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SDG 2 – ending hunger: the effect of Nigeria's land titling on production output and food security of farming households

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Achieving zero hunger is intricately linked to sustainable agricultural production and the workings of a farming system. With land being the most important resource in smallholder agriculture in developing countries; including Nigeria; the effect of legal land ownership is a *sine qua non* for the process of achieving zero hunger in Nigeria. This study examined Nigeria's attempt at making agricultural land both accessible and utilizable for smallholders in Nigeria through the Presidential Technical Steering Committee on Land Reforms in 2009. The aim was to explore the extent to which land ownership had become legalized; so that it had positive investment incentives for smallholder farmers to improve their investment portfolio on their holdings. A secondary dataset of 4,032 respondents obtained from the Living Standard Survey Integrated Survey on Agriculture (LSMS/ISA) of the 2018/2019 season, was used for the study. Data analysis included descriptive statistics and a 2-stage least square model. The apriori being that legal land ownership provided a perception of security that would enhance farm-level investment; which would therefore increase production output and hence food security. The findings revealed that although land titling was low (~12%) within the agricultural system; its return on production output was highly significant (5.3; $p < 0.05$). The possession of land title would also increase *per capita* food consumption expenditure (0.35; $p < 0.05$) among the farming households. On average, households with access to land titles had a significantly higher (at $p < 0.01$) food expenditure (N9, 868.00) than those without land titles (N6171.72). Other farm-level investment variables such as credit use, and mechanization through tractor use were significant in improving food security amidst the security presented by possession of land title. Thus, expediting the implementation and coverage of formal land registration and titling may be a first step to contributing meaningfully to the food security drive of the SDGs in Nigeria.

KEYWORDS

SDG, land titling, production output, food security, farming households

1 Introduction

1.1 Background

Food security and sustainable agriculture are major focal areas in the Sustainable Development Goals (UN, 2018). Food security describes a situation where all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Matemilola and

Alabi, 2020). This is in line with achieving zero hunger which is the second of the sustainable development goals (SDGs). Zero hunger goal aims to end hunger, achieve food security and improved nutrition, as well as promote sustainable agriculture and food systems; coupled with resilient agricultural practices (Blesh et al., 2019). Thus, ending hunger is indeed associated with increasing agricultural production outputs which is the starting point for enhancing food security; following which other components of accessibility, utilization, and then the stability of access is required (Ayinde et al., 2020; Otegunrin et al., 2020).

However, Nigeria ranked 107th out of 113 countries and 25th out of 28 sub-Saharan Africa (SSA) countries with a GFSI score of 42/100 in the GFSI 2022 (Otegunrin et al., 2023). Also, in the 2022 Global Hunger Index (GHI), Nigeria ranked 103rd out of 121 countries, scoring 27.3/100. The need for agricultural transformation to drive food and nutrition security has led to calls for greater investment in agricultural systems through technological innovations such as land improvement, improved seed, enhanced biotechnology, etc. Increased agricultural investment will however largely depend on an incentive to invest; that is, the perception of potential returns to the stakeholders involved. Thus, at the production level, farmers will invest in their farm holdings if the prospect of such an investment is guaranteed to produce sustained returns. These positive investment incentives within agricultural systems have been shown to rely heavily on the right to own and use land (Lawry et al., 2014; Bambio and Agha, 2018; Zhou et al., 2022).

Land remains a veritable factor of development in the agricultural sector and central to the challenge of improving food security the world over (Viana et al., 2022). The majority of the Sustainable Development Goals are premised on the sustainable ownership and use of land. In traditional Nigerian society, land is an asset, a major production input, and the source of material wealth for the majority of smallholders (Udoekanem et al., 2014; Obayelu et al., 2017). Thus, smallholders with their fragmented land areas have been the bedrock of domestic food production in Nigeria (Iheke and Amaechi, 2015). Albeit land rights have been a major constraint to smallholder transformation and productivity improvement over the years. The continued competition of agricultural land use with urbanization, population growth, and industrialization has further increased the land constraint within the Nigerian agricultural system. Therefore, land availability and rights are integral to transforming the Nigerian food system in its bid to achieve food security as with other developing countries (Narh et al., 2016). With up to 85% of the rural population depending on agriculture for their livelihood (Oluwatayo et al., 2019); the agrarian nature of rural Nigeria has been established. Unfortunately, land access and right to use are limited as a communal land allocation system with poor documentation is still much prevalent (Twene, 2016). Informally, families and community heads still manage to hold land rights, thereby determining land access.

