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Impact of land access and ownership on farm production
Empirical evidence from gender analysis in Southwestern Nigeria

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ABSTRACT

Context and background

Millions of poor people who live in rural areas and rely on agriculture for a living need secure access to productive land. Gender disparities in access to productive resources, such as agricultural land, remain a major concern, especially in Nigeria.

Goal and Objectives:

This study investigated the impact of land access and ownership on farm production across gender in Southwest Nigeria.

Methodology:

A multi-stage sampling technique was used to select a total of 480 respondents comprising of 240 male headed households and 240 female headed households across the three states in Southwest Nigeria. Cross-sectional data were obtained through structured questionnaire and subjected to statistical analysis such as propensity score matching (PSM), inverse probability-weighted regression adjustment (IPWRA), and instrumental variable (IV) regression approach to control for possible endogeneity that could arise from the data collected.

Results:

Farm yield of household heads was used as indicator to estimate the impact of land access and land ownership. Results show that most (56.7%) of male and 46.4% of female headed households acquired land through family inheritance. The significant difference existed between farm yield gained by male and female headed households due to their level of land access and land ownership at 5%. The size of the estimated treatment effect indicates a high improvement in the farm yield outcome of male headed households compared their female counterparts. Reliable data on male and female headed households' access to land and land ownership are critical for providing an accurate picture of female headed households' land tenure arrangement, improving policy formulation and monitoring progress towards the attainment of gender equality in land access is hence encouraged.

Keywords:

Gender, Impact assessment, land access, ownership, income, yield

1. INTRODUCTION

Agriculture is the primary source of income in many developing nations, particularly in Africa south of the Sahara, and greater agricultural productivity has the potential to boost farm revenue and relieve rural poverty. Given Nigeria's current level of agricultural growth, the availability of land for agriculture determines sufficient food production and livelihood security. This is because, due to insufficient and unequal access to farmland, farming operations will stay at a subsistence level. In reality, it is estimated that 95% of Nigeria's farmland is untitled (Hull et al., 2016). Farmers' ability to use their land as collateral to obtain formal loans from financial institutions is harmed as a result of this (Hull et al., 2016). Again, the lack of absolute or nonderivative property interest limits farming households' ability to cultivate cash crops, restricting their income-generating potential (Odoemelam, et al., 2013). As a result, food security is becoming more challenging as the population grows and agricultural land becomes limited (FMARD, 2016). Inadequate access to land, funding, and technology, an inconsistent policy regime, a lack of infrastructure, and unfavorable climate change impacts have all been highlighted in the literature as impediments to agricultural production and food security (FAO, 2017; Oladapo and Olajide, 2015).

Since the beginning of time, land has been an important component of production and a fundamental factor of production in the agricultural sector all over the world, providing a foundation for crop production in Nigeria and Sub-Saharan Africa. Millions of poor people living in rural areas who rely on agriculture, livestock, or forests require secure access to productive land for their livelihood. Agriculture is the main source of income in rural Nigeria, with 85 percent of the population relying on it for survival. However, access to land is restricted because it is still controlled by families and community leaders, who determine who has access to it. The beneficiaries of the community land allocation system are not explicitly recognized as legal holders of land rights, according to the position of the Nigeria Land Use Act 1978. Again, family and community leaders rely on memory and references to natural and man-made elements to identify parcels of property that are prone to boundary confusion (Twene, 2016). This is due to the fact that the majority of community land grants remain undocumented (Twene, 2016).

Nigeria has a total land mass of 924,768 square kilometers, a population of around 200 million people, and an annual population growth rate of 2.8 percent, according to statistics (National Population Commission, NPC 2018). Nigeria is home to about 250 ethnic groups spread throughout 36 states and the Federal Capital Territory (Nuhu, 2009). In Nigeria, land is both an asset and a factor of production for households (Omole, 2009). The state, on the other hand, determines the level of access and title ownership (Udoekanem, Adoga, and Onwumare, 2014). As a result, the land tenure system is defined by a number of actors, including the government, community leaders, families, lawyers, and middlemen. The government regulates all of the different actors' activity through regulations and programs. Land allocation and ownership in Nigeria are influenced by factors such as geography, gender, and socioeconomic status (Odoemelam, et al., 2013). In Nigeria, men traditionally hold more land than women in terms of ownership structure. The majority of landowners inherited it from their families, with only 7% and 2.2 percent of male and female landowners, respectively, reporting property purchase (National Bureau of Statistics, 2007, World Bank and Federal Ministry of Agriculture and Rural Development, 2016).

Land tenure systems in most of Africa south of the Sahara are changing as a result of rising population pressures, changes in land allocation institutions, and the implementation of land registration programs,

all of which may stimulate land rental and purchase markets (Jayne, Chamberlin, & Headey, 2014). Land demand is fast rising due to a variety of factors, including population increase and climate change (Holden and Otsuka 2014). Meanwhile, empirical research suggests that land availability and tenure security are important factors in the growth of rural economies (Deininger et al., 2011; Jayne et al., 2014; Holden and Otsuka 2014; Ali and Deininger 2015; Frank *et al.,* 2017). Furthermore, Africa's diverse land tenure systems confound the (Western) concept of land ownership and make it impossible to compare land ownership figures across, and even within, countries. For example, in communally owned lands, the right of alienation – the transfer of land ownership – may not exist or be difficult to apply (FAO, 2003).

Gender disparities in access to productive resources, such as agricultural land, remain a major concern, especially in low-income nations. The Sustainable Development Goals (SDGs) adopted in 2015 recognize that in order to reduce poverty (Goal 1), equal rights to land ownership and control, as well as equal rights to the inheritance of productive resources (target 1.4), would be required. The SDGs also state that policy and legal reforms are needed to offer women equal rights and control over land and other economic resources in order to achieve gender equality and empower all women and girls (Goal 5). As a result, establishing gender equality in land rights is widely acknowledged as a key road to poverty reduction and economic development on the international development agenda. Many households in Nigeria have limited access to land unless it is inherited, purchased, or leased. However, land leases are often for a brief period of time and are determined by land tenure norms (Ariyo and Mortimore 2011; Adesugba and Mavrotas, 2016). Due to differing norms, religious practices, and customs across Nigeria, inheritance has played a key role in the access of farming households to land over the years (Aluko and Amido, 2006). Furthermore, Nigeria's diverse succession and inheritance rules make harmonization of land tenure systems a substantial difficulty (Oni, 2014). Age and sex are major variables of inheritance in Nigerian customary law. In any inheritance distribution formula, a female child, regardless of age, appears to be underrepresented (Mabogunje, 2010; Edu, 2016). The female child may be given the last say in property distribution, and her entitlements may be reduced in comparison to her brothers' claims, regardless of age (Oni, 2014). This gender prejudice is most obvious in circumstances when the land can only be inherited by the first-born son. Land markets in Nigeria have made it possible for both men and women to purchase land, however they are not well structured, and this is totally dependent on the availability of finances (FAO, 2014). As a result, because inheritance laws are complex and difficult to change, any land reform initiative is expected to focus on reorganizing land markets. Bringing land into the open market would eventually help to reduce gender bias in land disposition throughout the country (Mabogunje, 2010). More specifically, Quisumbing et al. (2014) claimed that if women had the same access to productive resources as males, farm production would improve by 20-30%. They do, however, have less access to productive resources and opportunities than males, particularly in terms of land assets, inputs, financial services, extension, technology, and agricultural training.

Furthermore, land is often the most important household asset for rural women and men in terms of sustaining agricultural productivity and ensuring food security and nutrition. Secure land tenure is linked to better levels of agricultural investment and productivity, and so to higher incomes and economic well-being, according to research. Women's land rights are frequently linked to better results for themselves and their children, such as increased bargaining power in the home and community, improved child nutrition, and lower levels of gender-based violence. In many places of the world, both men and women have insufficient access to secure land rights. Women are disproportionately affected in this aspect. Therefore, sex-disaggregated land data is critical for identifying gender discrepancies in land rights and access. This allows us to better formulate policies and track progress toward gender equality in agriculture and land tenure. In light of the growing call for a review of the land use act, the

study was deemed vital for Nigeria and other developing countries with similar land tenure arrangements to empirically determine how land access and ownership affect household farm output and income. Furthermore, a better knowledge of the gender difference in land access and right to own land among farming households would give policymakers with information on how to improve land accessibility and acquisition, which will help increase farm productivity and income potential in the research area. Researchers and educational institutions will benefit from the study since it will propose areas for additional research. It will serve as the foundation for a literature review for future studies. Against the above background that this study sought to determine the impact of land access and ownership on farm production across gender in Southwest Nigeria. Specifically, to; examine mode of land acquisition and level of accessibility across gender; investigate the determinants of land access and ownership among male and female farming households; and determine the effect of land access and ownership on household heads' farm output in the study area.

