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Determinants of peri-urban and urban agricultural locational choice behaviour in Lagos, Nigeria

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ABSTRACT

This article quantitatively assessed factors that shape locational choice behaviour of urban farmers. Three hundred questionnaires were randomly administered to farmers in ten localities with a view to identifying factors that shape their locational choice behaviour. The average number of farmers per locality was designated as the index of attractiveness and was correlated with six broad categories of factors identified by farmers as influential in urban agricultural site selection. These broad factors are proximity to water, proximity to residence, access to land, proximity to market, suitable fertile soils, and availability of labour. These factors were subsequently broken down to sixteen categories. Almost all the variables exhibited negatively significant correlations with the index of attractiveness. Urban farmers prefer sites which were closer to water, free with minimal lease and rental cost, and also sites with fertile soil that is closer to farmer's residence, where aggregate costs of production is minimal and labour relatively available. The results obtained can be used in mainstreaming urban agriculture into city planning while at the same time provide avenue for increased urban agricultural productivity.

Introduction

Urban agriculture comprises the production, processing and distribution of a diversity of foods, including vegetables and animal products within or on the fringe of an urban area, with the motive of food production or income generation (Baumgartner and Belevi, 2001; Zezza and Tasciotti, 2010). It has therefore become an important land use to city dwellers globally (Smit and Nasr, 1992) and a major source of livelihood. This is because it contributes to household food security and income generation especially for the urban poor in cities (Islam and Siwar, 2012; Lynch et al., 2013; Zasada, 2011). Additional benefits from urban agriculture include; provision of security against hunger and malnutrition, poverty alleviation, improved urban environment, pollution reduction, and strengthening of cities economic base (Smit and Nasr, 1992; Zasada, 2011). Despite these benefits, multiple challenges arise from shortage of land, land tenure, vagaries of weather, household and industrial pollution, inaccessibility to basic factors of production, and inputs such as fertilizers limits the potential benefits of urban agriculture (De Bon et al., 2009; Islam and Siwar, 2012; Lynch et al., 2013; Van Veenhuizen, 2006). These challenges in addition to the rapid urbanization can limit the amount of land available for urban agriculture. This might likely worsen food challenge confronting cities, while at the same time, inhibits the attainment of the United Nations Millennium Development Goals (MDG) of eradicating extreme poverty and hunger by 2015.

Overcoming threats of food insecurity and expanding urban agricultural frontiers with a view to achieving food security, food sovereignty, and sustainable urbanization require a conscious identification of factors considered by farmers in the choice of farmlands especially in cities. This could pave ways for increased productivity and consequently increase income, improve urban food security and reduce urban poverty. However, the quantification of factors that shape locational choice behaviour of urban farmers has not been deeply research (Zezza and Tasciotti, 2010). Hence, the available information on the processes and mechanisms that determine where agricultural activities take place in urban and peri-urban localities is lean. A good understanding of these factors will help urban planners to mainstream urban agriculture into city planning, and would likely prevent the usual conflict between urban agricultural activities and city development, since the identified factors can provide the basis for designating some areas of the city as urban agricultural zones. Moreover, the outcome of this study has potential to inform international donor agencies about pertinent factors for planning and ensuring urban food security. This paper therefore contributes to the growing debate on locational choice behaviour of urban farmers with a view to unravel factors that influence the locational choice behaviour of urban and peri-urban farmers.

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Study area

Lagos State is one of the World's emerging megacities with the lowest urban living standard (Linden, 1996; Oduwaye, 2005). It was the seat of the Federal Government of Nigeria (FGN) prior to 1986 after which Abuja became the new Federal Capital Territory (FCT). Despite this relocation, Lagos State remains the commercial and industrial nerve of the country. The perceived opportunities for improved living standard have been the singular force attracting people from both within and outside Africa into the city. The state has an areal extent of 3671 km^2 with a population of 9,113,605 in the 2006 census. Its projected population for the year 2010 was 10,578,000 and this is expected to rise to an estimated population of 12,427,000 by 2015, 14,162,000 in 2020 and 15,810,000 in 2025 (Un-Habitat, 2010). Thus, it is the second fastest growing state in Nigeria, with an estimated growth rate of 3.2% and population density of 2725 per km^2 (Lagos State Government, 2013). The implication of these increasing population pressure arising from continuous migration not only increases the demand for food, but also indirectly reduces its supply through building development, environmental degradation and marginalization of food production.