Extant literature has established that land titling is critical to the sustainable development of Sub-Saharan African countries (Borras and Franco, 2010; Bennett and Alemie, 2016). Particularly, the availability and regulation of land are key to the productivity and food security of farming households in Nigeria, given the level of agricultural development (Odoemelam et al., 2013). This is because farming operations will remain subsistent with inadequate access to land. As of a 2016 study by Hull et al. an estimated 95% of agricultural lands in Nigeria are not titled. This expectedly undermines the capacity of farmers to present lands as

collateral to access formal loans from financial institutions (Grafton et al., 2015). Further, the lack of absolute or non-derivative property rights constrains the ability of farming households to invest at the farm level such as to plant cash crops, consequently limiting their income generation potential (Odoemelam et al., 2013; Oluwatayo et al., 2019). Also, Reddy et al. (2020) in a similar study found that respondents without formal land rights remain largely unable to benefit from government support and were unable to access credit and farm extension services from private institutions. Therefore, attaining adequate agricultural production and food security is difficult as the population continues to grow and agricultural land becomes scarce, fragmented, and illegally held [Federal Ministry of Agriculture & Rural Development (FMARD), 2016].

The Land Use Act of the 1979 constitution (Federal Republic of Nigeria, 1978) formerly known as the Land Use Decree of 1978, governs land ownership and rights in Nigeria. This act particularly conferred all land in each state of the Federation to the Governor of that state, who is to hold such land in trust for the people and is to administer the land for the use and common benefit of all Nigerians. Further, the Act provides that all land in all urban areas in a State be under the control and management of the State Governor, while all other lands in other areas (rural) be controlled and managed by the local government. The law made provisions for granting two types of land use rights (statutory and customary rights of occupancy) to all categories of land users in Nigeria (Federal Republic of Nigeria, 1978). The statutory right of occupancy gives the bearer a right over the use of land in any area of a state, rural or urban, and it is granted under the State Governor, as provided by the law. The customary right of occupancy, on the other hand, is granted under the Act by the local government and refers to the right of a person or community to lawfully use or occupy land by customary law (Federal Republic of Nigeria, 1978).

However, given the stipulation of the Nigerian Land Use Decree of 1978 that all land belongs to the government which holds the same trust for the public, the beneficiaries of the communal land allocation system are not formally recognized as the legal land right holders (Alarima et al., 2012). The government, therefore, has the sole right to allocate land to individuals and corporate entities based on the objectives of the interested parties (Oloyede et al., 2014). This lacuna created an avenue for more educated land speculators and developers to obtain large portions of hitherto agricultural land for other uses. This led to the 2009 initiation of a Presidential Technical Steering Committee on Land Reforms; which was saddled with the responsibility of cadastral mapping of all lands in Nigeria; and subsequent easing of land registration especially in rural areas for agricultural development (Oluwadare and Kufoniyi, 2019). Two pilot states (Ondo and Kano) were selected to test run the implementation of the Systematic Land Titling and Registration process in 2012 (Olusola, 2013); and the subsequent implementation across other states to follow. Empirical evidence of the implementation of this policy statement and the effect on the Nigerian agricultural system is the thrust of this study.

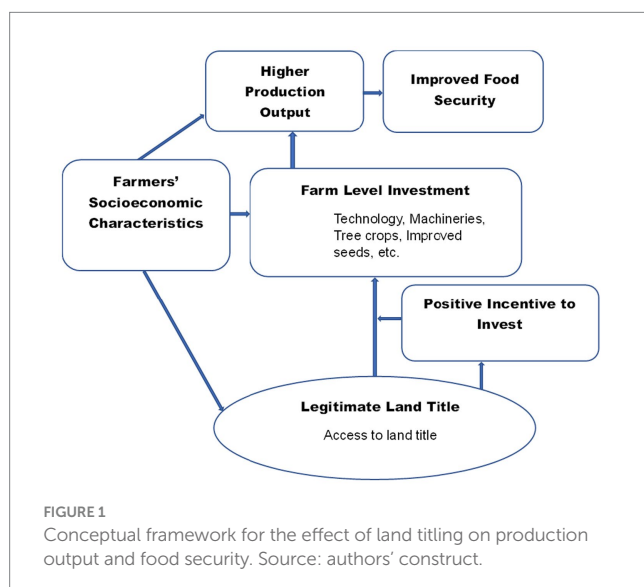
1.2 Theory of change

The study adopted the Theory of Change to explain how land titling affects the production output and food security of farming households in Nigeria. Ownership of legitimate land titles can

improve the production outputs and the food security status of Nigerian farming households through the pathway considered in this study as shown in Figure 1. It was posited that the relationship between the possession of land title and agricultural output and food security is not strictly linear, but interacts across observable and unobservable characteristics within the farming system. Agricultural investment is a mediating factor through which land titles can translate to increased output as well as improved food security for agrarian families. This mediator is thought to be the driving force through which farmers are able to take up technology, and other sustainable farming practices (Pedersen et al., 2012; Benjamin, 2020).