2. Overview of Land Policy in Nigeria

Land tenure arrangements play a significant role in the development debate (Zoysa, 2015). This is because unplanned or lax regulation stifles development as informal settlements expand, putting further strain on already strained infrastructure (Omole, 2009). In literature, the Nigerian land system has evolved over time and is divided into three periods: precolonial, colonial, and postcolonial (Babalola, 2015). The following are the explanations for the three periods:

(a*) Precolonial land ownership structure:* Lands were solely owned by families and communities before to the colonial era. The property was controlled by the community and family heads, who distributed it according to their subordinates' requirements (Omuojine, 1999). At the communal or family level, the legal estate or power existed. At the communal or family level, the legal estate or power existed. As a result, community and family leaders had absolute interests, whereas constituents only had derivative interests.

(b) Ownership structure during colonial rule: Prior to independence, colonial authorities restricted land ownership. The Treaty of Cession (1861), the Land Proclamation Ordinance (1900), the Land and Native Rights Act (1916), the Public Lands Acquisition Act (1917), the State Land Acts (1918), and the Town and Country Planning Act were among the laws enacted (1947). The colonial laws were designed to keep property rights out of the hands of local leaders. For example, Lord Lugard's Land Proclamation Ordinance of 1900 took into account native law and custom and stated that land titles could only be obtained through the high commissioner (Udoekanem, Adoga, and Onwumare, 2014).

(c) *Postcolonial ownership structure:* Since independence, two significant legislations have been enacted: the Northern Nigerian Land Tenure Law of 1962 and the Land Use Act of 1978. Northern Nigeria's 1962 land tenure law stated that the minister in charge of land matters controls, holds, and distributes land (unoccupied or occupied native lands) to Northern Nigerian. This means that non-natives could not obtain land titles without the minister's approval. Northern Nigerians were granted the right to possess land for a set period of time under the law. The individual/native may sell, mortgage, or transfer the land with the agreement of the minister. The law attempted, among other things, to reduce unequal access to land and land resources, which had caused the citizens a considerable deal of pain. Citizens having unrestricted access to land and land resources could help boost economic growth in an economy that is primarily reliant on agriculture and mineral resources. The Land Use Act was aimed at lowering the high land costs associated with industrial estates and mechanized agriculture. Because of these factors, the law appeared to nationalize land by entrusting it to the government as a custodian to keep in trust and administer for the use and benefit of all Nigerians. According to the Nigerian land usage order of 1978,

all land belongs to the government, which holds it in trust for the people (Alarima, et al., 2012). This means that the government distributes land to individuals and corporations based on the goals of those who are interested (Oloyede et al., 2014). However, after more than three decades of operation, it is clear that most of the problems it was intended to address have returned, and key sections of the law have harmed residents and tended to stifle economic development, particularly agriculture, which the Act was intended to promote.

In addition, the Nigerian Land Use Act of 1978 nationalized all land to abolish the customary tenure system. When the Act took effect, Nigerian women and men could apply for one of two types of land use certificates: customary or statutory, both of which were valid for a set period of time. They couldn't be transferred without government approval in general, even within the lineage. Land certificate registration was both costly and time-consuming, which limited its use in practice. Furthermore, awareness of the law remained poor, and land transactions were still governed by customary norms. The customary system provides land rights that are flexible, including the ability to transfer land (even through sale). Despite the fact that statutory rules specify that men and women have equal inheritance rights, the legislation only applies to women who are legally married. In Northern Nigeria, Islamic law governs inheritance patterns, with women inheriting only half of what their brothers do, and often relinquishing even that land due to social pressures. Women are similarly discriminated against under customary laws, and women can only get land usage rights through their husbands. Furthermore, land is usually always registered in the names of men.

3. METHODOLOGY

The study area: This study was carried out in Southwest region of Nigeria (Fig. 1). The region is made up of six states namely: Ekiti, Lagos, Ogun, Ondo, Osun and Oyo States. These states are in the tropical rainforest agro-ecological zone with swamp forest in the coastal regions of Ondo, Lagos, and Ogun states. The region falls within latitudes 6° N, 4° S and longitudes 4° W, 6° E; covering about 114, 271kilometre square, which represents 12% of the country's total land area. It had a total population of about 27,581,99 million but is estimated to be 30,416,396 million by 2016 (NBS, 2017). Climatic conditions of the zone are humid, with rainfall between 1500 mm and 3000 mm per annum with a mean monthly temperature range of 18 - 24°C during the rainy season and 30 - 37°C during the dry season (Adepoju *et al.,* 2011) and 36.38% of the population is engaged directly in agriculture (Nigerian Employment in Agriculture, 2019). Notable food crops cultivated in the area include: cassava, maize, yam, cocoyam, cowpea, vegetables and cash crops such as cocoa, kola nut, rubber, citrus, coffee, cashew, mango and oil palm. The study population of study comprised all rural farming households in the region.

Fig. 1: Map of the study area
Source: Author (2021)

Sampling procedure and sample size: A multi-stage random sampling technique was used for the selection of respondents for the study. Stage one: involved a random selection of 50% of the 6 states in the region and these states include; Ekiti, Ogun and Oyo. At stage two; 2 agricultural zones were randomly sampled from each of the 3 selected states and making a total of 6 agricultural zones. In stage three; from each of the selected 6 agricultural zones, 4 farming communities were randomly selected to make a total 24 farming communities for the study. Lastly, stage four: from each of the selected rural communities, 20 farming households (10 male and 10 females headed) were randomly selected giving a total of 480 respondents. Effort to sample equal number of male and female headed households for the study proof abortive as 237 and 229 of male and female headed households respectively with total sample size of 466 were eventually used for the study.

Method of data collection and analysis: The data were collected using questionnaire which was pre-tested twice by trained field enumerators. Respondent's consent was sort before responding to questions that were posed to them by trained enumerators. All respondents were advised not to participate in the study if they felt uncomfortable or withdraw at any stage of the survey. The purpose of the study and the need to participate in the study were adequately explained to every respondent. The survey instrument was designed to elicit detailed information on socio-economic characteristics of household head, farming characteristics, membership of association, access to credit and extension services as well as production (farm yields) of household head. In terms of land accessibility and ownership or tenure security, relevant data were collected on the level of accessibility of land by household head as well as on mode of land acquisition (land ownership). The collected data were subjected to both descriptive and inferential statistics such as frequency counts, percentages, charts and mean, standard deviation, and propensity score matching (PSM), inverse probability-weighted regression adjustment (IPWRA), and instrumental variable (IV) regression approach to control for possible endogeneity that could arise from the data collected.