In terms of climate, two dominant air masses affect the distribution of rainfall in the State and these are the moist tropical maritime air mass, and the dry tropical continental air mass. Rainfall is typically double maxima with the first peak occurring between June and July, and the second peak between September and October each year (Ayoade, 1983). Temperature is relatively high and stable with high relative humidity throughout the year (Ayoade, 1983). In Lagos, urban agriculture is practiced either as primary or secondary occupation. As primary occupation, it provides a means of livelihood for farmers, while as a secondary occupation; it complements the meager income from other income generating activities. Urban agriculture in Lagos includes poultry keeping, artisanal fishing in coastal villages; roadside horticulturists; market gardens at flood plains; and free-range herds on coastal grasslands (Adedeji and Ademiluyi, 2009). Typically, urban agriculture is practiced on public land along roads, power lines, drains and streams, and on privately or institutionally owned land (Drechsel et al., 2006).

Although land remains a scarce resource for urban agricultural expansion, the numerous creeks, rivers and lagoons provide water needed for urban agricultural production all year round in the State. Crops typically grown include vegetable, maize and cassava; in addition, vegetables are widely grown because of their high demand especially in dry season (Gockowski et al., 2003; Van Veenhuizen and Danso, 2007). Vegetables include African spinach, waterleaf, fluted pumpkin, lettuce, and cabbage that contribute to a balanced diet particularly among the urban poor (Premanandh, 2011). Despite the potential for the urban agriculture in Lagos State, there are clusters of urban farmers in certain locations that necessitate the need to understand the locational attraction of such sites to farmers. Some of the prominent Local Government Areas (LGAs) where urban agriculture is practiced include Ojoo, Amuwo Odofin, Ikorodu and Surulere.

Methodology

Von Thünen's agricultural location theory provides the theoretical underpinning for this study. The theory, which was propounded in 1826 and was translated into English in 1966, is concerned with the process of location and allocation of land as well as the spatial organization of agricultural landuse. Von Thünen posited that economic rent is a major determinant of agricultural land use and that transportation cost is a major determinant of economic rent (Kennedy et al., 2011). The physical distance between farm and market, transportation costs, market prices, yield, and production cost thus, determine urban agricultural rent (Fujita, 2012; O'Kelly and Bryan, 1996). Based on his model, agricultural activities are organized in a concentric manner around the city with the inner ring being zone of dairy and intensive farming (Fujita, 2012). Perishable products such as milk and vegetables that must get to market quickly occupied the inner ring. These produce correspond with the major specialty of urban farmers in the present day. Although, the theory has been criticized for using numerous unrealistic assumptions in envisaging an extremely simple situation, nevertheless, the model remains valid, and its variations are still widely used in economic geography and other allied disciplines such as urban economics, and regional science (Mäki, 2011). The economic version of this theory enunciated by Ricardo emphasized the physical qualities of land and urban demand as a major determinant of rent rather than transportation cost (Kellerman, 1989). The model has also been modified to explain the spatial organization of land use in cities (Dicken and Loyd, 1990).

Data collection for the study relied on the use of Focus Group Discussions (FGDs) and open-ended structured questionnaires. The study posited that, the choice of urban agricultural site is a product of several intuitive iterations of factors that influence farmer's locational choice decision. However, at individual level, there might be factor trade-off in the site selection process. Questionnaire drafting for the study was based on the results of the Focus Group Discussions (FGDs) held with farmers at different urban agricultural sites in Lagos State. Farmers identified various factors that influence their site selection choice. These factors were broadly synthesized into six categories namely; proximity to water, proximity to residence, access to land, proximity to market, suitable fertile soils, and availability of labour. Measuring these factors objectively using suitable indicators was one of the major challenges in the study. The identified factors were disaggregated into measurable indicators that permit an assessment of their contribution to farmers' locational choice decision. Indicators used in measuring proximity to farmer's residence for example included; the average travel time, average cost of transportation and average physical distance between residence and farm site. Proximity to market was assessed using the average travel time, average cost of transportation and average physical distance between farm and market. Indicators used in measuring access to water include, average physical distance to water source, average amount spent on purchase of water and average time distance to water source. Availability and accessibility to land was measured using average cost spent on land lease, and average amount paid as annual rent by farmers. Indicators of soil fertility include, the cost incurred in the purchase of manures, and fertilizers for soil enrichments. Labour availability was measured using the average number of labour employed per plot per annum and the average cost of labour per plot per annum.