Legal land title creates a perception of security of farm holdings, which serves as a positive incentive for farmers to scale up their production activities by engaging in more intensive or long-term agricultural capital investments. This further results in an increased likelihood of sustained returns on any investment made on such a holding (Ebe et al., 2018). Agricultural investment could be in terms of adoption of new technologies, use of machinery, planting trees or cash crops, etc. It is critical for reducing hunger and poverty, as well as improving food security. According to Nilsson (2019), investing in improved production activities through land consolidation, while enabling rights to land, was found to significantly increase agricultural production in Rwanda. Also, the effect of technology (as an investment) is able to move the frontier of farming households forward, leading to positive outcomes (Pawlak and Kołodziejczak, 2020), such as by changing land use decisions (Hettig et al., 2016) or stimulating commercialisation (Awotide et al., 2016). This tends to move forward the production frontier, leading to higher farm income, which in turn enhances the households' food security status. The interaction between land titling and the sociodemographic features of the farming households is able to make such a possibility even in small holdings; hence the position of the empirical investigation in this study.

This study was thus an attempt to examine the extent to which land titling and registration had become entrenched among farmers in the Nigerian agricultural system. Thereafter, we estimated the effects of land titling on the production output of farming households on the one hand; and their food security status on the other hand.



2 Methodology

2.1 Scope of the study

The study made use of secondary data obtained from the National Bureau of Statistics/World Bank General Household Survey (GHS). A sample of 4,032 respondents obtained from the 2018/2019 agricultural season data of the Living Standard Survey Integrated Survey on Agriculture (LSMS/ISA) was specifically used for the study. Information was obtained as regards Land use and rights; Agricultural investment types; production output and food expenditure and the socioeconomic characteristics of crop farming households in the dataset.

2.2 Empirical techniques

The analytical techniques used were descriptive statistics and a 2 stage least square model. Percentage distribution and appropriate charts were used to describe the land right profile of the sampled households as well as compare socioeconomic and farm-level characteristics with respect to the possession of a legal land right. The econometric analysis was based on the use of Instrumental Variable Two Stage Least Square (IV-2SLS) to account for inherent endogeneity in the empirical analysis.

2.2.1 Two-stage least square model

The implicit model in this study is based on the following hypotheses:

H_0 : value of output is not influenced by access to a legal land title

H_0 : Per capita food expenditure is not influenced by access to a legal land title

So that:

$$Y = B_0 + B_1LT_i + B_2X_i + \mu_i \quad (1)$$

Where Y is (1) Output;(2) Food security; LT is access to land title and X represents vectors of other independent variables including, age, gender, household size, yield, land size, literacy, residence (urban/rural), credit access, tractor use, and irrigation.

In this study, the dependent variable of "Access to land title" is necessarily endogenous within a farming system (Tămășilă et al., 2018; Noack and Larsen, 2019) and jointly determined with the outcome variables. This possibility arises due to unobservable factors that affect both the outcome variables (Output and food security) and the main predictor variable (legal land title). Its inclusion in the model estimating its effect on production output and food security must consider this potential endogeneity. Solving this requires a series of simultaneous equations, with the need to account for endogeneity within the structural models; one of which involves the 2SLS regression model.

The 2SLS aims to account for the situation where the dependent variable has error terms that are correlated with the independent variable (Sheikhi et al., 2022). In the two-stage least squares (2SLS) methodology, the dependent variable is included

as a function of instrumental variables (s) in the first equation in the simultaneous model. The predicted value of the endogenous predictor variable is now inputted into the hypothesized model. This predicted variable is said to be free of endogeneity; and thus, the resulting estimation is unbiased. Thus, in general, a 2SLS includes four types of variable(s): dependent, exogenous, endogenous, and instrument.

In the first hypothesis, the first stage of the estimation, uses instrumental variable(s) to generate a predicted value of the endogenous predictor variable (Land title- LT) – Equation 2.

$$LT_i = \hat{\alpha}_i + \hat{\alpha}_2 Z_i + \hat{\alpha}_3 X_i \quad (2)$$

Where “ Z ” is the instrument(s).

Predicted value of the estimated in (2) thus become usable in the next estimation,

$$Y = B_0 + B_1 \widehat{LT}_i + B_2 X_i + \mu_i \quad (3)$$

Where \widehat{LT} : Land Title (1 = Yes; 0 = No); predicted value from Eq. 2.

In the second model, with food security as the dependent variable, land title remains an endogenous variable. However, with farming households, output represents both a physical source of food security as well as a means of generating income for food purchases. Within the farming system, we assume that output will therefore also be an endogenous variable. The application of the 2SLS therefore also applies, so that in addition to predicting Eq. 2 for Land title, an additional endogenous variable for Output (Y) is included (Eq. 4).

$$Y_i = \omega_i + \omega_2 Z_i + \omega_3 X_i \quad (4)$$

And the full equation is therefore:

$$FS_i = \beta_0 + \beta_1 \widehat{LT}_i + \beta_2 \widehat{Y}_i + \beta_3 X_i + \mu_i \quad (5)$$

The evidence to support the need for a 2SLS was interrogated using the Hausman test for model specification. The models were further subjected to confirming the fit by testing the hypothesis of (i) Exogeneity of the primary dependent variable using the Durbin–Wu–Hausman test, (ii) strength of the instruments and (iii) over-identification, using the Sargan test (See results in [Appendix](#)).