Measurement of variables: **In this study t**he variables of interest include independent and dependent variables. Dependent variable is the impact of land access and ownership on farming households' production. The farm production was thus measured in yield/ha. The independent (socioeconomic characteristics of household head) were measured as follows (See Table 1):

Table 1: Description of the variables used in the estimation model

Variables	Measurement of variables	Category	Expected sign
Age of household head	Actual age of household head in years	Continuous	+/-
Gender of household head	1 if male, 0 otherwise	Dummy	+
Marital status	1 if married, 0 otherwise	Dummy	+
Level of education	Years of schooling	Continuous	+
Household size	Number of people within the household	Continuous	+
Farming experience	Number of years of farming	Continuous	+
Farm size	Total size of land under cultivation (ha)	Continuous	+
Income	Average annual net farm income	Continuous	+
Membership of association	1 if belong, 0 otherwise	Dummy	+
Mode of land acquisition	1 if acquired, 0 otherwise	Dummy	+
Access to extension	1 if access, 0 otherwise	Dummy	+
Access to land	Have access=1 and 0=otherwise	Dummy	+
Ownership of land	1 if owned land, 0 otherwise	Dummy	+
Number of years live in community	Actual years of resident in community	Continuous	+/-
Access to varietal information	Have access=1 and 0=otherwise	Dummy	+

Source: Author's elaboration from field survey (2021)

Estimation method

To put the concept of an average causal effect into practice, proper impact measurement necessitates controlling for both observable and unobservable factors by randomly assigning individual households to treatments. Selection bias may continue in the absence of random assignment because individuals observed and unobserved traits may influence the likelihood of receiving treatments as well as outcome indicators. Due to the cross-sectional nature of the data gathered, propensity score matching (PSM), inverse probability weighted adjusted regression (IPWRA), and instrumental variable (IV) regression techniques were used to compensate for endogeneity bias. The primary principle underlying PSM is to pair each treated home with a comparable untreated household, then calculate the average difference in the outcome variable between the two. When there is mis-specification in the propensity score model, one of the key concerns with employing propensity score matching is that the estimates provide biased results (Robins, Sued, Lei-Gomez, & Rotnitzky, 2007; Wooldridge, 2007; Wooldridge, 2010). As a result, we used the inverse probability weighted adjusted regression (IPWRA) estimator, which combines regression and propensity score approaches to obtain some resilience against parametric model mis-specification (Imbens & Wooldridge, 2009; Robins & Rotnitzky, 1995; Wooldridge, 2010). The IPWRA model estimates the outcome and treatment models as follows: Suppose that the outcome model is represented by a liner regression function of the form;

$$Y_i = \alpha_i + \theta_i x_i + \varepsilon_i \dots\dots\dots\dots (1)$$
$$for\ i\ =\ [0\ 1]$$

where, Y_i = the outcome variable of interest;

x_i = a set of controls;

α and θ = parameters to be estimated;

ε = the error term.

Furthermore, suppose that the propensity scores are given by $p(x;\vartheta)$. In the first stage, we estimate the propensity scores as $p(x,\hat{\vartheta})$. In the second stage, we employ linear regression to estimate (α_0,θ_0) and (α_1,θ_1) using inverse probability-weighted least squares as follows:

$$\min_{\alpha_0,\theta_0} \sum_{i}^{N} (Y_i - \alpha_i - \theta_i x_i)/P\left(x,\hat{\vartheta}\right)\ \ if\ I_i = 0 \dots\dots\dots\dots (2)$$

$$\min_{\alpha_1,\theta_1} \sum_{i}^{N} (Y_i - \alpha_i - \theta_1 x_i)/P\left(x,\hat{\vartheta}\right)\ \ if\ I_i = 1 \dots\dots\dots\dots (3)$$

The average treatment effect (ATT) is then computed as the difference between Equations (2) and (3).

$$ATT = \frac{1}{N_w} \sum_{i}^{N_w} \left[(\hat{\alpha}_1 - \hat{\alpha}_0) - \left(\hat{\theta}_1 - \hat{\theta}_0\right)x_i\right] \dots\dots\dots\dots\dots (4)$$

where,

$\hat{\alpha}_1$ = estimated inverse probability-weighted parameters for household (with land access or ownership)

$\hat{\alpha}_0$ = estimated inverse probability-weighted parameters for household (without land access or ownership).

N_w = total number of households (with land access or ownership).

I_i = an indicator which takes a value of one if a household have access to land or own a parcel of land for farming and zero otherwise.

In order to establish a causal impact, both observable and unobservable factors that influence families' access to land or ownership of a parcel of land for agricultural operations, as well as their farm yield

(outcomes), must be controlled at the same time. In this scenario, estimations from equation (4) may produce biased results due to unobservable factor biases. In order to control for the potential endogeneity of having access to land or owning a plot of land for farming activities, an instrumental variables (IV) regression approach was used. This potential endogeneity may arise from the fact that each farming household with adequate access to land or the capacity to acquire/own a parcel of land may be able to do so due to unstable income, high food insecurity, and challenges in accessing land markets and input support, all of which may be related to the outcome variables (farm production and income) (Chibwana, Fisher, & Shively, 2012; Ricker-Gilbert, Mason, Darko, & Tembo, 2013). The second reason is that households with access to land or who own a piece of land may share some socioeconomic characteristics such as access to credit, adequate extension visits, association membership, and technical and management skills, all of which are likely to be related to farm productivity and income. Instrumental variables (IV) regression approach was thus employed to address these issues. Therefore, it is necessary to use a valid binary instrumental variable that satisfies the exclusion restriction conditions, i.e., it must be uncorrelated with the potential outcome other than through the treatment variable. According to recent studies by Abdoulaye et al. (2018) and Shiferaw et al. (2014), access to knowledge on enhanced agricultural technology is an effective instrument for its adoption. However, in this study, household heads' access to varietal information was used as an instrument for land access or ownership of farmland. It's assumed that household heads' access to varietal information can influence their access to or own some parcel of farmland but may not necessarily have an effect on their outcome (farm yield). Hence, as stated in equation (5), the probit model was employed to complete this process:

$$Pr(D_i = 1|X_i, R_i, Z_i) = \Phi(X_i, R_i, Z_i, \psi) \ldots\ldots\ldots\ldots (5)$$

where D_i represents the household heads' access to farmland or ownership of farmland which takes the value of 1 if the household head have access or own parcel of land and zero if otherwise. *Pr* denotes probability and Φ denotes the Cumulative Distribution Function. X_i represents a vector of socio-economic and plot-specific variables; R_i is the state-wise fixed effect that accounts for state-level heterogeneity in the land accessibility among household heads. Z_i is adopted instrument: access to varietal information.

4. RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The results in Table 2 present the descriptive statistics of the key variables of socioeconomic characteristics including the difference in means between male and female headed households based on their land access and land ownership in the study area. As shown in Table 2, the mean age of male headed households in the whole sample was 54.67years while the mean age of female headed households was 53.62years. In comparing the respondents age between male headed households (54.18 and 55.01years) and female headed households (53.39 and 52.81years) of those who actually have access to land and owned a parcel of land respectively, there was no significant difference between the two categories in terms of age. But this suggests that the both household heads were in their middle active ages, an indication that they will be active to access and acquire land for agricultural production. Results revealed that most of the male headed households are married (80.0%), while more than half (62.0%) of female headed households are married. Also, most of the male and female headed households are literate with post-primary education, with an average of 8.07 and 7.90 years of schooling respectively. This suggests that there is high transition to higher education among the respondents. However, the male headed households were relatively more educated than their female counterparts in the study area. Results in Table 2 showed that the average household size for male headed households was about 9.23 members and 9.15 members for the female headed households in the whole sample. In comparison, the average

household size between male headed households was (9.19 and 9.14) persons and female headed households was (9.18 and 9.20) person respectively for those that have accessed land and/or owned land, this finding therefore did not find a significant difference in male category but a significant difference among the female headed households. The large number of household size observed in both categories of household heads would provide labour for agricultural especially for the households that rely heavily on family labour. Moreover, the average farming experience for male headed households in the whole sample was 23.80years while, it was 23.97years in the female headed households. While comparing the farming experience between male and female headed households (23.97years and 23.68years) and female headed households (22.06years and 23.99years) of land access and ownership respectively, this suggests significant difference between the two groups. This implies that both male and female headed households were experienced farmers, hence, they had over the years acquired enough farming experience needed to access the size of land needed for farming. This conformed with the work of Tsue *et al.* (2014), which indicated that the majority of arable crop farmers had an experience far above 10 years. Also, the mean total farm size of male headed households in the whole sample was 5.48ha while the mean total farm size of female headed households was 2.86ha. In comparison between male headed households (5.55ha and 5.80ha) for those that have access to/own farmland and female headed households (2.94ha and 3.02ha) for those who actually have access to land and owned a parcel of land respectively, there was no significant difference between the two categories in terms of farm size