Subsequently, an open-ended questionnaire containing measurable indicators of farmer's locational choice factors, together with socio-economic characteristics of farmers, and challenges of urban agricultural production, most especially those related to vagaries of weather and transportation was developed and administered to the farmers. The questionnaire administration took place in ten purposively selected localities where urban agriculture takes place in Lagos State. These sites are in Iyana Iba, Ojoo-Badagry Expressway, Iyana Iba neighbourhood, Sabon gari Volkswagen area, Vniger along Lagos-Badagry expressway, Alakija along Lagos-Badagry, Laspotech area also along Lagos-Sagamu expressway, Idi Araba around the Lagos State University Teaching Hospital, Dantata along Lagos-Badagry road (Fig. 1). Thirty (30) farmers were randomly selected in each of the ten (10) urban agricultural sites. In order to avoid farm sites with disproportionate number of farmers,

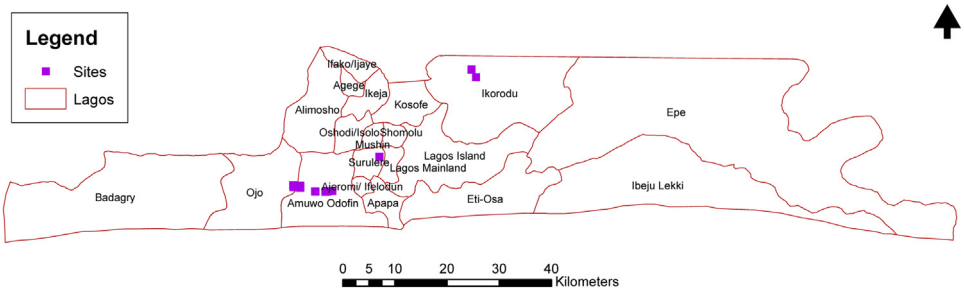

Fig. 1. Sampled urban agriculture sites in Lagos State, Nigeria.

which could exact undue influence on the result, an equal number of farmers were selected from each of the sites.

Statistical methods used to analyze the results obtained from the questionnaire included; mean, range, percentage, standard deviations, correlation and regression. Correlation was used to analyse the relationship between and among the variables, while regression was used to identify the most important variables influencing the locational choice behaviour of urban farmers. The average reported number of urban farmers at each farm site was used as the index of urban agriculture site attractiveness. Thus, the dependent variables in the regression analysis was the average number of urban farmers in each of the 10 sites, while the independent variables were the aggregates of each of the factors divided by the total number of respondents. For example, all the distances between farm and residence for each farm sites were aggregated and divided by the number of farmers interviewed. Since size of available land can be a strong limiting factor to urban agriculture, partial correlation analysis was used to control for the effect of farm site on correlation coefficients. However, for some of the variables, the inconsistencies in the unit of measurement indicated by farmers necessitated the conversion of data into a common unit.

Table 1
Socio-economic characteristics of urban farmers surveyed.

Socio-economic characteristics	Percentage
Age characteristics	
Less than 20 years	8.0
Between 20 and 40 years	24.0
Between 41 and 60 years	49.0
More than 60 years	19.0
Marital status	
Married	85.0
Single	13.0
Separated, divorced and widowed	2.0
Educational attainment	
Primary school	48
Secondary school	24
Tertiary education	12
No formal education	16
Experience in urban agriculture	
Less than 5 years	16
Between 6 and 10 years	64
More than 10 years	20
Farmers relocation	
Relocated at least twice	16
Relocated more than four times	6
Never relocated	78
Reasons for relocations	
Inaccessibility to water	18
Reduction in water level	9
Residential relocation	12
Depleted soil fertility	14
Conflict with land owners	6
Conflict with other farmers	3
Urbanization/land development	38
Mode of urban agriculture	
Part time farmers	15
Full time farmers	85