2.2.2 Test for model specification

The assumption of a 2SLS was to provide a possibility of correcting for endogeneity bias within the estimated models. In order to test that the use of the 2SLS was indeed required, a Hausman specification test was conducted. In the Hausman specification, a consistent parameter (b) is compared with an efficient, but inconsistent parameter (B). The Null hypothesis being that there is no systematic difference between “ b ” and “ B .” A probability value <0.05 is indicative of accepting the null hypothesis of the efficient parameter. In this study, the choice between a 2SLS (b) and an OLS regression (B), was examined from the Hausman specification view. The results are in the [Appendix 2 and 3](#).

2.3 Description of variables

The variables in the estimation process are as presented in [Table 1](#). The outcome variables are Value of production output and *per capita* food expenditure for production output and food security, respectively. The use of the value of production output rather than the quantity produced was intuitive. The valuation of production output suggests that there may have been some form of commercialization of harvested output; and since, farming households do not rely on their own production mainly for food needs; expected income may also drive food expenditure profiles. Thus, consumption expenditure is expected to be driven largely by the extent to which farming households have received value for their production activities. Literature has shown that higher-valued farming outputs return higher incomes to farming households with the possibility of improved food security outcomes ([Pawlak and Kołodziejczak, 2020](#)).

The use of food expenditure to proxy for food security is a means of ensuring that the food security measured is the actual experience of the farming household. The 2018 LSMS/ISA data requested for food expenditure in a 7-day recall period for each household. This study thus followed the reasoning of [Nicholson et al. \(2021\)](#), in which experiential measures of food security, such as using actual food expenditure a better metric than other subjective measures such as food availability, food access, coping strategy index, nutrient content of food, self-assessment of food scarcity, expected future food consumption, self-reported food shortages, vegetable consumption per person, length of hunger periods, etc.

Possession of land title was the main predictor variable in this study. The hypothesis is that access to land titles will stimulate production; as well as food security among farming households. However, it has been observed that the possession of land title alone does not have the capacity to increase production output ([Aikins et al., 2021](#)). Rather, the effect is largely on the possibility of providing a form of positive investment incentive, for which farmers have a perception of security of farmland investment ([Ebe et al., 2018](#)). On the basis of this, the analysis was carried out only for farmers who had positive land use within the production season. The variables related to farm-level investment included irrigation, tractor use, and credit use within the planting season of 2018.

The attainment of improved production output and food security is multifaceted; and linked to various socioeconomic, natural, and political factors. These include gender, education, availability of infrastructure, availability of credit facilities, government policies, and agricultural land area under cultivation, among others ([Haddabi et al., 2019](#)). Thus, for example, land titles can reduce the limitations on access to formal credit by providing collateral to credit-demanding farmers. Indeed, even when farmers do not need collateral to have effective access to formal or informal credit, the availability of a land title can improve the conditions of the loan, which may include reductions in accompanying interest rates ([García Hombrados et al., 2015](#)). The interplay of these factors is believed to influence livelihood outcomes in agricultural systems; which this study investigated.

TABLE 1 Definition of variables in the analytical models.

Variable	Value
Exogenous variables	
Age	Years
Sex of household heads	Male = 1; Female = 0
Household size	Number
Sector of residence	Urban = 1; Rural = 0
Marital Status	Married = 1; Non-Married = 0
Land size	Hectares
Access to credit	Yes = 1; No = 0
Irrigation	Yes = 1; No = 0
Tractor use	Yes = 1, No = 0
Accessed credit	Yes = 1, No = 0
Outcome variables	
Production output	Value of harvested output (Log)
Food security	Per capita food expenditure (Log) in a 7-day recall
Endogenous variable	
Access to land title	Yes = 1; No = 0
Yield (Log)	Output per hectare
Instruments	
Geopolitical zone	North Central = 1, Northeast = 2, Northwest = 3, Southeast = 4, South South = 5, Southwest = 6
Possess non legal land titles	Yes = 1, No = 0

3 Results and discussion

3.1 Access to land titles and types in the Nigerian farming system

Access to title is still low within the Nigerian agricultural system, with only 11.8% of farming households possessing some form of legal land title (See Figure 2). The registered title deed was the most frequent kind of legal land title held by farming households (29%), followed by the customary certificate of occupancy and right of occupation (24%). Only 22% of individuals with land titles reported having a certificate of occupancy (C of O). Although, the more permanent Certificate of occupancy still has lower representativeness; there may be some traction to increasing formal registration through the efforts of the Presidential Steering Committee on Land Titling and Registration.