Results in Table 2 further present the difference in means (of all covariates) between male and female headed households in term of land access and land ownership at varying degree. The mean differences are statistically significant for all our outcome indicators except in age, distance to nearest markets and years of residence in the community. For instance, majority (84% and 86%) of male headed households who have access to land and owned parcel of land had access to credit while among the female headed households that had access to credit, 78% and 82% of them have access land and ownership. The difference in the mean between the two groups is statistically significant at 1%. This suggests that households who have access to credit had land access and owned more parcel of land. More results in Table 2 showed that about 87% of male headed households and 89% of female headed households for the whole sample are members of cooperative societies. To compare the two groups, 85% access land and 93% owned parcel of land among male headed households who are members of one association or the other. In female category, majority (95% and 97%) have access to farm and owned farmland respectively of those that are members associations in the study area. This difference is also statistically significant at 1%. In addition, findings show that more than half (56%) of the male headed households who have accessed land (60%) and owned parcel of land (63%) have access to extension services while, about half (48%) of female headed households that accessed land (49%) or owned farmland (52%) have access to extension services. Thus, we also found significant difference between the two categories at 5% and 1% respectively. In terms of the instrumental variable we used, access to varietal information, we discovered that 61% of male headed households and 53% of female headed households for the entire sample had access to varietal information. While in comparison, about 68% and 72% of male household heads who had access to and owned parcel of land had higher access to varietal information than those in female headed household's category (57% land access and 55% land ownership). The differences in mean were discovered to be statistically significant at 1% level. Farmers that are aware of improved agricultural technology and so have access to it are more likely to employ it, according to Issahaku and Abdulai (2019) and Abdoulaye *et al.* (2018). In our study, all household heads who had access to and ownership of a parcel of land had more access to varietal information, implying that access to varietal information is a good instrument for land access and ownership.

Table 2: Descriptive statistics based on land access and land ownership by gender

Socioeconomic variables	Male headed households (N=237)							Female headed households (N=237)						
	1	2	3	4	5	Mean difference	Mean difference	1	2	3	4	5	Mean difference	Mean difference
	Total sample (N=237)	With land access (N=177)	Without land access (N=60)	Owned farm land (N=139)	Farmland not owned (N=98)	(2-3)	(4-5)	Total sample (N=229)	With land access (N=146)	Without land access (N=83)	Owned farm land (N=127)	Farmland not owned (N=102)	(2-3)	(4-5)
	Mean	Mean	Mean	Mean	Mean			Mean	Mean	Mean	Mean	Mean		
Age (age of the household head in years)	54.67	54.18	56.13	55.01	54.19	-1.95	0.82	53.62	53.39	54.01	52.81	54.62	-0.62	-1.81
Marital status (1=married, 0=otherwise)	0.80	0.89	0.87	0.71	0.92	0.02**	-0.21	0.62	0.63	0.60	0.59	0.65	0.03***	-0.06
Education (Years of schooling)	8.07	9.28	4.50	9.01	6.73	4.78***	2.28	7.90	8.85	6.24	8.51	7.16	2.61***	1.35
Household size (Family size in numbers)	9.23	9.19	9.35	9.14	9.35	-0.16	-0.25	9.15	9.18	9.11	9.20	9.01	0.07*	0.19*
Farming experience (Years)	23.80	23.97	23.28	23.68	23.97	0.69*	-0.29	23.97	22.06	23.87	23.99	22.96	-1.81	1.03**
Total farm size (ha)	5.48	5.55	5.27	5.80	5.03	0.28**	0.77	2.86	2.94	2.71	3.02	2.65	0.23**	0.37**
Access to credit (1=yes, 0=otherwise)	0.70	0.84	0.28	0.86	0.48	0.56***	0.38	0.62	0.78	0.35	0.82	0.38	0.43***	0.44***
Membership of association (1=yes, 0=otherwise)	0.87	0.85	0.76	0.93	0.79	0.09***	0.14	0.89	0.95	0.77	0.97	0.78	0.18***	0.19***
Access to extension (1=yes, 0=otherwise)	0.56	0.60	0.43	0.63	0.44	0.17**	0.15	0.48	0.49	0.43	0.52	0.42	0.06***	0.10***
Distance to farm to market (km)	12.69	12.27	13.94	11.41	14.51	-1.67	-3.10	12.49	11.57	14.14	11.39	13.88	-2.57	-2.49
Number of years of residence (Years)	26.78	26.76	26.87	26.62	27.02	-0.11	-0.40	27.61	27.96	26.99	27.98	27.14	0.97	0.84
Instrumental variable														
Access to varietal information (1=yes, 0=otherwise)	0.61	0.68	0.49	0.72	0.51	0.19***	0.21***	0.53	0.57	0.35	0.55	0.41	0.22***	0.14***

The t-test was conducted to test for difference in socio-economic characteristics between male and female headed households;
*, **, ***: Significant at 10, 5 and 1%, respectively.
Source: Field survey (2021)

Mode of land acquisition by household heads

Figure 2 present the method of land ownership and acquisition among male and female household heads in the study area. As shown in the Figure 2, the major form of land ownership and acquisition among the two categories of household heads was through family inheritance (56.7% of male and 46.4% of female headed households), implying that most household heads (either male or female) acquired their farm land through family transfer or inheritance. Land ownership by inheritance is prevalent and has always been a dominant form of land ownership in Africa south of Sahara. This is in line with the findings of Ekenta et al. (2012), who discovered that among male farmers, land inheritance was the most common ownership structure, while female farmers purchased land for agricultural production. According to National Bureau of Statistics; World Bank and Federal Ministry of Agriculture and Rural Development (2016) that majority of the land owners inherited it from their family, while only few of male and female, respectively, reported purchase of land. Furthermore, results in Figure show that 21.3% of male and 19.1% of female headed households owned land through outright purchase, 13.5% male headed households and 24.8% female headed households have rented or leased farmland. This suggests that female headed households rented more farmland compared to their male headed household counterparts. This supports the findings of Isaac et al. (2019), who claimed that in Nigeria, men often possess more land than women. Some 4.9% of male headed households and 9.7% of female headed households used land free of charge while only 3.6% of male headed households source their farmland through community allocation.

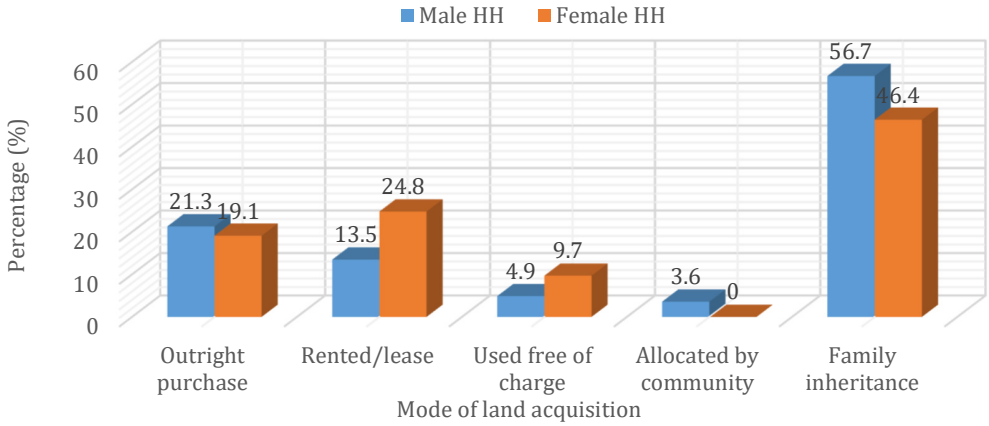

Fig. 2: Distribution of male and female headed household by mode of land acquisition
Source: Field survey (2021)

Impact of land access and land ownership on farm production (outcome) indicator of household heads by gender

Determinants of land access and land ownership among male and female headed households

The maximum likelihood estimates from the probit model, as well as the average marginal effects of land access and land ownership on farm yield in male and female-headed households (outcome) are presented in Table 3. The marginal effect, on the other hand, is more effective than the coefficient at characterizing the magnitude of a probability model. The reason is because the sign and amount of the marginal effect determine the direction and extent of socioeconomic characteristics' potential influence on their level of accessibility (Lokshin, and Sajaia, 2004).