Results and discussions

Socio-economic characteristics of sampled farmers

The average age of urban farmers surveyed was 42 years, while most farmers were between the ages of 35 and 50 years (Table 1). This observed average age of farmers is in tandem with earlier research in other parts of the country (Obinne and Anyanwu, 1991; Ajayi and Solomon, 2010). Farmers who indicated they were married accounted for 85% of the sampled population. In the absence of other job opportunities and faced with the need to feed their family, some people resolve into urban agriculture, especially those who do not earn sufficient income from non-farming activities (Islam and Siwar, 2012). Forty-eight percent of the farmers surveyed indicated they had primary school education, 24% had secondary education, while 12% had tertiary education. Generally, about 84% of the farmers can be considered literate, while the remaining 16% were non-literate (Ajayi and Solomon, 2010).

More than 80% of the farmers have had more than five years' experience in urban agricultural practice, although the largest percentages have between 6 and 10 years' experience in farming. Farmers who had relocated at least twice from the sites initially cultivated, accounted for 16%, while 78% had no occasion to relocate. Reasons advanced for urban farm relocation included inaccessibility to water, reduction in water level at the site, residential relocation, depleted soil fertility, conflict with landowners, and other farmers, as well as urbanization/land development. Full-time farmers dominate urban agriculture, while part-time farmers accounted for less than 20%.

Factors influencing urban agricultural location

As with every other locational decision, the factors that influenced the choice of urban agriculture locations included availability of and accessibility to water, accessibility to land, distance from residence, distance to market, suitable fertile soils, and labour availability. Urban farmers considered all or some of these factors before situating their farm, however some of these factors may exact more influence on farmers locational choice decision than others.

Average number of farmers

The average number of farmers recorded per site ranged between 35 and 112 farmers, with Ojo locality recording the highest number of farmers (112), while Surulere recorded the least number of farmers (35). The average number of farmers per site was used as a measure of site attractiveness adopted in the study.

Table 2
Availability of water indicators.

Sources of water for urban agriculture	Percent	Distance to water points	Percent	Cost on water usage	Percent	Amount spent on water	Percent
Depend solely on water from rivers/streams	66.2	Less than 40 m	56.6	Incurred cost on the use of water	68.3	N3000–4000	42.1
Depend on shallow hand dug wells	19.6	Between 41 and 60 m	38.4	No cost on the use of water	31.7	N4001–5000	22.4
Depend on rivers/streams and hand dug wells	14.2	More than 60 m	5			N5001–6000	19.6
						More than N6000	15.9

Availability of water indicators

Water is an essential requirement for urban agricultural production and it guarantees the possibility of urban agricultural practices in any location (Premanandh, 2011). The seasonal nature of some streams and rivers whose setbacks and floodplains are used for urban agriculture constitute a grave challenge to urban agriculture (Cooper et al., 2012; Dongus et al., 2009). The unpredictability in climate condition especially in developing countries such as Nigeria where there are no adequate resources to forecast the anticipated changes in climate remains a challenge (Schlenker et al., 2007). Farmers identified rivers/streams, and hand dug shallow wells as sources of water for urban agriculture. The percentage of the farmers that depended on the use of water from rivers/streams was 66.2%, while almost one out of every five farmers depended only on water from hand dug shallow wells (Table 2). Almost one out of every seven farmers used a combination of water from rivers/streams and water from hand dug well. Farmers depend on waters from rivers/streams during the rainy season and use water from shallow hand dug well during the dry season. Inability to secure farm plot closer to watercourse and the need to produce all year round might compel farmers to rely on hand dug wells.

Accessibility to water is most likely to be affected by the distance between farm site and water source, and the amount spent by farmers in getting water to their farms through the use of water vendors (human and vehicular). The minimum distance between water points and farm site was 10 m with a maximum distance of 70 m, while the average distance was 45.3 m. More than 90% of the farmers do not travel more than 60 m before getting water used in their farm (Table 2). The observed shorter distances to water points could be due to the presence of hand-dug wells within the perimeter of most farms.

