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The Effect of Farm Accessibility and Market Proximity on Farmer Efficiency in Oyo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The effect of farm accessibility and market proximity on the farmer's food production capacity remains unclear. The main concern is how farmers' productive ability is influenced by market-farms accessibility and proximity. Optimal food production is contingent on the ease of accessibility to purchase farming inputs and an enabling environment for farmers to maximize their benefits. As important as the accessibility *vis*-à-*vis* facilitating farmers' movement from farm to market in the agricultural production process, the required attention is lacking in the scheme to reposition agriculture and promote food self-sufficiency. Previous studies examined the market location outside the present study area and they did not examine farmers' technical efficiency and its determinant. This paper used remote sensing and GIS technique and a parametric model to first examine the location pattern of the agricultural input market and estimated farmers' technical efficiency and its determinants. The Nearest Neighbor Index (NNI) of 2.15 and a z score of 5.41 revealed a proximity differential in the location of agricultural input markets indicating that the

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markets are dispersed and not equidistant from the farmlands. In addition, the efficiency estimation did not return labour as a significant variable, however, herbicide, fertilizer, and the size of farmland cultivated were significant in reducing farmers' inefficiency. It emerged age and access to credit significantly reduced the inefficiency of the farmer's production process. The outcome of the study suggests more use of GIS and RS to solve agricultural challenges; improving accessibility by tarring more roads; intensely training farmers before loan disbursement and paying attention to variables promoting inefficiency among farmers to ensure the optimal deployment/allocation of their resources to achieve optimal production and efficiency in the study area.

Keywords: Spatial location of input market; technical efficiency; inefficiency; farm-market distance; Nigeria.

1. INTRODUCTION

Food production, particularly in sub-Saharan Africa is dominated by smallholder farmers. Here, as a norm, farmers produce food in a naturally challenging environment of climate vagaries and cultivation relies heavily on rainfall. Farmers till their farmland with practices that are unsustainable and erode the nutritional integrity of the soil to support the growth and development of their cultivated crops. The past 2 decades have witnessed increasing calls for environmental decarbonization, and this has led to the simultaneously increased in the economic value of land and competition to use land for other purposes other than food production [1]. This occurrence exacerbates farmers' level of poverty subjecting them to a continuous search for tillable land adequate in chemical and physical property to cultivate and earn a livelihood. By extension, farmers' continuous pursuit to earn a living by farming limits them to farmland that is mostly inaccessible to the existing road network, and farther away from the existing market where they can buy farm inputs and sell off their farm produce.

The location of the farm and access routes through and around it are crucial to the process of food production. According to Stewart [2], accessibility converges an economic advantage to and around an area in the form of short average distances to the destination particularly to input markets. Thus, the inaccessibility of farmlands especially at the onset of production would have a large impact on the success or failure of the food production process. For instance, Hau and Von Oppen [3] revealed that a short distance between the farm and the market increases the use of farm inputs in the farming season. Oyatoye (1994) reported that an accessible road network avails farmers the opportunity to a wider range of product markets where a choice of input could be sourced at a competitive price. Gouse *et al*. (2021) in South Africa found that access to affordable and high-quality agricultural inputs significantly improved the profitability and technical efficiency of smallholder farmers. The authors further added that smallholder farmers in more remote areas often faced significant challenges in accessing inputs, and are therefore hindered from competing with larger farms located in areas that support their access to input resources. Nhamo *et al*. [4] believe that farmers' ability to source agricultural input reduces transportation costs, improves access to credit and information, and ultimately improves farmers' livelihoods. Analogous to farmland located around the inaccessible route is the farmers' inability to timely source agricultural inputs with resultant negative impacts on their performance and livelihoods, including but not limited to reduced crop yield, decreased quality of produce (Ali *et al*., 2020), increased production costs [5], and vulnerability to climate change (Faye *et al*., 2021).

The foregoing underscores the report of Pingali [6] where he recommended the provision of additional roads and agricultural input market infrastructure to fast-track farmers' transition from small to large scale. Farmers' adequate access to the input market aided by an accessible road network is a fundamental unit in accessing the general productivity and efficiency of food production. And by examining farmers' productivity and efficiency, the source of the gap between productivity and efficiency would be revealed. In essence, this would translate into financial gains for farmers. Furthermore, the outcome of the examination would also serve as a platform to improve policies designed to drive positive performance in food production. As the productivity of the production unit is the ratio of output to input, differences in productivity could also arise from the production environment, production technology, and production efficiency.

Therefore, the production efficiency of a unit is the ratio of the observed maximum output that could be produced from a defined set of inputs.

Geographical Information System (GIS) has been useful in recent times. For example, Garcia-Perez and Casares-Hontaño [7], Mahabir *et al*. [8], Prieger *et al*. [9], Grigsby-Toussaint *et al*. [10], and Hua *et al*. [11] used the GIS techniques to provide important insight into analyzing the location of markets, recreation facilities, and health facilities, and how such analysis can inform public policy and improve public health outcomes.

Similarly, this research employs the same technique. Thus, this study adds to the body of knowledge by empirically exploring the spatial distribution of input markets and consequently examining the accessibility attributes as they influence the technical efficiency of farmers in the Surulere local government area of Oyo state, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

Surulere Local Government according to Köppen climate classification is regarded as a Tropical savanna climate. It lies between latitude Latitude: 8.07179, Longitude: 4.4149 **(**8° 4′ 18″ North, 4° 24′ 54″ East) and it is about 372m (1220 ft) above sea level. It is bounded by Ifelodun and Orolu Local government of Osun State, Asa local government in Kwara State and Orire, Ogbomoso North and South local governments, of Oyo State.

