CoH and Local authority, respectively).

Factors influencing farmers to exchange land. The Nagelkerke R-squared of the model showed that the independent variables in the model accounted for 69.1% of the variations in the probability to exchange land. The Chi-squared statistic of the model was statistically significant at 1% level of probability. This means that the alternative hypothesis was accepted, implying that factors influencing farmers to exchange land had significant effect on land exchange practice. The results show that number of plots significantly ($p<0.01$) increased the probability to exchange land. This means that farmers having many farms could easily agree to exchange their farms in order to optimize their production technique. Reduction of distance among plots, practice of mechanization, reduction of production cost, and improvement of efficiency, defined as dummy variables increased significantly at 10, 1, 5 and 1% level respectively, the probability to exchange land in the study area. This implies that farmers were highly aware of the benefits of land exchange. This result is more or less in conformity with Yaslioglu *et al.* (2007), who found that farmers are motivated in that general process of land consolidation in order to increase their farm size, to reduce inter-farmer conflicts, to practice mechanization and to make use of the irrigation system.

Estimates of parameters in stochastic production function and percentage distriction of technical efficiency

The maximum likelihood estimates (MLE) of the Cobb-Douglas stochastic production frontier model for rice production had the gamma values (γ) of 0.62, 0.71, 0.66 and 0.59, respectively, for DKIS, VEGFRU, NIHORT/CoH and Local authority which revealed the presence of technical inefficiency effects. Moreover, these values of gamma were significant at 1% level of probability. This implies that about 62%, 71%, 66% and 59% of variation in the output of rice farms respectively for DKIS, VEGFRU, NIHORT/CoH and Local authority were due to differences in the technical inefficiencies of the rice farmers. The coefficients of sigma square (σ^2) were all less than unity and significant at 1% level of probability except for NIHORT/CoH, that was significant at 5% level of probability. This indicates good fitness and correctness of the specified distribution assumption of the composite error term.

The frequency of distribution of the predicted technical efficiency is presented in Table 3. The mean technical efficiency for DKIS, VEGFRU, NIHORT/CoH and Local authority were 0.88, 0.94, 0.86 and 0.65 respectively. This implies that farmers were technically efficient. However, the technical efficiency of rice farmers under irrigation farming in the study area could be increase by 0.12, 0.6, 0.14 and 0.35 respectively using available resources given the current level of technology and better extension services.

Effect of land exchange and other factors on technical efficiency of rice farmers. The likelihood ratio chi-squares of 56.77 with a p-value of 0.0001, revealed the fitness of the models at 1% ($p < 0.01$) level of significance. That is to say that this model was fit significantly better than a model with no predictors. However, this was not enough to determine the model's fitness.

According to Smithson and Verkuilen (2006), the estimators in beta regression are consistent and efficient when the model is correctly specified. In fact, the model with the lowest Bayesian information criterion (BIC) values is better than the models with higher BIC values. Four links models (logit, cloglog, probit, and loglog) were estimated until the model with the lowest BIC value was obtained.

Subsequently, the coefficients on the predictors and marginal effects were recorded and interpreted. The result shows that four out of the eighteen variables were found to have a significant influence on the technical efficiency of rice farmers in the study area. These variables included household size, rent, land development, and hired labor.The household size positively influenced technical efficiency at 5% significance level ($p<0.05$). An increase in household size of 1 person, holding all other factors constant, would immediately increase the technical efficiency score value by 0.26%. Other scholars also found similar results that revealed the positive influence of household size on technical efficiency (Umeh and Ataborh, 2006; Laniyan *et al.,* 2018).

The results further showed that rented land was positive and statistically significant at 10% level of probability ($p<0.1$). This implies that technical efficiency increases when land is rented. More explicitly, the use of rented land would lead to an instantaneous increase in the technical efficiency score value by 5.7%. This means that there is no technical efficiency loss on rented plots. Using rented land forces farmers to adopt appropriate production techniques to face the high cost of land. The findings are in line with those of Feng (2008), who found that rented land increases the technical efficiency of rice farmers in rural China. Moreover, the study also found that households that rented land achieved higher technical efficiency than households that did not rent land.