Not all the farmers incurred cost on water and this could be due to their location relative to water points. Almost seven out of every ten farmers incurred costs on water use. This higher percentage of farmers who indicated they incurred cost could possibly have resulted from their inability to separate the cost of fetching water from costs incurred on other farming activities. It could also have arisen from the extra cost incurred on water during the dry season due to low water table. However, seasonal farmers did not incur costs on water usage since they practice urban agriculture only during rainy season. The costs included payment for water vendors, renting water pumps, buying fuel used for the water pumps, and buying water sprinkler especially during the dry season. Using the exchange rate of $0.15871 to a Naira, the overall cost incurred on water usage ranged between N3450 and N6500 with an average cost of N5148 monthly. At least four out of every ten farmers paid between N3000 and N4000 for water use, while one out of every seven farmers paid more than N6000. It is obvious that 64.5% of the farmers spent below N5000 on water per annum. There is however wide variations in costs incurred in the use of water among farmers in the different sites.

Access to land indicators

Access to land refers to the availability, affordability and willingness of landowners to release land for urban agriculture. Characteristically, urban agriculture is practiced within setbacks of utilities such as roads, electricity line, natural features such as creeks and lagoons, and on institutional lands where farmers pay little or nothing as rent (Drechsel et al., 2006; Adedeji and Ademiluyi, 2009). Land availability may influence the number of plots cultivated by farmers. The number of plots cultivated amongst farmers ranged from 0.4 to 9.0 plots of land with an average of 1.8 plots per farmer. However, some of the farmers indicated having less than a plot of land, while others had more than ten plots. Sometimes, due to scarcity of land, farmers may share a single plot of land. At least one out of every three farmers cultivated less than two plots of land, and at least one out of every five farmers cultivated between 2.1 and 4.0 plots of land (Table 3). Furthermore, one out of every ten farmers had more than eight plots of land. At least 75% of the farmers cultivated less than a hectare of land. Although there is no national standard of minimum urban agricultural farm size, nevertheless, it appears that, farm sizes were small among the sampled farmers and this may be a pointer to the challenge confronting farmers in land acquisition (Thornton, 2008; Woodhouse, 2010). Similarly, Lynch et al. (2001) had observed that plot size for urban agriculture in Kano State, Nigeria, ranges from 0.01 to 0.4 ha in the builtup neighbourhoods, while it ranges between 0.1 and 2.0 ha in the peri-urban neighbourhoods.

Setbacks and right-of-ways are sensitive corridors around utilities and natural features, which ordinarily should be devoid of any development or human activities. However, because they are not being used, some of the farmers plant crops within the corridors. Nevertheless, a number of farmers still pay money to some self-acclaimed agents of utility owners for using such land (Lynch et al., 2001). These are in addition to those that leased land from private landowners and pay money. In view of the low socio-economic profile of most urban farmers, it was envisaged that the higher the cost of leasing land, the less attractive the site will be, while the lower the cost, the more attractive such site is likely to be to farmers (Maxwell, 1995). The amount paid per plot for land leased by farmers ranges between N1800 and N7000 with an average of N3925 monthly. Almost four out of every ten farmers paid between N2001 and N3000, while about three out of every ten farmers paid more than N4000 for leasing land. This amount represents the initial cost paid for the use of land and not the cost of buying the land. The actual cost of land purchase in most wetland areas where urban agriculture was practiced ranged between N500,000 and N5,000,000 which most urban farmers could not afford due to their low socio-economic status as well as low return on urban agriculture.

Closely associated with the cost of land leasing was the monthly rent payable for use of land. The amount farmers were willing to pay as rents depended on the estimated profit from the use of the land for urban agriculture, while from the landowner's point of view, the amount would be influenced by the opportunity cost of the land. The rent paid by farmers ranged between N1000 and N4000 with an average of N3500. At least four out of every 10 farmers paid less than N1000 as monthly rent and eight out of every ten farmers paid less than N4000 as monthly rent for use of land. Some of the farmers indicated that landowners permitted them to use their lands for urban agriculture out of their generosity for them

Table 3
Accessibility to land indicators.

Number of plot cultivated	Percent	Average amount paid for land lease	Percent	Monthly rent pattern	Percent
Below 2.0 plots	33.3	Below N2000	28.4	Below N1000	41.4
Between 2.1 and 4.0 plots	23.6	N2001 and N3000	38.6	Between N1001 and N2000	26.3
Between 4.1 and 6.0 plots	18.4	N3001 and N4000	23.8	Between N2001 and N3000	18.1
Between 6.1 and 8.0 plots	14.1	More than N4000	9.2	More than N3000	13.9
More than 8.0 plots	10.6				

to earn a living. However, because such land was not used for any other purpose and may be at the risk of trespassers, the farmers thus became "watchdogs" against trespassers on such land.