The administrative headquarter of the Surulere local government is Iresaadu and has about 260 communities. Notable among them are Iresaadu, Oko, Iresa-apa, Iregba, Orile-igbon Gambari, Gbede, Ajase, Iwofin, Arolu, Ilajue, Bade-oba, Baayaoje, Mayin and Iware. The local government spans over a 925 Km^2 area of land with 142 070 people living there according to the 2006 census. Today the number of people has increased to about 200, 000 people as reported by the local government administration. In addition to calving calabash, inhabitants of Surulere Local Government are predominantly farmers cultivating among other crops Yam, Cocoa, oil palm, maize and tobacco.

The soil type found in the study as shown in Fig. 2 are luvisols, acrisols, lixisols and leptosols. These soils have varying characteristics such as good drainage, nutrient retention capacity, balanced texture and well-developed horizon.

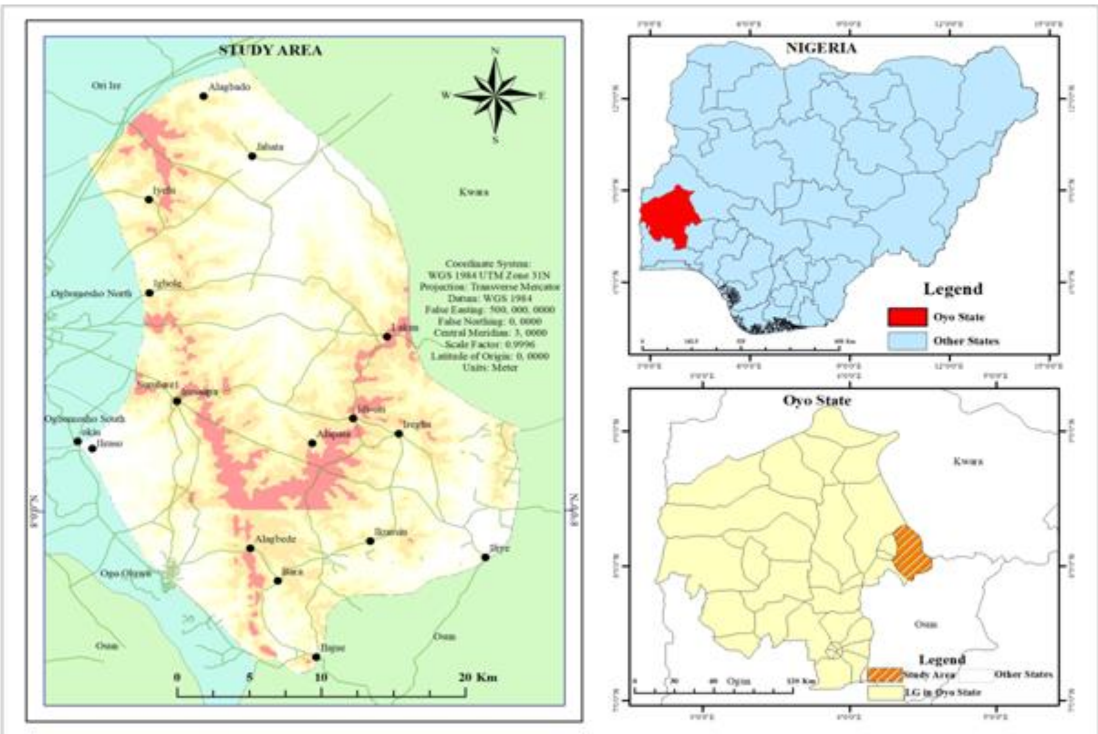

Fig. 1. Map showing the study location

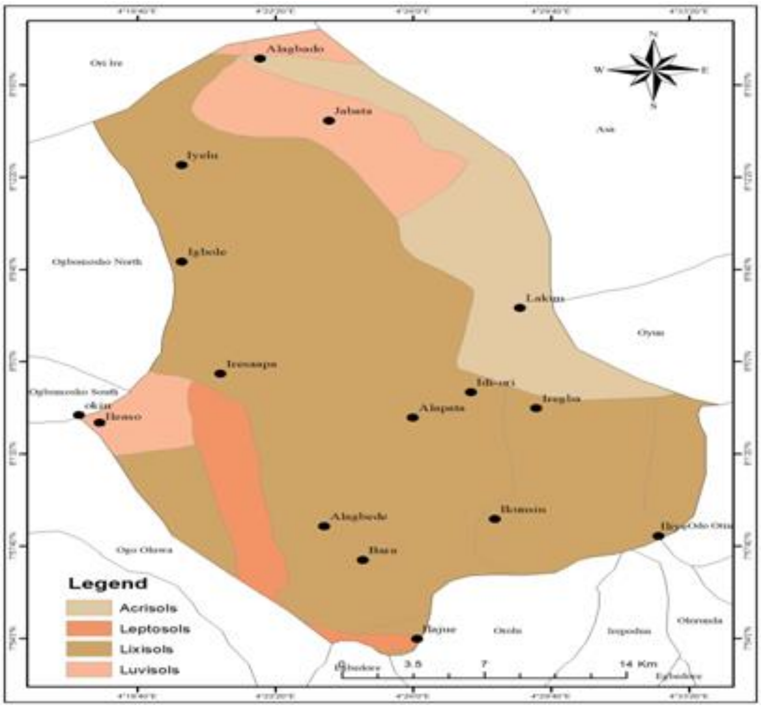

Fig. 2. Map showing soil type variation

The Lixisols have a little variant characteristic making agriculture possible only with frequent fertilizer applications, minimum tillage, and careful erosion control. Lixisols are a more adequate medium to cultivate perennial crops.