In Nigeria, the highest form of land title is a Certificate of Occupancy, which is normally issued to an occupier as evidence of having been granted a statutory right of occupancy on the land by the State Governor. A vital requirement for the issuance of a Certificate of Occupancy in most states of the country is the evidence of having duly acquired the land from the landowners who are usually the indigenous people or local communities. However, most land rights enjoyed on agricultural lands in Nigeria are defined, acquired, and/or transferred, under the customary rights of occupancy, governed by the largely

undocumented customary laws in various localities (Shittu et al., 2018). This further suggests that despite the vast body of knowledge on land titling, property rights on agricultural lands in Nigeria are still mostly informally defined and prone to unfair expropriation, given the overriding powers of the State Governor and local governments, coupled with the lack of methods and institutions for executing this tenure reform (Shittu et al., 2018; Lengoiboni et al., 2019).

3.2 Description of farming households land titling frame in Nigeria

The description of the households' socioeconomic characteristics (land right owners and non-owners) is presented in Table 2. The results revealed that a greater percentage (81.5%) of the respondents were male with only 18.5% female. The disaggregation by ownership of land title showed the same pattern with owners and non-owners having 89.7 and 80.3% male composition, respectively. This follows previous studies that found that Nigerian agriculture is male dominated (Bello et al., 2021). The average age of heads of farming households was 50.56 ± 15.28 years; with most (63.9%) of the respondents across the two categories being between 36 and 65 years old. This suggests that a greater proportion of the sampled population was still in their active and productive years.

The results further revealed that the mean household size for land title owners was 7 members while it was 6 for non-owners. The majority (87.5%) of the sampled households had between 1 and 10 members. This result is in line with Munene (2003) and National Bureau of Statistics (2019) which indicated that households in agrarian areas are usually large. In terms of education, we used literacy instead of focusing on formal education. The premise is that the Nigerian agricultural system thrives more on literacy related to the framing operation rather than more formal classroom training. In this case, over 60% of the farming household heads had some form of literacy. Majority of those who has possession of land title were also found to be literate (89%).

Adequate access to credit and extension services is critical to improving the performance, technology adoption, and productivity of actors in the agricultural sector (Mgbenka et al., 2016; Ojo and Ayanwale 2019; Chandio et al., 2020). However, the study showed that a huge proportion (84.4%) of all sampled farming households did not access financial credit facilities. Similarly, only 2.4% of all the households, comprising 2.5 of land title owners and 2.3% of non-owners had access to extension services. This may constitute a disincentive to the acquisition of land titles among the farming population.

It is also interesting to note from the study that the average farm size (hectares) cultivated by the households were 0.83 ± 1.2 and 0.62 ± 1.3 for the owners and non-owners' groups, respectively, and 99.4% of all the households across both groups cultivated less than 5 hectares of land. There was a large degree or skewedness of farm size in this study, which may be related to the influx of medium scale farm entrepreneur with larger farm size than existing farmers (Omotilewa et al., 2021). In general, however, most of the farmers can be categorized as smallholders due to the size of the land cultivated. This agrees with the findings of Anderson et al. (2017) who stated that more than 80%

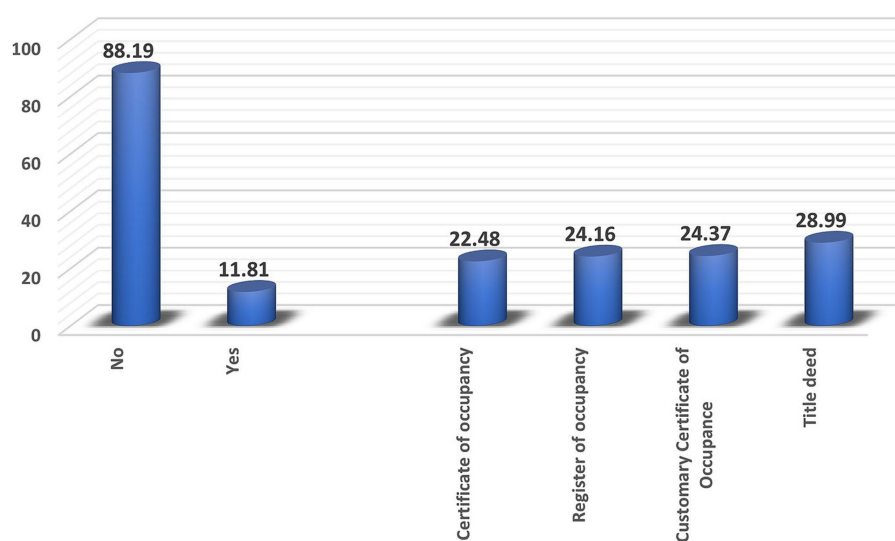


FIGURE 2
Profile of land title access and typology in Nigerian agricultural system.

of farmers in Nigeria are considered smallholders because they own and cultivate less than 5 hectares of land.