Distance from residence indicators

Distances between farmers' residence and farmland could influence the preferred location of urban agriculture (Thapa and Murayama, 2008). Farmers generally prefer location that is closer to their residence (Lopez et al., 1994). The physical distance relates to the number of kilometers between farmers' residence and farm location. The cost of commuting affects transportation, hence the longer the average physical distance, the higher the transportation cost, and time it takes to commute to farm and the less attractive the sites. These three attributes of distance can affect the choice of sites for urban agriculture directly or indirectly. The physical distances between farmers' residence and farmlands ranged between 1.5 km and 12.7 km with an average of 3.22 km. Almost four out of every ten farmers travel less than 2 km to their farms, while seven out of every ten farmers do travelled between 2 and 3 km to their farms. This shows that most of the farmers have preference for nearby locations where they do not incur transportation cost (Kilkenny, 1998). The increasing urbanization and sub-urbanization may however influence how close farmers can live to their farmlands. Urbanization leads to relocation of farms and increases the distance between farmer's residence and their farms, with its attendant consequences on the cost of transportation (Thapa and Murayama, 2008). Hence, the increasing urbanization coupled with high population has not so much reversed the trend in which farmers chose to live close to their farms. In addition, the inability to afford rent at the city center forces low-income earners to live at the periphery of cities where land is available for urban agriculture. Thus, the situation has resulted to a negative distance relationship between number of farmers and distance from farm. Nonetheless, locations close to residence has implication on how much time can be devoted to urban agricultural activities and other measures of distance used in this study. Although the von Thunen model advocated a decreasing agricultural landuse intensity pattern with increasing distance from the city, however, with the increasing urbanization of cities and competition for land by different activities; it is difficult for urban agricultural intensity to decrease with increasing distance from urban center. This is because the closer the farms are to cities, the more profitable they are likely to be, based on the need to minimize transportation cost and due to the perishable nature of produce they supplied (Livanis et al., 2006) (Table 4).

The cost of commuting to and from the farm ranged between N200 and N800 amongst farmers and the location of farmer's residence and choice of transportation mode determined the amount paid on transportation. Farmers living near their farm did not pay anything, while those living further away paid as much as N800 daily in commuting between their farm and home. This cost was subject to variation especially when there were transportation congestion, and during rainy season when most roads are partially motorable. The cost of transportation also varied based on the mode of transportation utilized by farmers, and distance travelled to farms. Commercial motorcycles appeared to be the most expensive of all the modes. Motorcycles are used as part of the public transportation modes in most cities in Nigeria and they provide door-to-door service especially in cities that suffered traffic congestion (Oluwadiya et al., 2009; Morenikeji and Umaru, 2012; Gujba et al., 2013). The average amount spent daily on transportation by farmers was N252.00, while over 61% spent more than N400 daily on transportation. About 38.2% of the farmers spent less than N400, while the remaining 61.8%. The high commuting cost might be one justification for preference for closer farm sites as compared to more distant farm sites. For the part-time farmers, it was difficult to separate the cost of transportation to work place and farm because most of them left for their farms after closing from work instead of going home. Hence, the cost of transportation to workplace and farm was shared between these two activities.

The time between home and farm ranged between 15 and 75 min with a mean of 44 min among the sampled farmers. The breakdown of the time spent to travel to farm showed 14.3% of the farmers travelled less than 20 min, 28.4% travelled between 21 and 40 min, 41.3% travelled between 41 and 60 min, and 16.0% travelled more than 60 min. The farther the farm, the more time it took to commute and cost incurred by the farmer on transportation.

Proximity to market indicators

Three methods were employed by farmers to dispose their produce. These included direct sale of produce to consumers on the farm, selling to market women, and direct sale of produce in market by the farmers. For the male farmers, their wives or other female members of their immediate family handled the direct sale of produce, even though some of them were directly involved in the sale of produce. Four percent of the farmers engaged in direct sale of produce, 88.9% sold to market women, and the remaining 7.1% took their produce to the market. The distance separating farms from market may influence the decision of market women to patronize some farms at the expense of others (Vail, 1982; Miles, 2011). Farms that minimize the overall cost of transportation to market are preferred, while those with the maximum cost are least preferred. Produce from urban agricultural farms are sold in markets such

Table 4
Distance from residence indicators.