Surulere LG belongs to the Guinea Savannah receiving between 1100-1500mm of rainfall annually [12]. Fig. 3 shows the land use land cover inventory.

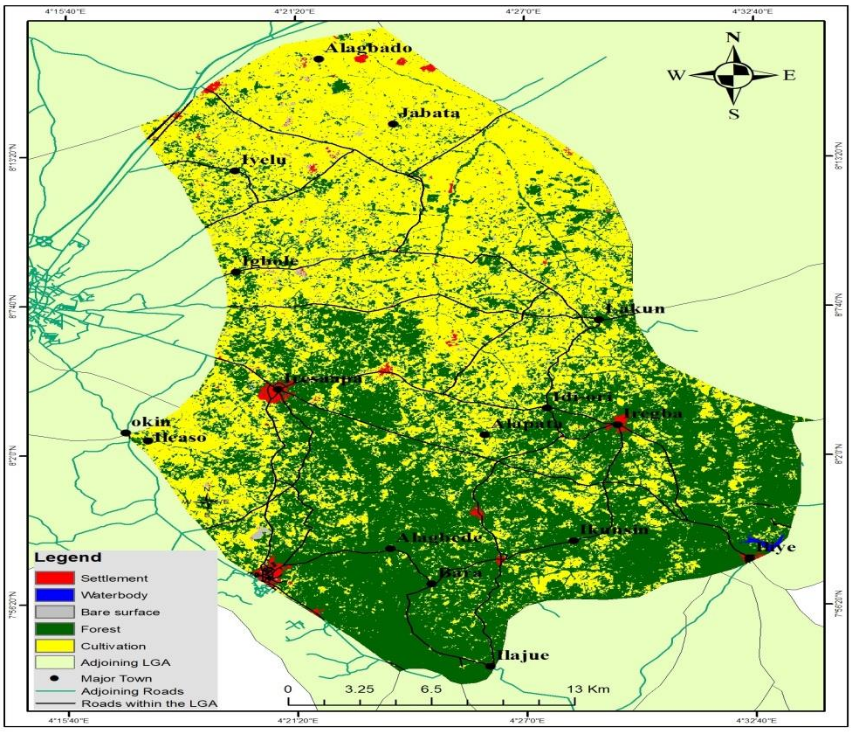

Fig. 3. Land Use Land Cover map

The settlement occupies about 10.450 Km^2 accounting for 1.11% of the study area. The area of land occupied by waterbody and the bare surface is 0.693 km^2 and 7.464 km^2 which account for 0.07% and 0.79% of the study area respectively. The area of land occupied by forest (441.564 km^2) and under agricultural cultivation (482.847 km^2) is the highest with forest accounting for 46.82% and cultivation 51.20%. This statistic indicates that the inhabitant of the Surulere local government area are mostly farmers.

2.2 Data Collection, Sampling, and Sample Size

This original research employed both primary and secondary data sources. Two Primary data were collected. First, GPS coordinates of the markets were obtained using a GPRS device. Farm-level information was the second, and it was gathered through a cross-sectional survey carried out with a questionnaire. Presented in Table 1, the farm-level data was collected from maize farmers in the Surulere local government area of Oyo state between November 2018 and April 2019. This period marked the end of the annual growing season in the study area, which is characterized by dry harmattan wind. Maize grown during this period is considered suitable for storage due to its lower moisture content making it ideal for storage in silos. The secondary data (i. e. the 30-meter Shuttle Radar Topographic Mission (SRTM) was sourced from USGS, and the soil map for Nigeria from the Centre for World food studies and Nigeria Grid 3) was employed for the spatial analysis.

Studies [13-15] have shown that the use of technology and complementary agronomic/ cultural practices can have a positive impact on farmers' production and efficiency. On the other hand, Kassie *et al*. [16] and Zeng *et al*. [15] have reported that these technologies can be rendered inaccessible or less profitable for farmers due to structural impediments. In this study, we focused on the status quo of farmers and the condition under which they are currently growing their crops paying attention to hindrances confronting farmers. We identified inaccessible tarred roads as a primary impediment, and we identified their provision is outside the control of farmers. We also considered the advantage inherent in mixed cropping but it was discovered that the economic disincentive may burden farmers who have to use different agronomic practices in such a system. Given these challenges, we decided to focus on a single crop, maize. Maize is the most important cereal crop grown by farmers in Nigeria, and it is estimated that 6.5 million farmers grow maize in the country. This number represents 25% of all farmers in Nigeria. The average yield of maize per hectare in Nigeria is 1.6 tons, which is considered low compared to other African countries. We believe that by focusing on maize, we can better understand the factors limiting production and develop strategies to improve maize production in Nigeria.