The coefficient of land development was negative and statistically significant at 1% level of probability ($p<0.1$). This indicates that the farmers' perception of the state of physical infrastructure would result in low technical efficiency. That is to say that one-unit change in rice farmers' perception of the reliability of infrastructure would lead to a 6.6% decrease in technical efficiency. This result describes the negative effect of the poor physical infrastructure on the efficiency of rice farmers in the study area. In fact, the land development project that was supposed to boost the irrigation potential of farmers has not been accomplished for many years. This ongoing situation may explain the farmers' bad perception of the state of infrastructure development in the study area, which affects negatively their technical efficiency. However, the result of Adeoye *et al.* (2017) confirms the fact that technical efficiency is improved by staying in villages with good physical infrastructure.

Hired labor affects positively the technical efficiency at 5% significance level ($p<0.05$). An increase in hired labor by one person would result in an instantaneous increase in the technical efficiency score value of 1.8%. This means that hired labor contributes to resource use efficiency thanks to the high level of experience acquired by farmers and the technical support provided by the DKIS office in terms of training. The same result was also revealed by Akinbode et al. (2011). From the result, the practice of land exchange has no significant effect on technical efficiency of rice farmers in the study area.

Conclusion and Recommendations

This study analyses the practice of land exchange and its effect on technical efficiency of rice farmers in North-Eastern zone of Nigeria. The results show that farmers exchange land in the study area, since 16.07% of them have practiced it. However, the practice of land exchange is predominant in local land and is mainly done informally among farmers. Land exchange for use (or farming purpose) and exchange of property were the two approaches used by farmers to exchange land in the study area. The results also show that: number of plots, reduction of distance among plots, practice of mechanization, reduction of production cost, and improvement of efficiency are factors influencing farmers to exchange land in the study area by increasing the probability to do so. It was also concluded that farmers were technically efficient, and that efficiency could be increased given the level of technology and efficient use of available resources. Farmers under VEGFRU administration were more technically efficient than those under DKIS, followed by NIHORT/ CoH, and local authority. Household size, rented land, and hired labor have positive effects on technical efficiency, whereas farmers' perceptions of land development have a negative effect on technical efficiency. The study further concludes that the practice of land exchange does not affect the technical efficiency of rice farmers in the study area. It is therefore recommended that the Government policy should clearly state rights related to the use of lands and allow land transactions such as the sale of rights of occupancy, the transfer of leasehold rights, or rent among farmers to strengthen the land market and improve the efficient use of land.

Acknowledgment

The authors acknowledge the funding support provided by the Federal Government of Nigeria, the World Bank and the "Transforming Irrigation Management in Nigeria (TRIMING) project, under which the "Innovative Action Research on "Identification and Implementation of Land Administration and Consolidation Approaches to Development of Dadin Kowa Irrigation Project, in North-Eastern States of Nigeria" was conducted. The authors also thank the Gombe and Borno States Governments, Yamaltu/Deba and Bayo local Governments, Traditional leaders and rural farmers for the provision of the information used in the study. Any opinions, findings, and conclusions, or recommendations expressed in this study are those of the author(s) and do not necessarily reflect the views of any organization. Finally, this paper is a contribution to the 19th RUFORUM Annual General Meeting and Conference held 28th October -2nd November 2023 in Yaounde, Cameroon.

References

Adeoye, O.A., Olojede, M.O. and Rasaki, W.A. 2017. Impact of Rural Infrastructure Development Under National Fadama II Project on Agricultural Production in Oyo State, Nigeria. Retrieved from: https://journal.slideafrica.org/index.

Akinbode, S.O., Dipeolu, A.O. and Ayinde, I.A. 2011. An Examination of Technical, Allocative and Economic Efficiencies in Ofada Rice Farming in Ogun State, Nigeria. *African Journal of Agricultural Research* 6 (28):6027-6035.

Ayoola, J.B., Dzever, D.D., Abu, G.A., Biam, C.K., Ayoola, G.B. and Sani, R.M. 2022. Factors Affecting Land Fragmentation and Willingness to Exchange Land Among Rice Farmers in Gombe and Borno States: The Dadin-Kowa Irrigation Scheme Experience, Nigeria. *European Journal of Agriculture and Food Sciences* 4 (6):62-71.

Barau, A.D., Atala, T.K. and Agbor, C.I. 1999. Factors Affecting Efficiency of Resource Use under Large-Scale Irrigation Farming: A Case Study of the Dadin-Kowa irrigation Project, Bauchi State, Nigeria. *Nigerian Journal of Rural Economic and Social Studies* 1 (5):1-6.