Distance from residence	Percent	Cost distance	Percent	Time distance	Percent
Less than 2 km	39.4	Below N200.00	13.4	Below 20 min	14.3
Between 2.1–3 km	36.4	N201–N400.00	24.8	Between 21 and 40 min	28.4
Between 3.1–5.0 km	12.1	N401–N600.00	24.3	Between 41 and 60 min	41.3
More than 5.0 km	12.1	N601 and N800	15.6	More than 60 min	16
		N801–N1000	13.4		
		More than N1000	8.5		

Table 5
Nearness to market indicators.

Average distance between market and farm	Percent	Time distance	Percent	Cost of transportation	Percent
Less than 4.0 km	9.1	Less than 30 min	41.1	Less than N200	34.3
Between 4.1 and 6.0 km	16.9	Between 31 and 50 min	34.7	Between N201 and N300	15.3
Between 6.1 and 7.0 km	27.4	Between 51 and 70 min	20.2	Between N301 and N401	18.6
Between 7.1 and 8.0 km	31.2	More than 70 min	4	Between N400 and N500	20.7
More than 8.0 km	15.4			More than N500	11.1

as Agege, Ikeja, Oshodi, Mile 2, Obalende, Surulere, Festac Town, Ejigbo, Oyingbo, Ajegunle, Mushin, Yaba, Ikotun, and Igando etc. Based on the analysis of the distance separating market from farms, it was discovered that more than 87% of the produce from urban farms are sold in markets within 10 km radius of the farms and that the farther the market, the fewer the sellers that patronize such market (Table 5).

The effects of transportation cost on agricultural production have been examined and concepts such as that of "food miles" has been introduced into the literature to depict mobility of agricultural produce from farm to the market while some authors have described agriculture as also eating fossil fuels (Pfeiffer, 2006; Manning, 2004). The average distance between farms and markets ranged between 2.3 and 9.6 km. The observed mean distance to market among sampled farmers was 6.22 ± 1.5 km. One out of every ten markets were within a distance of less than 4.0 km from urban farms, four out of every 10 markets were between a distance of 4.1 and 7.0 km from urban farms, while three out of every ten markets were located at a distance of more than 7.1 km from markets. The largest numbers of markets were between a distance of 7.1 and 8.0 km from urban farms, and as the distance from farms increases, the number of markets increased and declined after 8.0 km.

The time distance between farm and market ranges between 30 and 80 min with an average of 44 min and 18 s. At least four out of every ten markets required a journey of at least 30 min, while at least five out of every ten markets required a journey between 31 and 70 min (Table 5). As the time distance between the farm and the nearest market increased, the number of farmers that patronized such markets decreased. Furthermore, in terms of the cost of transportation between the farm and the nearest market, the results showed that the average daily cost of transportation ranged between N200 and N800 with an average of N405. About thirty-four percent (34.3%) of the farmers spent less than N200 commuting between farms and market, while 54.6% spent between N201 and N500 (Table 5). Cost of transportation is mostly influenced by the choice of mode of transportation employed, the volume of load carried, time of day, and the negotiating power of the people involved. The modal choice and their associated costs are two intrinsic costs consideration that may influence the choice of urban agricultural site selection. The most regularly patronized mode of transporting agricultural products between farms and markets are the commercial buses and pickup vans, and they account for 62.5% of the mode used by farmers and market women. This was followed by commercial taxis (16.7%), human portage (6.3%), motor cycles (5.2%), while the use of mini-trucks, lorries and wheel barrows account for 3.1% each. Farmers used wheelbarrows mainly to convey produce from farm to roadside.