Table 1. Variable description

Variables	Description	Variable type
Y	Maize output (kg)	Continuous
X_1	Herbicide (litre)	Continuous
X_2	Fertilizer (kg)	continuous
X_3	Farm size (Acre)	Continuous
X_4	Labour (Man hour)	Continuous
Age	Age of the respondents	Continuous
Exp	Experience of the respondents (years)	Continuous
Dis	Distance from the respondent farm to the market (km)	Continuous
Sch	Years spent schooling (years)	Continuous
HH-Size	Household size of the respondents	Continuous
EXTSERV	Extension service (Yes/No)	Categorical
MemAss	Member of association (Yes/No)	Categorical
CredAcc	Respondents’ access to credit (Yes/No)	Categorical
HFarMkt	Transportation fare commuting from home-farm-market expensive? (Yes/No)	Categorical
AcctoFarm	Access road to farm tarred? (Yes/No)	Categorical

Source: Authors compilation

Moreover, maize cultivation is sensitive to time, especially in environments like the study area that depends on rainfall and any time lag in the cultivation process could result in lowered productivity. The study employed a multistage sampling technique to select farmers. In the beginning, the Surulere local government area in Oyo state, Nigeria was purposively selected because of its accessibility coupled with the land resources that is available for agriculture, particularly maize cultivation. Then, simple random sampling was employed to select 6 markets (with the following names and coordinates: Gambari: 8.267386 ° 4.319245 °; Iresa-adu: 8.07249 ° 4.34741 °; Oko: 7.953478° 4.341298 °; Iregba: 8.052987 ° 4.487885 °; Iresa-apa: 8.072456 ° 4.347432 °; Iwofin: 8.128461° 4.302314°) in the local government. These markets were selected because they are the major markets that operate every 5 days. This made it easy to access and interview farmers who come to buy farm inputs or sell their farm products on the market day. The third stage involved the combination of simple random selection and snowball method to select farmers for interviews in the market. The plan was to interview 60 farmers in each market, for a total of 360 respondents. Nevertheless, only 251 respondents were successfully interviewed.

2.3 Stochastic Frontier Estimation

The model in this study follows the steps taken by Balogun *et al*. [17]. The stochastic frontier approach allows us to estimate individual farmers' technical efficiency and the determinants of inefficiency, as explained by Battese and Coelli (1995). The suitability of this model for the study lies in its ability to address the unpredictable events that often accompany agricultural processes, especially in sub-Saharan Africa, where many factors are beyond the control of farmers. These factors include but are not limited to, drought, insect infestation, and damages caused by grazing animals, all of which have been documented as events outside the control of farmers. The stochastic frontier model captures the aforementioned events as an error term in the inefficiency aspect. The model's ability to account for statistical noise makes it a robust choice for assessing farmers' activities in a difficult environment, such as the current study area, where amenities are not readily available. The stochastic frontier model also eliminates the loss of discriminating power that could occur when there is no clear relationship between inputs and outputs, which might result in an individual farmer being misidentified as an efficient unit operating at the frontier. Consequently, the estimated functional form stated below fits variables that are specific to maize production in order to discern farmers' technical efficiency and the factors that could inhibit their optimum performance under the current circumstances.

$$ln\, Y_j = \beta_0 + \sum_{i=1}^{i=4} \beta_i\, ln\, X_{ij} + v_j - u_j$$

Where;

ln refers to a natural logarithm; *i* and *j* are subscripts, respectively, representing the inputs *i* used by farmer *j*.

The random parameter that has zero mean and an unknown variance σ_v^2 is denoted by v_j. Furthermore, the technical efficiency in the maize production process of the j^{th} farmer with a non-negative random term $(u_j \geq 0, \forall_j)$ is denoted by u_j. This is assumed to be independently and identically distributed between observations and is obtained by truncation at point zero of the normal distribution with mean u_j, and variance σ_v^2, where the mean equation is explained as follow.

$$\mu_j = \delta_0 + \delta_1 Age_j + \delta_2 Exp_j + \delta_3 Dist_j + \delta_4 Sch_j + \delta_5 HHSIZ_J + \delta_6 EXTSERV_j + \delta_7 MemAss_j + \delta_8 CredAcc_j + \delta_9 HFarMkt_j + \delta_{10} AcctoFarm_j$$

3. RESULTS AND DISCUSSION

3.1 Nearest Neigbourhood Estimation

Access and proximity to the farm market are vital ingredients to the food production process. Surulere LG consists of many hamlets, villages, and settlements. Many of the hamlets are temporary shelters for farming households. From this temporary accommodation, many farmers move their farm produce to the market for sale as well as buy the farm input they need. The location of these markets and the distance (proximity) occasioned by the absence of untarred roads which farmers have to travel from different points and the likely effect it could have on farmers' production capacity underscores the spatial assessment of the farm-market location and distribution of such markets in the Surulere local government area of Oyo state as displayed in Fig. 4.