Table 3: Probit model estimates of determinants of land access and land ownership among male and female headed households

Variables	Male headed households				Female headed households			
	Land access		Land ownership		Land access		Land ownership	
	Coefficient	Marginal effects	Coefficient	Marginal effects	Coefficient	Marginal effects	Coefficient	Marginal effects
Age of the household head	-0.044**(0.018)	-0.006**(0.003)	0.015 (0.015)	0.005(0.005)	0.003(0.017)	0.001(0.0050	-0.013(0.017)	-0.005(0.006)
Marital status	-0.886***(0.399)	-0.087***(0.034)	-0.896***(0.352)	-0.273***(0.082)	0.163(0.251)	0.04990.0780	-0.269(0.235)	-0.100(0.086)
Education	0.158***(0.029)	0.022***(0.005)	0.056***(0.021)	0.020***(0.008)	0.106***(0.025)	0.032***(0.007)	0.055***(0.022)	0.021***(0.008)
Household size	-0.116(0.074)	-0.016(0.011)	-0.068(0.059)	-0.025(0.021)	0.047(0.047)	0.014(0.014)	0.032(0.047)	0.012(0.018)
Farming experience	0.314***(0.082)	0.044***(0.014)	0.049(0064)	0.018(0.023)	0.046(0.049)	0.014(0.015)	0.008(0.047)	0.003(0.018)
Farm size	-0.069(0.089)	-0.009(0.013)	0.191***(0.076)	0.069***(0.027)	0.078*(0.052)	0.023*(0.016)	0.104***(0.049)	0.039***(0.019)
Mode of land acquisition	0.261**(0.121)	0.037**(0.017)	0.415***(0.101)	0.150***(0.035)	0.422***(0.129)	0.126***(0.035)	0.530***(0.118)	0.200***(0.042)
Access to credit	2.196***(0.323)	0520***(0.018)	1.539***(0.261)	0.554***(0.079)	1.359***(0.246)	0.433***(0.075)	1.197***(0.226)	0.444***(0.076)
Membership of association	-0.960*(0.589)	-0.082*(0.033)	1.711***(0.403)	0.599***(0.099)	1.103***(0.330)	0.398***(0.123)	0.926***(0.334)	0.356***(0.119)
Distance to nearest market	-0.110***(0.041)	-0.016***(0.006)	-0.184***(0.035)	-0.066***(0.012)	-0.154***(0.034)	-0.046***(0.010)	-0.140***(0.032)	-0.053***(0.012)
Access to extension services	0.151(0.332)	0.022(0.048)	-0.059(0.262)	-0.022 (0.094)	-0.690**(0.337)	-0.207**(0.097)	-0.069(0.289)	-0.026(0.109)
Years live in community	-0.022(0.030)	-0.003(0.004)	-0.028(0.026)	-0.010(0.009)	0.073***(0.029)	0.022***(0.008)	0.046*(0.024)	0.017*(0.009)
Instrumental variable								
Access to varietal information	-0.161(0.348)	-0.022(0.045)	0.296(0.281)	-0.109(0.106)	1.285***(0.029)	0.385***(0.096)	0.626**(0.288)	0.235**(0.106)
Constant	0.988(1.714)		-2.038(1.528)		-5.562(1.849)		-2.934(1.684)	
Number of observations	237		237		229		229	
LR chi^2	145.70***		146.41***		139.05***		134.56***	
Pseudo R^2	0.5433		0.4555		0.4636		0.4276	
Log likelihood	-61.2386		-87.5067		-80.4292		-90.0824	

Source: Author's computation (2021). *, ** and *** represent 10%, 5% and 1% levels of significance, respectively.
Standard errors are reported in parentheses.

As a result, the average marginal effect depicts the change in the likelihood of farmland accessibility or ownership as a function of a unit change in the explanatory variable. A log-likelihood of -61.2386, Pseudo R2 of 0.5433, and the LR (chi^2) of 145.70, and a log-likelihood of -87.5067, Pseudo R2 of 0.4555, and LR (chi^2) of 146.41, respectively, were significant ($p<0.01$), implying that the model has a strong explanatory power capable of jointly influencing the level of access to land and land ownership among male headed households in the study area. Similarly, among female-headed households, the probit regression shows a log-likelihood of -80.4929, Pseudo R2 of 0.4636, and the LR (chi2) of 139.05, and log-likelihood of -90.0824, Pseudo R2 of 0.4276, and LR (chi2) of 134.56 respectively were significant ($p<0.01$), indicating that the model has a strong explanatory power capable of jointly determining the level of land access and ownership.

Table 3 shows that seven and six of the thirteen model factors are statistically significant in explaining the amount of land access and ownership among male-headed households, respectively. At a 5% level of significance, the results show that the age of male household heads has a negative and statistically significant association with land access, implying that the age of male led households reduces the possibility of accessing farm land by 4.4 percent. As a result, elder male-headed households are more likely to lack access to land than younger households. Male-headed households' marital status was also found to be negatively and significantly associated to both land access and ownership at the 1% level, implying that male-headed households were 8.7% and 27.3 percent less likely to have land access and own a parcel of land, respectively. The education coefficient is positive and statistically significant and explains the likelihood of male-headed families having access to or owning farmland. The marginal effects of a unit increase in years of education on the conditional probability of accessing or owning a parcel of farmland are 0.022 and 0.08 percent, respectively, implying that an additional year of schooling for male-headed households will increase land access and ownership by 2.2 and 0.8 percent. This suggests that the more educated male household heads are, the more likely they are to have access to land and possess a farming land. The likelihood of having access to land increased dramatically with male-headed families' farming expertise, which is likely due to the fact that experienced household heads know where to get land for farming activities. The likelihood of owning farmland increases with farm size among male-headed households, which is likely due to the fact that greater farm holdings or farm size need more production resources to work on. The probability of owning a piece of land increased by 2.7 percent for every unit increase in farm size. This implies that most male headed households with large farm size are more like to own more parcel of farm land than those with small farm size and which may be due to other supports.

Furthermore, at a 1% level of significance, the variable indicating the form of land acquisition was found to be positive and significantly influence land accessibility and ownership in male-headed households. This shows that households headed by men have more opportunities to access or own land than those led by women. With access to credit, the likelihood of having access to land and owning a plot of land improves among male-headed households. This is because access to credit motivates farmers to cultivate additional farmland, which supports Baruwa et al (2015)'s finding that access to credit increases the possibility of adopting enhanced maize varieties in Osun State, Nigeria. Also, the positive correlation of access to credit with land access and land ownership among male household heads is in tandem with Twumasi, et al. (2019) and Maritim, et al. (2019) for agribusiness youth participation in Ghana and Kericho County, Kenya, respectively. Being a member of an association or a farmers' cooperative union has a favourable and considerable impact on the likelihood of male-headed households being able to obtain or own land for farming purposes. This means that male headed households with who belong to

a farmers' association are more likely to obtain or gain access to land for farming. Many farmers' unions have as their primary goal the access to production resources, as well as the welfare and development of their members. Furthermore, belonging to a group can give farmers with easier access to farm inputs, which is consistent with Onumadu and Osahon's (2014) results that belonging to a group influenced the adoption of enhanced rice technology in south-southern Nigeria. Results also show the distance to the nearest market is another important demotivating factor affecting male headed household's access to land and ownership of land. The marginal effect of distance to the nearest market variable is 0.016 (land access) and 0.035 (land ownership), suggesting that the likelihood of having access to farmland and/or own parcel of land reduces with the distance to the nearest market among the male household heads in the study area. This implies that male headed households that live very farther away from land market are less likely to have land access or own land. This effect is statistically significant at the 1% level, and it supports previous research by Abdoulaye et al. (2018), who found that distance to seed markets is a major barrier to adoption.