Battese, G.E. and Coelli, T.J. 1995. A Model for Technical Inefficiency Effect in Stochastic Frontier Production for Panel Data. *Empirical Economics* 20:325-345.

Benjaminsen, T.A. and Lund, C. 2003. Securing Land Rights in Africa. *Routledge.*192 pp.

Demetriou, D. 2014. Land Fragmentation: The Development of an Integrated Planning and Decision Support System for Land Consolidation. Retrieved from https://www.researchgate.net/ publication /299679131.

Hartvigsen, M. 2015. Land Reform and Land Consolidation in Central and Eastern Europe after 1989 – Experiences and Perspectives. Ph.D. Thesis, Aalborg University.

Hassan, A., Matthew, O., Abraham, A., Matthew, A.F. and Ayeni, D. 2015. An Assessment of the Irrigation Scheme on Registered Rice Farmers of the Upper Benue Rice Basin Development Authority in Dadin Kowa, Gombe State, Nigeria. *Journal of Multidisciplinary Studies* 4 (1):1-24.

Ito, J., Nishikori, M., Toyoshi, M. and Feuer, H.N. 2016. The contribution of land exchange institutions and markets in countering farmland abandonment in Japan. *Elsevier, Land Use Policy* 57:582–593.

Knight, R.S. 2010. Statutory Recognition of Customary Land Rights in Africa: An Investigation into Best Practices for Lawmaking and Implementation. Rome; FAO.312 pp.

Laniyan, A.W.O., Ologbon, O.A.C. and Idowu, A.O. 2018. Analysis of efficiency among rice farmers in Oyo State, Nigeria. *African Journal of Science and Nature* 6:54-65.

Len, P. 2017. Methodology of prioritization of land consolidation and land exchange interventions. *Conference on Earth Environmental Sciences.* 95/032010.

NBS (National Bureau of Statistics). 2006. Population Census, Federal Republic of Nigeria. *Archived from the original Archived July 4, 2007.*

Noel, B.B. and Omar, A.H. 2020. Farmers' perception on the effect of rainfall variability on rice yield in Dadin-Kowa of Gombe, Gombe State. *International Journal of Archaeology* 8 (2):15-21.https://doi.org/10.11648/ j.ija.20200802.12

NPC (National Population Commission). 2018. Nigeria's Population. Retrieved from: http://population.gov.ng/nigerias-population-hit-198m-people-npopc-chairman/

Sani, M., Ayoola, J.B., Umeh, J.C., Asogwa, B.C., Ayoola, G.B., Abu, G.A. and Sani, R.M. 2023. Technical Efficiency of Rice Farmers Under Public and Private Land Administration in Dadinkowa Irrigation Scheme Area of Gombe and Borno States, Nigeria. *European Journal of Agriculture and Food Sciences* 5 (1):32-29. http://dx.doi.org/10.24018/ ejfood.2023.5.1.523

Smithson, M. and Verkuilen, J. 2006. A better Lemon Squeezer? Maximum-likelihood Regression with Beta-Distributed Dependent Variables. *Psychological Methods* 11:54–71.

Tijjani, A. and Bakari, U.M. 2013. Determinants of allocative efficiency of rain-fed rice production in Taraba State, Nigeria. *European Scientific Journal* 10 (33):1857-7881.

Umeh, J. C. and Ataborh, E. M. 2007. Efficiency of rice farmers in Nigeria: potentials for food security and poverty alleviation. In: *Proceedings of 16th International Farm Management Congress* 613-625 pp.

Yamani, T. 1973. Statistics: An Introduction Analysis. *Harper and Row* 3:43.

Yaslioglu, E., Aslan, S.T., Gundogdu, K.S., Kirmikil, M. and Arici, I. 2007. Personal, physical and socioeconomic factors affecting farmers. *Spanish Journal of Agricultural Research* 5 (2):204-213.

Yimer, F.A. 2014. Fit-for-Purpose Land Consolidation: An Innovative Tool for Re-allotment in Rural Ethiopia. M.Sc. thesis. Faculty of Geo-Information Sciences and Earth Observation, University of Twente. Enschede, The Netherlands. 79pp.