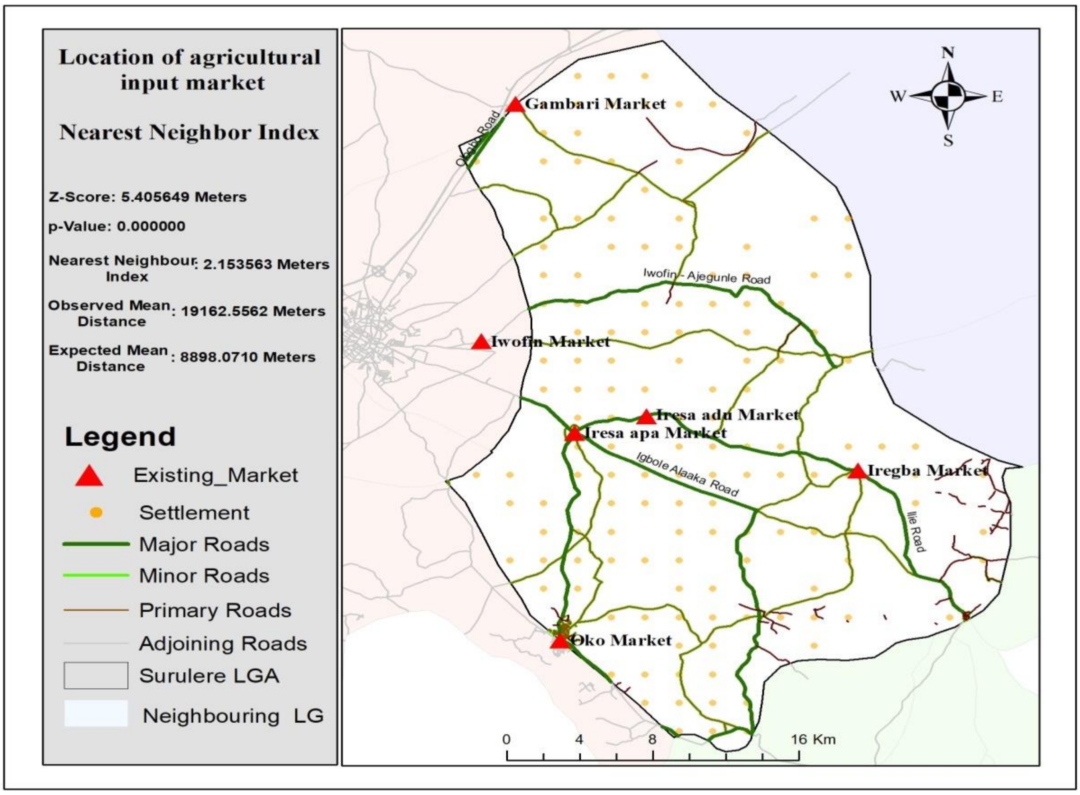

Fig. 4. Nearest Neighourhood Analysis of Surulare LGA of Oyo state

The Geographical Information System (GIS) and Remote Sensing (RS) techniques establish the statistical level of clustering or dispersal using the nearest neighbour. The proximity from a market to its nearest neighbour is measured and a consequent measure of the mean distance of all is calculated. A hypothetical set of data is created from two different points with the corresponding number of features and places located within the area. The real data is thereafter compared with the average measure of these features. Where the hypothetical data is less than 1 the observed nearest neighbor index reveals clustering and where it is greater than 1, it implies the features are dispersed. The Z score reveals random or pattern occurrence.

The statistic contained in Fig. 5 shows the proximity differential of market location in the Surulere local government area of Oyo state. The Nearest Neighbor Index (NNI) is 2.15 and the z score is 5.41. Since the NNI is greater than 1, it implies that the market in the study area is dispersed. By implication, the location and distribution of the market are not equidistant with the farms, hamlets, villages, and settle in the study area.

3.2 Sociodemographic Description of the Respondents in the Study Area

The sociodemographic continuous variables present in Table 2 show that the mean age of the respondents in the study area is 51. The estimates showing how experienced the farmer is on average is 12 years. This hints at a significant level of experience on average. Going by the years spent in school which could be understood as the level of education acquired by the respondents shows that on average, respondents in the study area spent 7 years in school. This could mean that average respondents had a primary school education.

The mean distance between the farm and the market in the study area as shown in Table 1 is 6 km. By implication, an average farmer travels this distance to buy his or her farm input or move the harvested produce to the market. The mean size of farmland cultivated by farmers in the study area is 3 acres. This result reveals that farms in the study area are majorly small-scale farmers.

According to Table 3, accessibility to the majority of the farmer’s farmland in the study area is not tarred. Across the variables and regardless of accessibility (whether tarred or not tarred) to farmers' farmland, it was observed that the majority of farmers were on a leasehold. This implies that these farmers are likely to be subject to conditions to which they could use the land. Furthermore, this hints at the possibility of the farmers not being able to grow their choice of crop on the leased land.

In addition, farmers whose access to their farmland is not tarred and who leased their farmland were observed to have the majority of the farmers: with access to credit; hired labour for their farm activities; consider the cost on home-farm-market (H-F-M) too expensive; and are a member of the association.

Farmers whose access to their farm is tarred as shown in Table 3, have the number of farmers who purchase or inherited farmland in a single-digit frequency making the frequency across the variables higher for farmers holding land on lease higher than farmers who purchased or inherited their farmland in the study area.