In contrast, the results in Table 3 demonstrate that nine and eight of the thirteen factors used in the model specification are statistically significant in explaining the likelihood of female household heads having access to land and owning land. Level of education, farm size, mode of land acquisition, access to credit, membership of association, distance to the nearest market, access to extension, number of years lived in the community, and access to varietal information are some of the factors that have a significant impact on the likelihood of female-headed households accessing or owning land. This finding corroborates the earlier findings by Deininger *et al.* (2014) and Adekola *et al*. (2013) in Nigeria where similar research has been conducted. Land accessibility and ownership were positively and significantly related to education among female-headed households. This means that literate female household heads are more likely to have access to land and have a better chance of owning a piece of land than those who are less educated, which could affect their agricultural output level. This is in line with the findings of Ersado et al. (2004), who found that educated household heads are more likely than uneducated heads to adopt new and improved technology. With the expansion of the farmland, the chances of getting land and/or owning a plot of land increased dramatically. One possible explanation is that female-headed households with big farm sizes may have the financial means to purchase more land for cultivation, thereby increasing their output. In addition, female-headed households with a large farm were more likely to apply sustainable land management strategies. The mode of land acquisition coefficient was shown to be positive and statistically significant, and it describes the likelihood of female-headed households having access to land and owning a parcel of land. The partial effects of a unit increase in land acquisition on the conditional probability of female household heads having access to land or owning land are 0.126 and 0.042, respectively, implying that an additional increase in land acquisition will result in 12.6 and 4.2 percent increases in land access and ownership. This finding is in line with that of Douglas et al. (2017), who found a link between access to productive assets like land and youth agricultural engagement in Swaziland.

Similarly, having access to credit increased the likelihood of female-headed households having access to land and owning land. This indicates that women who have access to finance are more likely to have better purchasing power and be able to acquire more farmland for agriculture. Being a member of an association has a positive impact on the household head's access to and ownership of land. This highlighted the fact that a household in an organization or union group had a greater chance of receiving help from other members or the group in securing a productive asset, such as agricultural land. This conclusion supports the findings of Onumadu and Osahon (2014), who found that belonging to a group influenced the adoption of better rice technology in southern Nigeria. Distance to the nearest market was found negative but statistically significant at 1% with land access and ownership among female

headed households in the study area. The marginal effects of distance to nearest market are 0.046 and 0.053, respectively, showing that distance to nearest market reduces the chance of land access and ownership. The implication is that female-headed households living further from the market are less likely to have access to or own land. Access to extension was also shown to be negative, affecting household heads' access to land significantly. This shows that extension agents may not provide information on land to female-headed households, or that the number of extension agents per household head is minimal. As a result, household heads may be unaware of how to obtain agricultural land. The number of years the household head has lived in the community is another important driver of land access and ownership among female-headed households. This could be explained by the fact that household heads who have lived in a community for a long time have a better awareness of land administration and so have a higher proclivity to access and buy land for farming purposes. The marginal effect and the coefficient of access to varietal information variable are both positive and statistically significant at the 1% level, implying that the excluded IV instrument had an impact on the likelihood of having access to land and/or owning a parcel of land among female-headed households. As a result, female-headed households with access to land acquisition information are more likely to own agricultural land, which supports the validity of our instrument. Abdoulaye et al., 2018; Wossen, Abdoulaye, Alene, Feleke, Ricker-Gilbert, et al., 2017) verify this finding.

Impact of land access and land ownership on farm production (yield)

The impact of the land access and land ownership on the outcome (farm yield) of male and female headed households are compared using matching techniques and inverse probability weighted regression adjustment (IPWRA) specifications.

Propensity Score Matching

Various diagnostic tests were undertaken to ensure that the matching process was consistent and reliable before using the PSM to estimate the causal influence of land access and land ownership on output of male and female headed households. The common support condition was tested after generating the propensity score for male and female headed households to ensure that the variables did not differ. Figures 3,4,5, and 6 illustrate the density distribution of estimated propensity ratings for land access and land ownership among male and female headed households.

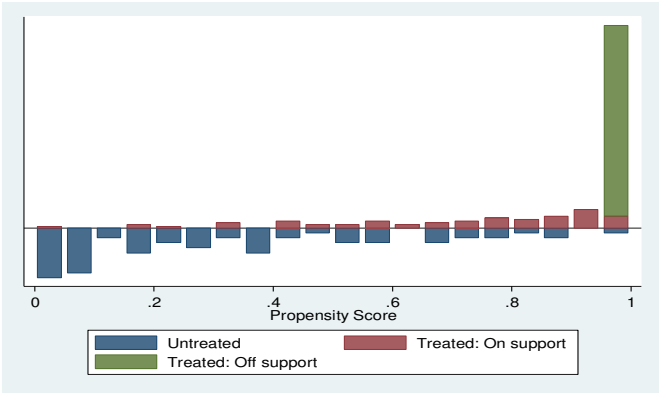

Fig 3. Propensity score matching and common support region for land access among male headed households. Source: Author's computation (2021)

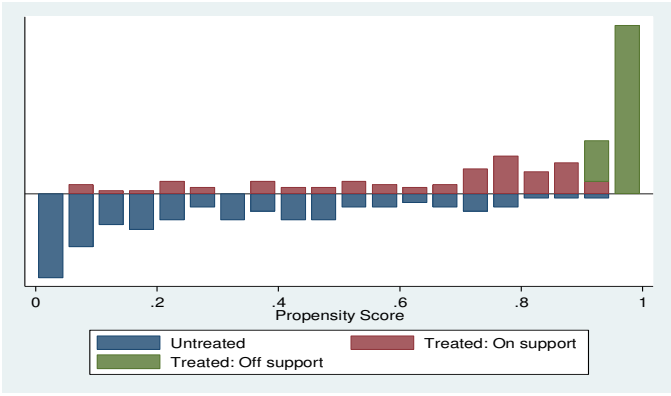

Fig 4. Propensity score matching and common support region for land ownership among male headed households. Source: Author's computation (2021)

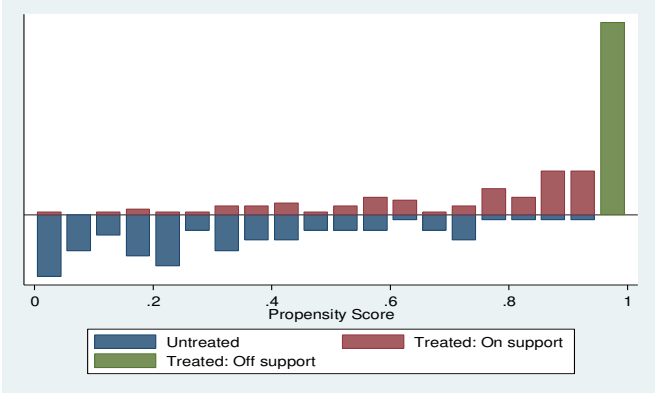

Fig 5. Propensity score matching and common support region for land access among female headed households. Source: Author's computation (2021)

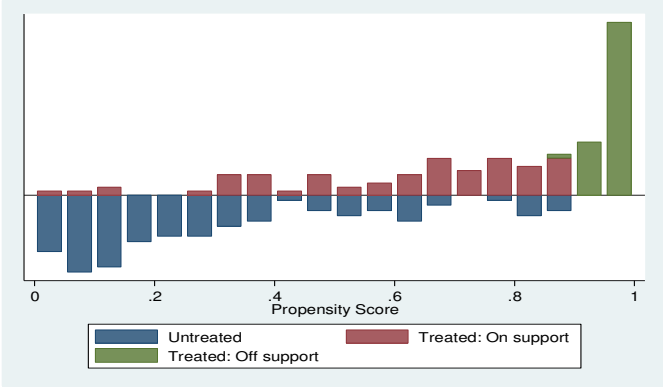

Fig 6. Propensity score matching and common support region for land access among female headed households. Source: Author's computation (2021)

Figures 3, 4, 5, and 6 show how the treatment (male and female HH with access to and/or ownership of land) and control groups (male and female HH without access to and/or ownership of land) share similar characteristics. In addition, the Figures show the distribution of propensity scores as well as the common support region between land access/ownership (upper portion) and no access to land/no ownership (lower portion). The common support requirement is met, as there is significant overlap in the propensity scores of both male and female headed households, according to a close analysis of the distribution of calculated propensity scores. Since the study reduced selection bias in land access and land ownership due to observable variables, any change in farm output (yield) could now be attributed to having access to land or land ownership. The propensity scores of land access or no access (treated and untreated) and land ownership or no ownership demonstrate that 52 percent and 72 percent of the male-headed households' profiles were matched, with only 48 percent and 28 percent of the profiles being eliminated, indicating the model's suitability (Table 4). Similarly, the propensity score of having access to land and with/without land ownership for both treated and untreated female-headed households revealed that 71 percent and 76 percent of their profiles matched, while about 29 percent and 24 percent of their profiles dropped, indicating the model's fitness.