3.3 Effect of land titling on production output

The aim of land titling is to ensure that the farmers are sufficiently confident enough to invest and/or make production plans on their plots. Thus, land title on its own does not lead to an increase in output; rather, through Farm level investment. The interaction of possession of a land title with the array of agricultural investment is expected to be the driver of productivity on the farm. On the narrative structure, there was no significant difference in the physical production output of farming households with or without land titles in Nigeria. This may not be surprising, as extant, farm holding in Nigeria as with many developing agricultural based economies falls within the 0.5-5 ha. The drive to secure land holding may therefore not necessarily lead to an increase in area cultivated. Moreover, recent findings have shown that increases in land holdings in Nigeria has been the result of medium scale farmers coming into the agricultural system, rather than expansion of land by already established actors (Omotilewa et al., 2021). However, it is expected that more secure land holding may reduce land fragmentation; with the opportunity to promote more efficient use of farm holding and technological innovations for better outcomes (Oyebanjo, 2023).

The estimated effects of land titles on the production output of crop farmers in Nigeria was based on a 2 stage least square estimation (2SLS) procedure. The premise for a 2SLS estimation was the understanding that “access to land title” was necessarily endogenously determined within the same farming system in which production output is determined. Thus, an OLS regression would have produced biased estimates, which would be inappropriate for policy purposes. The results of the 2SLS estimations are presented in Table 3.

Possession of legal land title, being male, tractor use, and yield were found to have increased the value of production output.

From the result, access to land title would increase the value of production output of crop farmers in Nigeria by over 500% ($p < 0.001$). This has been suggested by the theory of positive incentive for investment by Lawry et al. (2014). The fact that access to land title increases the perception of security of farm holding, and thus an increased likelihood of sustained returns on any investment made on such a holding (Ebe et al., 2018). However, Brasselle et al. (2002) in their study in Burkina Faso found that there were more complex societal dynamics that allowed such investments to become profitable.

From the foregoing, the model included two proxies to represent agricultural investment among the farmers. The finding suggests that indeed investment would drive production output in view of secure land holdings (Syed and Miyazako, 2013). The coefficient of “tractor use” as an agricultural investment would increase the value of production output by about 56% ($p < 0.001$).

The coefficients of land size indicates that a unit increase in land cultivated would increase production output by up to 30% ($p < 0.05$). The argument on land size and productivity has garnered evidence to suggest on the one side the efficiency of small holder farmers above larger farmers (Julien et al., 2019). Recent evidence is however supportive of land expansion with appropriate technological investment as prerequisite for farm system productivity in Africa (Muyanga and Jayne, 2019). In a recent study in Nigeria, Omotilewa et al. (2021), showed that higher productivity of small size could be confirmed without the confounding of medium farms in the model. However, the inclusion of medium farms, up to 40 ha showed higher productivity in terms of both output and value of output due to the presence of heterogeneity introduced by the characteristics of medium scale farmers in the pool. Our study thus confirms that there may indeed be heterogeneity in the farming system, with differential land size and productivity mix in Nigeria. The positive relationship of yield to value of output is intuitive; as the productivity of the farm holding is the requirement to get value for the valued output. In this

TABLE 2 Households' socioeconomic attributes by ownership of land titles.

Variables	Land titles		Total Freq. (%)
	No Freq. (%)	Yes Freq. (%)	
Age in years			
17–35	676 (19.0)	84 (17.7)	760 (18.9)
36–65	2,267 (63.8)	308 (64.7)	2,575 (63.9)
>65	613 (17.2)	84 (17.7)	697 (17.3)
Mean ± std. dev.	50.5 ± 15.35 years	51.04 ± 14.73 years	50.56 ± 15.28 years
Gender			
Female	699 (19.7)	49 (10.3)	748 (18.6)
Male	2,857 (80.3)	427 (89.7)	3,284 (81.5)
Marital Status			
Married	2,667 (75.0)	404 (84.9)	3,071 (76.2)
Single	135 (3.8)	12 (2.5)	147 (3.7)
Divorced	31 (0.9)	7 (1.5)	38 (0.9)
Separated	69 (1.9)	11 (2.3)	80 (2.0)
Widowed	654 (18.4)	42 (8.8)	696 (17.3)
Household size			
1–10	3,133 (88.1)	394 (82.8)	3,527 (87.5)
11–20	408 (11.5)	80 (16.8)	488 (12.1)
>20	15 (0.4)	2 (0.4)	17 (0.4)
Mean ± std. dev.	6.39 ± 3.66	6.95 ± 3.93	6.46 ± 3.70
Literacy			
Yes	2,401 (67.52)	396 (83.19)	2,797 (69.37)
No	1,155 (32.48)	80 (16.81)	1,235 (30.63)
Credit access			
Yes	543 (15.3)	86 (18.1)	629 (15.6)
No	3,013 (84.7)	390 (81.9)	3,403 (84.4)
Extension access			
Yes	79 (2.3)	9 (2.5)	88 (2.4)
No	3,291 (97.7)	348 (97.5)	3,639 (97.6)
Land size			
<5 ha	3,539 (99.5)	472 (99.2)	4,011 (99.5)
5–9 ha	14 (0.4)	4 (0.8)	18 (0.5)
10–19 ha	2 (0.1)	0 (0)	2 (0.1)
>20 ha	1 (0.03)	0 (0)	1 (0.02)
Mean ± std. dev.	0.62 ± 1.32 ha	0.83 ± 1.17 ha	0.64 ± 1.31 ha
Sector			
Urban	691 (19.4)	199 (41.8)	890 (22.1)
Rural	2,865 (80.6)	277 (58.2)	3,142 (77.9)

study, the yield was estimated as the “expected” output from the cultivated area; and thus, a factor of production output.