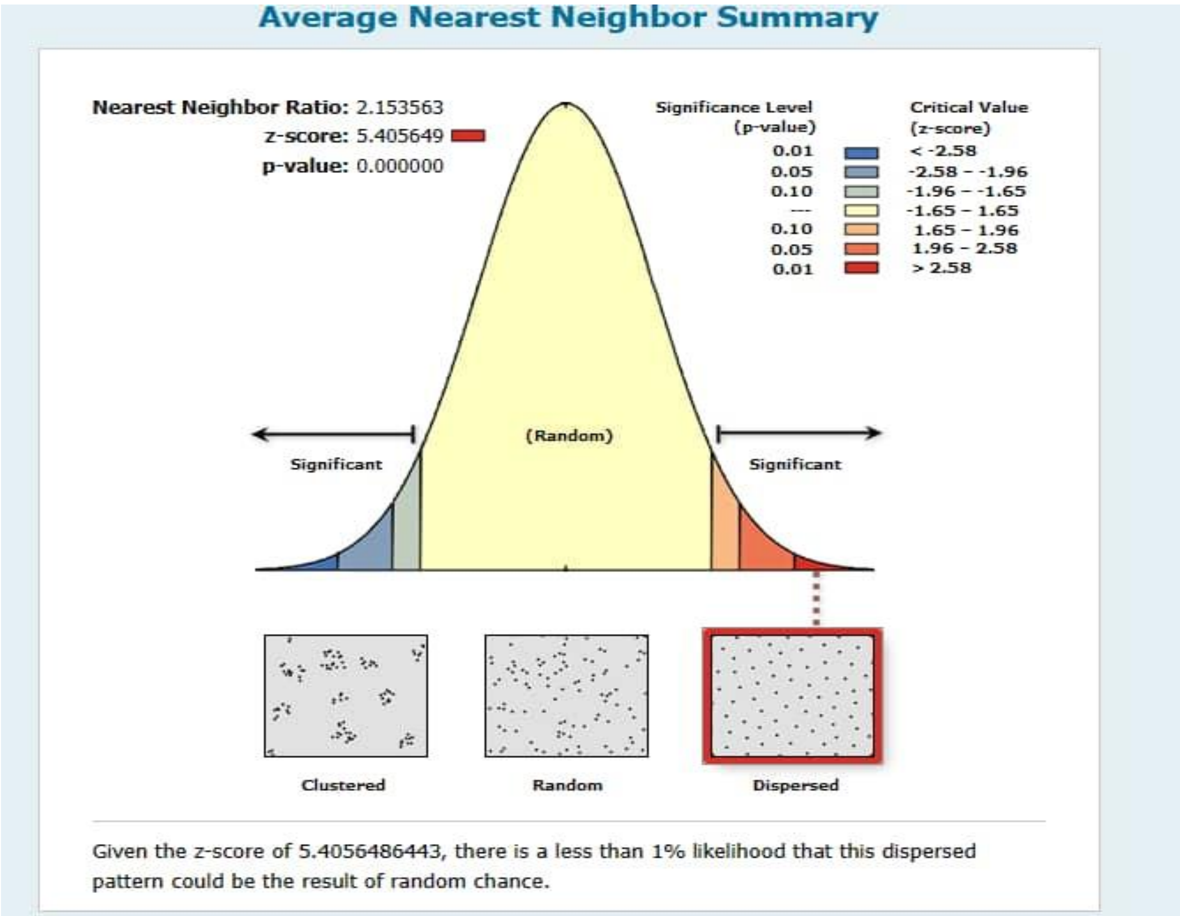

Fig. 5. Average nearest neighbor

Table 2. Sociodemographic continuous variables

Variable	Mean	Std. Dev	Min Val	Max Val
Age	51	5.03	39	66
Experience	12	5.99	1	30
Household size	4	1.47	1	8
Education	7	3.18	0	16
Farm-to-market distance	6	1.17	3	10
Farm size	3	1.20	1.08	5.75

Source: Authors' computation

Table 3. Description of categorical attributes

Variable	Category	Access to Farm and Land Ownership					
		Not Tarred			Tarred		
		Leased	Purchased	Inherited	Leased	Purchased	Inherited
Gender	Female	53	8	32	13	3	3
	Male	68	5	51	9	2	4
Member of Association	Non-member	29	4	33	6	2	4
	Member	91	9	50	16	3	3
Extension Service	No	75	8	49	6	-	3
	yes	46	5	34	16	5	4
Access to Credit	No	39	3	26	7	1	3
	Yes	82	10	57	15	4	4
Labour Type	Family	28	1	17	8	1	1
	Hired	93	12	66	14	4	6
H-F-M fare high?	No	31	3	21	4	1	2
	yes	90	10	62	18	4	5

Source: Author's computation

3.3 Estimation of Respondents' Technical Efficiency and Inefficiency

The lack of social amenities such as roads has important implications on farmers' food production process and by extension affects their efficiency. The interaction between factors that could be controlled by farmers, those that are outside their control, and factors depicting the farmer's production environment were fitted and estimated with the stochastic frontier model and the estimates are presented in Table 4 below.

Table 4. Stochastic frontier estimation

Variables	Parameter	Coefficient	Z	p>|z|
Intercept	β_0	2.53	19.50	0.000***
Herbicide	β_1	0.19	3.32	0.001***
Fertilizer	β_2	0.19	3.78	0.000***
Farm Size	β_3	0.57	8.73	0.000***
Labour	β_4	0.01	0.23	0.821
Inefficiency model				
constant	δ_0	10.74	1.53	0.126
Age	δ_1	-8.24	-1.99	0.047*
Experience	δ_2	-1.95	-1.42	0.155
Farm-Market Distance	δ_3	1.35	0.85	0.396
School	δ_4	0.00	0.01	0.989
Household size	δ_5	0.00	0.01	0.994
Extension Service	δ_6	-0.38	-0.13	0.894
Membership of Assoc.	δ_7	0.07	0.23	0.820
Credit Access	δ_8	1.15	1.81	0.070*
Home-Farm-Market Transportation fare	δ_9	-0.06	-0.20	0.840
Access to farm	δ_{10}	-0.55	-1.38	0.169
Sigma	v	-6.90	-12.57	0.000***
	u	-4.02	-23.14	0.000***
Loglikelihood		285.08		
Lambda		4.21		
Mean Efficiency		0.90		

*Source: Author's computation. Note: ***p>0.01, *p>0.1*

Of the four variables fitted to estimate the efficiency of farmers in the study area, only the quantity of labour employed during the growing season did not significantly contribute to the output. This hint that there is not enough evidence to conclude that the variable “labour” has not significantly influenced the efficiency of the quantity of maize output produced. However, the positive sign on the coefficient suggests that farmer who uses hired labour have a better chance of being technically efficient than farmers who used family labour. And this may be attributable to the belief that hired labour tends to be more productive because of their skill and experience relative to family labour. Although, Azam and Khan [18] a significant and positive relationship between the use of hired labour and technical efficiency in Pakistan, since our estimation returned insignificant, it follows that there is no sufficient relationship to conclude that the use of hired labour promotes farmers’ technical efficiency relative to family labour in the study area.