Table 4: Distribution of propensity score matching outcome

Household Heads	Treatment assignment	Land access			Land ownership		
		Off support	On support	Total	Off support	On support	Total
Male	Treated	113	64	177	67	72	139
	Untreated	0	60	60	0	98	98
	Total	**113**	**124**	**237**	**67**	**170**	**237**
Female	Treated	66	80	146	56	71	127
	Untreated	0	83	83	0	102	102
	Total	**66**	**163**	**229**	**56**	**173**	**229**

Source: Author's computation (2021)

The unmatched (before matching) and matched (after matching) estimates of the covariates balancing test are shown in Table 5. The significance of the explanatory factors in describing the probability of land access and land ownership among the two types of household heads is indicated by the Pseudo- R^2. The *p*-values of the probability ratio test were also utilized to show the joint significance of equality in the variables' distribution between those who have access to and own a parcel of land and those who do not have access to or own a parcel of land.

Table 5: Overall matching quality indicators before and after matching

Sample		Male headed households		Female headed households	
		Land access	Land ownership	Land access	Land ownership
Pseudo R^2	Before matching	0.543	0.618	0.905	0.628
	After matching	0.076	0.029	0.192	0.271
LR χ^2 (p-value)	Before matching	145.70 ($p>\chi^2$=0.000)	198.66 ($p>\chi^2$=0.000)	271.54 ($p>\chi^2$=0.000)	197.53 ($p>\chi^2$=0.000)
	After matching	13.44 ($p>\chi^2$=0.415)	125.62 ($p>\chi^2$=0.000)	221.81	53.40 ($p>\chi^2$=0.000)
Mean Standard bias	Before matching	38.80	40.30	36.50	26.50
	After matching	17.40	23.80	8.00	14.30
% Reduction (Bias)		55.15	40.94	78.08	46.04

Source: Author's computation (2021). Note: ***significance level at 1%.

In addition, data in Table 5 demonstrate a significant decrease in the value of the Pseudo- R^2 for land access and land ownership among male led households, from 0.543 (54.3%) pre-matching to 0.076 (7.6%) post-matching and from 0.618 (61.8%) pre-matching to 0.029 (2.9%) post-matching respectively. The joint significance was accepted for both the unmatched and matched samples (*p*-value = 0.000) in land access and land ownership, according to the likelihood ratio test *p*-values. Meanwhile, for land access, the standardized mean bias decreased from 38.8% before matching to 17.4% after matching, and for land ownership, it decreased from 40.3 percent before matching to 23.8 percent after matching. Matching reduces bias by roughly 55.15 percent and 40.94 percent in male-headed households, respectively. Table 5 also shows a significant decrease in the value of the Pseudo- R^2 for land access and land ownership in female-headed households, from 0.905 (90.5%) pre-matching to 0.192 (19.2%) post-matching and from 0.628 (62.8%) pre-matching to 0.271 (27.1%) post-matching. The joint significance was also accepted for both the unmatched and matched samples (*p*-value = 0.000) in land access and land ownership, according to the likelihood ratio test *p*-values. Furthermore, for land access, the standardized mean bias for general factors decreased from 36.5 percent before matching to 8.0 percent after matching, and for land ownership, it decreased from 26.5 percent before matching to 14.3 percent after matching. However, matching lowers bias by around 78.08 and 46.04 percent in female-headed households, respectively. As a result, for male and female headed households, the reduction in high total bias, insignificant *p*-values of the likelihood ratio test after matching, as well as reduced Pseudo- R^2, and a significant reduction in the mean standardized bias are indicative of successful balancing of the distribution of covariates between those with and without land access and those with and without land ownership. In comparison to their male counterparts, female-headed households have less access to land and authority to acquire land. This supports Lawanson's (2010) conclusion that women's restricted access to agricultural land may be due to sociocultural barriers that prevent women from owning property.

Estimation of impact of land access and land ownership on outcome variable (farm yield)

Based on propensity score matching (PSM) and inverse-probability weighted regression adjustment (IPWRA), the distributional effect of land access and land ownership on the outcome variable (farm yield) among male and female headed households is shown in Table 6. The results show that the percentage impact of land access and land ownership on the farm yield (outcome) of male and female-headed households varies between the two estimations. However, when comparing the PSM to the IPWRA estimations, the percentage impact of land access and land ownership was found to be higher in the PSM. The results of this study were interpreted based on IPWRA, which appear to be more robust than PSM and may be less susceptible to selection bias and endogeneity.

Table 6: Distributional impact of land access and land ownership on farm yield ('000 kg/ha) outcome based on PSM and IPWRA

Household head	Treatment variable=1 if farming household head have land access and owned parcel of land		Land access		Land ownership	
			PSM	IPWRA	PSM	IPWRA
Male	Farm yield ('000 kg/ha)	Control	3648.54*** (477.09)	3805.34*** (213.38)	2260.34*** (427.14)	1971.45*** (350.02)
		Treated	4675.23*** (191.69)	4538.87*** (238.86)	3003.56*** (595.42)	2466.12*** (352.50)
	% impact of land access/ownership[a]		[21.96]	[16.16]	[24.74]	[20.05]
Female	Farm yield ('000 kg/ha)	Control	3215.09*** (187.95)	3108.69*** (223.59)	2629.08*** (326.55)	2449.59*** (350.94)
		Treated	3844.69*** (204.46)	3597.60*** (185.60)	3181.26*** (338.35)	2959.03*** (319.68)
	% impact of land access/ownership[a]		[16.38]	[13.59]	[17.36]	[17.22]

Source: Author's computation (2021), Robust standard errors are reported in parentheses. ***represent significance level at 1%. PSM= Propensity score matching; IPWRA= Inverse probability-weighted regression adjustment. [a]Denotes the percentage impact of land access/land ownership in each of the estimate of farm yield. All estimations include set of controls included in Table 3.

The findings further show that both land access and land ownership have a positive and statistically significant impact on the outcome (farm yield) indicator. Table 6 shows that having access to land improved farm yields by 21.96% and 16.16% in male-headed households, respectively, and having land title or ownership raised farm yields by 24.74% and 20.05%. Land access has also raised farm production (yield) by 16.38% and 13.59% among female-headed households, respectively, and land ownership by 17.36% and 17.22%. These findings suggest an additional point gained by both male and female headed households due to their level accessibility to land and land ownership. But there is significant difference in the level point gained by the male and female headed households with male headed households reveal more point than their female counterparts. This conforms with Deininger *et al.* (2014) who identified weak protection of rights in practice, large gaps in female land access, and limited outreach and effectiveness of institutions to record rights and adjudicate disputes as major constraints to land acquisition in 10 African countries. In the meanwhile, these findings should be interpreted with caution, as they may be skewed or biased due to the lack of control for unobserved heterogeneity. The quality of our matching determines the trustworthiness or reliability of the PSM and IPWRA outcomes (Table 5).

The result of the IV-2SLS in Table 7 show that male headed households who have access to and own certain parcel of land increased their yield by 12.9% and 10.4% respectively. Our findings show that only access to extension is significantly improved yield per hectare in term of land access, while distance to nearest market and access to extension statistically significant at 1% and influence farm yield in term of land ownership among male headed households. The degree of education of household heads and access to extension services were significant and considerably enhanced farm yield per hectare in female-headed households, however the number of years lived in the community had a negative impact on farm produce per hectare using land access.