Larger household size continues to drive agricultural systems in Nigeria; especially as regards the provision of labor and management.

The coefficient of household size indicates that an extra family member on the farming system would increase the value of output by up to 1.8% ($p < 0.01$).

The coefficients of age, and literacy were negatively related to the value of production output among the farming households. The effect of age is intuitively implied as the fact that older farmers are less likely without additional technology or human support to produce as efficiently as younger farmers. However, with age and hence experience, there may be adequate production output as a result of existing investment outlays on the farm holdings. This is implied in the positive, albeit not significant coefficient of the age ² in the model.

3.4 Nexus of land title and food security

Does possession of a land title mean that a farming household would become food secure? Findings from this study showed that on average, households with access to land titles had a significantly higher (at $p < 0.01$) food expenditure (N9, 868.00) than those without land title (N6171.72).

The effect of possession of land title on food security was first estimated with the 2SLS model, using instruments to control the endogeneity in the land title variable, as with that of production output (Table 4). In this model, the effect of land title on food security was significant at 5%, indicating that food security among farm households increases with the possession of land titles. This was a slight deviation from the study of Kehinde et al. (2021); who also found a positive, but not significant effect of access to land title on the food security status of farming households in Nigeria; using data from the Household Food Experience Scale. Other studies have also found a positive relationship between possession of a land title and livelihood outcomes such as food security (Charoenratana and Shinohara, 2018).

Having a land title would increase household food security by approximately 36% ($p < 0.05$). This is probably due to the fact that land titles serve as incentives for increased investment in improved input, better production techniques, and mechanization, which will increase the productivity and income of farming households, thereby resulting in improved food security. In agreement to this, Akudugu (2011) and Mekureyaw (2017) argue that the ownership of land rights may increase land-related investments and hence increase agricultural productivity. Additionally, Kehinde et al. (2021) noted that the possession of land rights tends to reduce land disputes, facilitate land use as collateral for credit access, and stimulate investment in land improvement for increased productivity, income, and food security.

As expected, a percentage unit increase in the farm yield of the household would increase food security by 29.4% ($p < 0.001$). This suggests that given secured land rights, increased yield has the potential to increase food security because more food would be available for household consumption (Ogunniyi et al., 2021). Also, more income to purchase other food varieties that are not cultivated by the households would be made from the marketable surplus. This agrees with the discoveries of Grafton et al. (2015) and Mueller and Binder (2015).

It has been established that the metrics driving improved livelihood outcomes as a result of possession of land title is investment. In this study, the use of tractors, irrigation and credit were the proxies for farm level investment. The results showed

TABLE 3 2SLS estimation of effects of land title on production output.

Real value of output	Coefficient	Robust std. errs.	z	P>z
Legal land title	5.228***	0.977	5.350	0.000
Irrigate	0.014	0.271	0.050	0.959
Tractor	0.555***	0.162	3.430	0.001
Age	-0.044*	0.026	-1.720	0.086
Age2	0.219	0.156	1.400	0.161
Gender	0.424***	0.159	2.660	0.008
Household size	0.018	0.014	1.320	0.188
Literate	-0.322***	0.103	-3.110	0.002
Land size	0.305**	0.135	2.260	0.024
Yield (log)	0.537***	0.050	10.650	0.000
Constant	4.501	1.107	4.070	0.000
Wald Chi2	278.55***			
Instruments	Geopolitical zones (ref: North Central), Marital status			

***p < 0.01, **p < 0.05, *p < 0.1.

TABLE 4 Estimates of determinant of food security in view of access to land titles.

Per capita food expenditure	Coef.	St.Err.	t-value	Value of p
Legal land title	0.359**	0.182	1.97	0.049
Yield	0.294***	0.06	4.88	0
Age	0.08	0.002	-0.13	0.9
gender	-0.237***	0.089	-2.68	0.007
Household size	-0.091***	0.007	-13.17	0
Land size (ha)	0.121***	0.026	4.65	0
Literacy	0.313***	0.056	5.56	0
Sector of residence (ref:Rural)	0.252***	0.086	2.93	0.003
Credit	0.411***	0.075	5.50	0
Irrigate	0.088	0.148	0.60	0.551
Tractor	0.291***	0.079	3.70	0
Constant	4.723***	0.42	11.25	0
Wald chi ²	335.00***			
Instruments	Geopolitical zone (ref: North Central) Types of Non-Legal land title			