The quantity of herbicide had a significant effect on the farmers’ output and efficiency. This show that the variable is statistically significant at 0.01 level of probability. This reveals a strong and sufficient indication to infer that the use of herbicide had a significant influence on the efficiency and output of maize produced. This result does not imply that the use of herbicides is the bedrock that assures farmers level of efficiency but it revealed it is a crucial factor that should not be ignored in the food production process. This outcome tallies with the finding of Benhin and Adu-Gyamfi [19] and Ngo and Le [20] whose different research reported a positive impact of the use of herbicides on the productivity of farmers in Ghana and Vietnam.

Similarly, the use of fertilizer returned values that showed its use is crucial and statistically significant among respondents being examined. Put differently, there is a sufficiently strong indication that the use of fertilizer during the farming season contributed immensely to farmers in the study area’s efficiency and maize output. This might not be unconnected with the improved crop harvest associated with fertilizer application even when the same area of land is cultivated. This hint is not to conclude that other factors do not contribute to higher yield and the efficiency of farmers recorded, as such, it may also be important to examine other factors like farmers’ access to the market among others. This result aligns with the finding of Adepoju and Ogundele (2014) who documented that the use of fertilizer had a positive impact on the yield of maize and cassava in Nigeria.

Although, as shown earlier section the majority of the farmers examined in the study are small-scale farmers, the size of farmland a farmer cultivate could assist farmers take advantage of economies of scale which lowers the cost of food production and returns more yield. The foregoing is instructive given the strong indication to conclude that farm size contributed significantly to farmers’ efficiency and the output of the maize produced. However, it is important to mention that this finding cannot be generalized as it merely drew conclusions from the assessment conducted on the data gathered from farmers 251 in the Surulere local government area of Oyo State. In addition, this association between the size of cultivated land and farmers’ technical efficiency may have occurred as an ideal size after which the technical efficiency of farmers begins to fall and not more of a linear occurrence. This result shared the same view with Adhikari and Dey [21] who reported a positive and significant relationship between the technical efficiency of vegetable farmers in Nepal and the size of farmland cultivated.

The afore-explained relationship implies that an increase in the quantity of these variables in the right proportion would amount to an increase in the output of farmers. The mean technical efficiency value of 0.90 shows that farmers in this study area are demonstrates some level of efficiency in combining the factors of production stated above. The lambda value of 4.21 shows an inefficiency heterogeneity and given that the value is greater than 1 hints at some level of inefficiency in the production system. This value shows a significant variation in the data, attributing it to inefficiency, and also illuminates the gap between what could be achieved and what was achieved.

The 10 per cent that accounts for the inefficiency in the estimation could be explained by farmers’ age, experience, household size, the distance between farmers’ farmland and market, the years spent in schooling, farmers’ access to extension service, farmers being a member of farmers association, farmers access to credit, farmland having access road that is tarred and farmers considering transportation fare from home to farm and to the market is expensive.

3.4 Factors Impacting Farmers' Inefficiency (Determinants of Technical Efficiency)

The inefficiency side of the Stochastic Frontier Model (SFM) explains the factors that contribute to farmers' inefficiency. The coefficient of a variable on the inefficiency side indicates the direction of the relationship between the variables and inefficiency. A positive coefficient indicates that the variable is associated with higher inefficiency, while a negative coefficient indicates that the variable is associated with lower inefficiency.

From Table 4 Age is statistically significant at 0.05 level of probability. This outcome hints at sufficient indication to say that age has a significant influence on the inefficiency of farmers in the study area. The negative estimate of the coefficient of the variable "age" indicates a low level of inefficiency. This finding implies that farmers who are old are likely to be more efficient relative to farmers who are young in the study area. In addition, it shows that older farmers have a small gap between observed and maximum achievable output levels This might not be unconnected with the wealth of knowledge that older farmers have acquired over the years from which they can rationalize and help them make an informed judgment that may assist to operate at the frontier of production. This finding does not concur with Adeoti and Abiola [22] who discovered older farmers were less efficient technically relative to younger farmers in Nigeria. Furthermore, Adhikari [23] discovered that the age of farmers had no significant influence on the technical efficiency of farmers in Nepal. This indicates that the influence of age on technical efficiency is mixed.

Farmers' access to credit had a positive estimate which indicates that the more access farmers have to credit the higher their inefficiency. It implies that the gap between achievable and observed production increases with farmer access to credit. This variable shows an estimate that is almost significant but not at 0.05 level of probability. Although the magnitude of the effect of access to credit is 1.15 and not too large, this hint that the estimated relationship between access to credit and inefficiency may be a result of random chance compared to a true underlying association. Furthermore, this result suggests the likelihood that farmers with access to credit may be burdened with the repayment which eventually push them into a financial mess that makes them lose focus and thus declined in capacity to operate optimally. This outcome also suggests the need to examine the type of credit accessible to the farmers in the study area among a host of other things.

Although the remaining variables do not show statistical significance, the negative sign on their estimates attracts attention. For instance, the estimate of farmers' experience shows that as farmers gain more experience, their efficiency level increases. This finding tallies with conventional thinking as repeated years of farming in and out confers a better approach adoption that guides farmers' activities to operate at the frontier of production.