Table 7: IV-2SLS estimation of treatment effect on farm production (yield) outcome

Variables	IV-2SLS			
	Male headed Households		Female Headed Households	
	Yield by land access	Yield by land ownership	Yield by land access	Yield by land ownership
Land access/Land ownership	-0.129 (0.081)	0.104*(0.069)	0.267***(0.068)	0.178***(0.069)
Age of the household head	0.002(0.004)	0.001(0.004)	0.005(0.004)	0.006*(0.004)
Marital status	-0.044(0.071)	-0.025(0.071)	-0.042(0.054)	-0.025(0.055)
Education	0.003(0.005)	0.002(0.005)	0.008*(0.005)	-0.004(0.005)
Household size	-0.009(0.014)	-0.008(0.014)	0.011(0.010)	0.012(0.011)
Farming experience	0.007(0.015)	0.006(0.015)	-0.007(0.011)	-0.005(0.11)
Farm size	0.004(0.016)	-0.001(0.016)	0.007(0.015)	0.007(0.015)
Mode of land acquisition	0.025(0.019)	0.018(0.020)	0.007(0.021)	0.008(0.022)
Access to credit	0.048(0.067)	0.010(0.062)	0.001(0.059)	0.032(0.060)
Membership of association	0.102(0.079)	0.068(0.081)	-0.064(0.085)	-0.036(0.086)
Distance to nearest market	0.008(0.007)	0.012*(0.008)	0.003(0.007)	0.001(0.007)
Access to extension services	0.504***(0.053)	0.500*(0.053)	0.591***(0.051)	0.589***(0.052)
Years live in community	0.001(0.006)	0.001(0.006)	-0.013**(0.010)	-0.012*(0.006)
Joint significance of all regressors (F-test)	8.30***	8.55***	13.89***	12.73***
R^2	0.3261	0.3328	0.4564	0.4350
Durbin score chi^2	1.2539(p = 0.2628)	3.11736(p=0.0775)	0.3775(p=0.5390)	1.1738(p=0.2786)
Wu-Hausman F(1,233)	1.2393(p = 0.2668)	3.10559(p=0.0793)	0.3715(p=0.5428)	1.1593(p=0.2828)
Wald chi^2 (2)	375.28	85.88	408.01	190.11
Prob>chi^2	0.000	0.000	0.000	0.000
R-squared	0.6105	0.2448	0.6403	0.4574
Observations	237	237	229	229

Source: Author's computation (2021). *, ** and *** represent 10%, 5% and 1% levels of significance, respectively. Standard errors are reported in parentheses.

In terms of land ownership, the age of household heads and access to extension services were shown to be favorable factors that considerably improved yield, however the number of years spent in the community had a negative impact on farm yield among female-headed households. This finding is in line with Tesfamicheal et al. (2017), who discovered that GESS participants in Nigeria boosted corn output by 26.1 percent.

We further run a post estimation test using "estat endogenous" to test the hypothesis that land access and ability to own land are exogenous, in order to prove the assertion that land access and ownership may be endogenous. Durbin (score) chi2 (2) = 1.2539 (p = 0.2628); the robust regression-based test of Wu-Hausman F-statistics (1,233) = 1.2393 (p = 0.2668) for land access; and Durbin (score) chi2 (2) = 3.11736 (p = 0.0775); and Wu-Hausman F-statistics (1,233) = 3.10559 (p = 0.0793) for land ownership among male headed households. Durbin (score) chi2 (2) = 0.3775 (p = 0.5390); the robust regression-based test of Wu-Hausman F-statistics (1,233) = 0.3715 (p=0.5428) for having land access, and Durbin (score) chi2 (2) = 1.1738 (p = 0.2786); and Wu-Hausman F-statistics (1,233) = 1.1593 (p = 0.2828) for those who own some parcels of land were found among female headed households. Furthermore, we rejected the null hypothesis and concluded that access to land and land ownership among male and female-headed households were endogenous at a 1% significant level, suggesting that probit estimation might be used to quantify treatment effect consistency. As a result, the findings justify the use of instrumental variable method to estimate the treatment effect.

We also used the Stata command "estat first stage" to test the validity of instruments for both categories of household heads. Among male headed households, results show that the minimum eigenvalue (8.6199) is greater than the value of the nominal 5%, Wald test at 5% bias tolerance and the joint significant test (F= 12, 223, *p*=0.000) show that instruments are strong for land access and in land ownership, the minimum eigenvalue statistic (8.1455) greater than the value of the nominal 5%, suggesting that the instruments are also strong. Similarly, in female-headed households, the minimum eigenvalue (13.0248) is greater than the nominal value of 5%, Wald test at 5% bias tolerance, and the joint significant test (F= 12, 215 p=0.000), indicating strong instruments for land access and for ownership of land, the minimum eigenvalue statistic (12.1843) greater than the value of nominal 5%, Wald test at 5% bias tolerance at same joint significant test (F= 12, 215, *p*=0.000) meaning that the instruments are strong.

5. CONCLUSION

Using a cross-sectional data from farming household heads in rural Nigeria, this study has investigated the impact of land access and land ownership on farm production among male and female headed households in the study area. The study employed propensity score matching (PSM), inverse probability-weighted regression adjustment (IPWRA), and instrumental variable (IV) regression approach to control for possible endogeneity that could arise from the nature of the data collected. The matching approach made a comparison between male and female headed households who had access to land and owned parcel of land and drew conclusion by gender. Findings show that age, marital status, level of education, and farming experience, mode of land acquisition, access to credit, and membership of association and distance to nearest market are statistically significant relationship with male headed households' access to land and land ownership at various levels. While education, household size, access to credit, and membership of association, distance to nearest market, access to extension, years live in community and access to varietal information affects female headed households' access to land and capacity to own parcel of land. Using PSM and IPWRA estimates, findings show that having access to land

improved farm yields by 21.96% and 16.16% in male-headed households, respectively, and having land title or ownership raised farm yields by 24.74% and 20.05%. Land access has also raised farm production (yield) by 16.38% and 13.59% among female-headed households, respectively, and land ownership by 17.36% and 17.22%. The significant difference existed between farm yield gained by male and female headed households due to their level of land access and land ownership. Also, the impact of land access and land ownership was more felt in male headed households compared to their female counterparts in the study area. Findings reveal that there were gender differences in land accessibility and ownership in the study area as male headed households were found to have more access to farm land than their female counterparts.

By recommendation, a reliable data on male and female headed households' access to land and land ownership are critical for providing an accurate picture of female headed households' land tenure arrangement, improving policy formulation and monitoring progress towards the attainment of gender equality in land access. Gender-sensitive policy and legal frameworks (including their implementation) are fundamental for bridging the gender gap and advancing female headed households' access and opportunity to own land. Legislation that guarantees female headed households' equal rights to land, irrespective of their civil and marital status, is crucial. Also, group formation and membership should be promoted and encouraged especially among female headed households to enhance their purchasing power through access to credit, and common voice in accessing communal lands. This is so because findings from the study attested that membership of association and access to credit largely influences household heads' access to land and improved their production capacity.

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7. CONFLICT OF INTEREST

The authors have declared that no competing interests exist.

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10. KEY TERMS AND DEFINITIONS

Gender analysis: A gender is a systemic study of differences in the conditions, needs, participation or involvement rates, access to resources and development, control of assets, decision making powers etc. between women and men. Gender analysis explores these different roles and experiences so that policies, programmes and projects can identify and meet the different needs of women and men.

Gender disaggregated data: This refers to a process of data collection and analysis that focuses on issues of particular relevance to household heads, women and men, girls and boys, and their different roles and positions, access to land and other production resources within society.

Gender gap: This is a measure of gender inequality. It is useful social development indicator.

Land access: Access to land is governed through land tenure systems. Land tenure is the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land. Rules of tenure define how property rights in land are to be distributed within societies, along with associated responsibilities and restraints.

Land rights*:* The allocation of rights in land; the delimitation of boundaries of parcels for which the rights are allocated; the transfer from one party to another through sale, lease, loan, gift or inheritance; the registration of land rights; and the adjudication of doubts and disputes regarding rights and parcel boundaries.

Matriarchy: This term refers to a form of social organization in a culture or specific community in which descent and inheritance are traced through the female line of a family.

Patriarchy: This term refers to form of social organization, prevalent in most societies globally in Africa, in which descent and inheritance are traced through the male line of a family.