***p < 0.01, **p < 0.05, *p < 0.1.

that access to credit would influence household food security significantly ($p < 0.01$). The coefficient revealed that food security increased by 41% with a unit increase in credit access. Formal credit access can be facilitated with the use of land title as collateral. The credit obtained could be invested in the expansion

of farm holdings and adoption of modern agricultural technologies, hence increasing farming households' productivity and food security (Balana and Oyeyemi, 2022; Salima et al., 2023). The importance of technology use in agricultural system was further supported in this finding, with a percentage unit increase in the use of tractors on the farm leading to an 8.8% ($p < 0.001$) increase in *per capita* food expenditure. This is likely to be because land titling gives farmers more confidence to invest in farm mechanization. Tractor use enhances the farm power available to farming households and expectedly increases their production scale, crop diversity, productivity, and income, which consequently improve their food security status (Kansanga et al., 2018).

The model returned findings that have begun to challenge the status quo of male headed households' role in food security of their members, with the coefficient of the gender being negative (24%; $p < 0.05$) for being in a male headed household. This suggests that being in a female-headed household would improve food security (Doss et al., 2014). Recent literatures are supporting the role of women in driving food security. In the study of Egah et al. (2023); with increased output and income, women-headed farming households are more likely to be food-secured than men-headed households. This could be further enhanced by their ownership of land titles. Usually, women tend to prioritize spending on household food consumption compared to men and their preferences are more orientated toward ensuring greater dietary outcomes in the household (Argaw et al., 2021; Cornish et al., 2021).

Household size also had a negatively significant connection with food security. An additional member would reduce the food security status of the household by 9% ($p < 0.001$), implying that households with fewer members tend to be more food secure. The intuition behind this is that a large family size reduces the *per capita* food allocation within the households; with the probability of experiencing higher incidences of food insecurity (Drammeh et al., 2019). This is in contrast with the findings of Ogundari (2017) who found that the probability of a household attaining food security increases significantly and consistently with household size.

The coefficient of land size was positive and significantly related to food security at 1%. Thus, a hectare increase in the size of land cultivated by the farming households will improve their food security status by 12% ($p < 0.01$). Land size expansion may be a major pathway to increase production and hence food security outcomes for many smallholder farmers in Nigeria (Okpokiri et al., 2017).

Literacy and area of residence also had a positive influence on food security among the households at 1% level of significance. The coefficient of the household head's literacy indicates a significant increase in food security by 31.3% ($p < 0.01$) in households with literate heads. Literacy refers to the basic capacities to read and write that could be achieved through education, which has an important role in food security. Education improves farmers' capacity to diversify assets and enterprises, acquire land rights, adopt improved techniques and inputs, increase productivity and income, foster resilience, access information, and strengthen participation, which are all essential in achieving food security (De Muro and Burchi, 2007; Kusiluka

and Chiwambo, 2018; Oluwatayo et al., 2019). This finding is corroborated by Kehinde et al. (2021) who noted that household food insecurity reduces with an increase in the household head's years of education. The signs and significance with respect to urban residence may be more closely linked to the fact that urban residence rely mainly on food purchases, with minimal own production than rural households. However, the diversity of food supply in the urban and peri urban areas are factors that bring to bear on access to food.

In each model, the Hausman specification tests carried out confirm the instructiveness of using 2SLS to provide the estimation results. Further tests also support the fact that the variable of Lant title; and Yield were endogenous within the system; and thus, the support for a 2SLS Instrumental variable regression (See [Appendices](#)).

4 Conclusion and policy recommendation

This study examined the effect of possession of legal land title on the activities of output growth and food security In Nigeria. The possibility of endogeneity bias informed the use of the 2 stage least square regression model. The fit of the 2SLS model was supported by relevant tests of hypotheses. The finding revealed that despite its low spread within the Nigerian agricultural system, land titling has a highly significant positive effect on production output and food security.

Hence, the study concluded that the possession of land titles would increase the production output and *per capita* food consumption expenditure of smallholder households. Other farm-level investment variables such as credit use, and mechanization through tractor use were significant in improving food security amidst the security presented by possession of land title.

It was therefore recommended that increasing the coverage area and implementation of formal land registration and titling, which will in turn, provide a positive incentive to invest, may be a major step to contributing meaningfully to the food security drive of the sustainable development goals in Nigeria. Moreover, provision of opportunity for mechanization is important in enhancing farm level intensification and hence productivity growth in the Nigerian farming system. Also important is the need to ensure the provision of adequate and affordable credit facilities to finance agricultural investments through technology use that would translate to improved productivity.

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Data availability statement

The data presented in the study are deposited in the World Bank Microdata website: <https://microdata.worldbank.org/index.php/catalog/3557>. DOI: <https://doi.org/10.48529/1hgw-dq47>. REF. ID: NGA_2018_GHSP-W4_v03_M.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2023.1290576/full#supplementary-material>

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