With a small magnitude that suggests a random chance of occurrence compared to a true underlying association, access to extension services estimates indicate that when extension services are not deterred by the lack of social amenities (such as a road) from reaching farmers there is the ease of exposure to innovative extension methods, techniques, and services, thus, farmers' level of inefficiency in their production process declines. Similarly, access to farm estimates carries a negative sign. This hints that as more access roads (tarred roads) leading to farms are constructed farmers' level of inefficiency decreases. This finding hint that where hindrances are removed, farmers would experience fewer economic losses such as high transportation cost, and delay in buying agricultural inputs which could render them unproductive in the food production process. Although the magnitude of the coefficient is small, and not significant, it is, however, instructive to give the variable attention in the scheme of effort to provide infrastructure to improve farmers' efficiency level.

The estimate of Farm-Market distance according to Table 4 is not statistically significant. Going by the positive estimate of the coefficient, it follows that farmers whose houses are distant from the market would likely be less efficient, and this might not be unconnected with complexities in purchasing farm input and selling their harvest. This outcome tally with the spatial result in the earlier section that hints that markets in the study area are dispersedly located.

A positive relationship was observed between years spent in schooling and inefficiency. Although this relationship is not significant, and drawing from the magnitude of influence which is small, it could be said that the association occurred as a result of random chance compared to a realistic casual effect. This outcome points to the likelihood of farmers with more years in school having exposure and a greater level of awareness of innovative techniques but having difficulties importing and replicating them on their respective farms due to the accessibility exigencies. This finding corroborates the finding of Baldwin and Gu [24] where the relationship between technical efficiency and schooling had no significant relationship. On the other hand, the research conducted by Fan *et al* [25] negates this finding.

According to Table 4, the estimate of the household size of the respondent in the study area showed no statistical significance. The magnitude of influence as shown in the table suggests its occurrence could have occurred by random chance or no distinct link exists between technical inefficiency and household size. This finding agreed with De Janvry and Sadoulet [26] who found no statistically significant impact of household size on technical efficiency.

Being a member of an association was also discovered to increase the farmers' inefficiency in the study area. However, the relationship is not significant. This finding suggests that being a member of an association has no significant influence on farmers' technical inefficiency in the study area. The expectation would have been that farmers who are members of the association would be in the procession of skills that would help them improve their food production process. This is because an association is considered a point of convergence of like minds and a point where ideas could be shared to promote optimal production processes among its members. This outcome agreed with De Janvry and Sadoulet [26] who reported that agricultural associations had no significant impact on the technical inefficiency of Mexican farmers.

The estimate of home-to-farm-to-market transport fare is not statistically significant according to Table 4. But the negative sign suggests that farmers who consider the amount of money associated with this variable expensive have a higher chance of not being efficient in their food production process. This result shared similarity with the findings of Tsega and Mekonnen [27] who discovered transportation costs negatively impacted farmers' productivity in Ethiopia.

4. SUMMARY AND CONCLUSION

Remote sensing and GIS remain veritable tools. They have shown the dispersed pattern of agricultural input market location in the study area. The outcome of the study also shows that the pattern and location of the markets affect the capacity of farmers to produce food efficiently which implies that some level of inefficiency occurred among maize farmers in the Surulere local government area of Oyo state.

Although some of the factors that accounted for inefficiency may be explained to have occurred by random chance because of their magnitudes, however, one that draws attention is the absence of an access road which by extension makes commuting to purchase input or sell the harvested products during the production season difficult. This call for additional market spaces that should be centrally situated with accessible roads such that many farmers' farmland will only be a few meters away from motorable roads. The provision of these roads could be complemented with the agricultural hubs where farmers should be encouraged to converge their harvest, and with a little processing recommended for products with a short shelf life and subsequent movement to larger end users. This will reduce the hardship, time, and financial expenditure committed to the farming process and consequently help farmers improve their productivity.

Most farmers in the study area are small-scale farmers who leased their farmland. This underscores the need for government to make farmland more assessable to farmers in the study area. It also reveals the urgent need for government to review how land is held in the study area with the view of ensuring that held by those who can put it to more productive use. And farmers should as well be trained well on the optimal use of land to scale up production. Furthermore, this outcome underscores the need to understand why most farmer farm on leased land and the terms and condition under which the land was leased to them among others, and how such conditions impact their productive capacity.

Given that access roads to the majority of farmers' farmland are untarred, farmers are a member of the association and older farmers were more efficient, it follows that farmers need to organize themselves in a manner that would allow older active farmers to take up advisory roles, particularly in farmer's association groups.

This will allow symbiosis engagement with extension officers thus facilitating the ease of disseminating useful information amidst the absence of accessible roads through which extension officers could get in contact with farmers, particularly on farms. Furthermore, the foregoing relationship (often referred to as the participatory approach) helps to build a robust framework of innovative technology at the conceptualization phase of innovative techniques aimed at promoting the farmers' productive capacity.

The majority of the farmers whose access road to their farmland is untarred still had access to credit. This outcome centralizes the need for farm-specific training before loan disbursement to ensure that the loan is used optimally and not diverted for other use.

5. FUTURE STUDY

Future studies need to examine and suggest points where new markets could be located. It should examine the tenure system and its possible impact on the food production capacity of farmers in the study area. Another systematic assessment should focus on farmers' socioeconomic activities and elaborate on alternative economic activities deployed to mitigate the effect or impact of a failed cropping season This could be captured along with technological impacts on farmers food production process.

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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