Some of the problems confronting urban farmers in the process of transporting produce to markets can be broadly categorized into three groups namely; transportation related factors, material related factors and institutional related factors. The transportation related factors alone accounted for more than half of the problems (56.6%) and some of the identified factors under this category included high transportation fare, incessant traffic congestion, absence of good intra urban road linkages that will facilitate efficient movement, bad roads, etc. The material related problems included the bulky nature of produce from farms, problem with packaging the produce for market, the high perishable nature of most of the produce and sometime glut in supply emanating from excess supply over demand. These factors accounted for 28.2% of the challenges identified. The last category, which borders on institutional constraints, involved factors such as delays on the road caused by vehicle inspection personnel, or other law enforcement personnel who may delay vehicles conveying produce to markets because of incomplete vehicle papers or some other sundry issues. These could directly or indirectly increased the cost of transporting produce between farm and market and may influence the determination of viable and less viable farm sites.

Suitable soils indicators

Presence of good soil is one of the fundamental requirements of any agricultural production (Dexter and Czyż, 2011; Powlson et al., 2011). It influences the productivity of farmers (Buckley and Carney, 2013) as well as the choice of urban agricultural sites. The lower the amount spent on purchase of manure and organic fertilizers, the more productive is the land likely to be, while the higher the amount of money spent, the less attractive is the land (Kihara et al., 2010; Schittenhelm et al., 2011). The average amount spent on the purchase and transportation of manure and poultry droppings daily, ranges between N150 and N400 with an average of N254. At least five out of every ten farmers use only manure, while at least three out of every five farmers use a combination of manure and chemical fertilizers (Table 6). Thus, at least nine out of every ten farmers used either only manure or the combination of manure and fertilizer. The percentage of farmers that use only chemical fertilizers or are using neither fertilizers nor manure is less than 9%. Adedayo (2012) observed that poultry waste is an important component of soil enrichment for urban agriculture and that farmers sometimes travelled as far as 300 km to collect poultry droppings from Lagos. The cost of conveying droppings is usually high due to its weight and foul smell. Apart from the offensive odour from

Table 6
Suitable soils indicators.

Fertilizer usage	Percent	Profit per plot	Percent	Rainy season profit	Percent	Dry season profit	Percent
Use neither fertilizer or manure	2.1	Between N1000 and N4000	14.9	Less than N4000	53.6	Less than N4000	39
Use fertilizers only	6.1	Between N4001 and N8000	18	Between N4001 and N10,000	29.1	Between N4001 and N10,000	32.2
Use fertilizers and manure	35.5	Between N8001 and N11,000	35.2	More than N10,000	17.3	More than N10,000	28.8
Use only manure	56.3	Between N11,001 and N13,000	24.6				
		More than N13,000	7.3				

Table 7
Relationship between number of farmers and some identified determinants of urban agriculture site selection.

S/N	Factors	Correlation coefficient	*P*-value	Significant
1	Physical distance to water source	−0.688**	0.000	$P \leq 0.05$
2	Amount spent in getting water to farm	−0.462*	0.015	$P \leq 0.05$
3	Time Distance to water source	−0.789**	0.000	$P \leq 0.05$
4	Average number of Plots per farmer	−0.403*	0.031	$P \leq 0.05$
5	Average lease amount paid per plot	−0.684**	0.000	$P \leq 0.05$
6	Average amount paid as rent for a plot	−0.551**	0.004	$P \leq 0.05$
7	Physical distance between residence and farm	−0.684**	0.000	$P \leq 0.05$
8	Cost distance between residence and farm	−0.591**	0.002	$P \leq 0.05$
9	Time distance between residence and farm	−0.617**	0.001	$P \leq 0.05$
10	Distance between farm and market	−0.437*	0.021	$P \leq 0.05$
11	Cost distance between farm and market	−0.603**	0.001	$P \leq 0.05$
12	Time distance between farm and market	−0.629**	0.001	$P \leq 0.05$
13	Average amount spent on manure and fertilizers	−0.569**	0.003	$P \leq 0.05$
14	Estimated profit per plot per annum	0.939**	0.000	$P \leq 0.05$
15	Average number of labour employed	−0.411	0.029	$P \leq 0.05$
16	Cost of labour per plot per annum	−0.414	0.028	$P \leq 0.05$

* Significant at 95% confidence level.
** Significant at 99% confidence level.

it, its storage also provides breeding ground for variety of pests, rodents and leachates that can pollute surface water (Cairncross and Feachem, 1983; Adedayo, 2012).

Furthermore, the pattern of profit regime per plot per annum also ranged between N1000 and N15,000 with an average of N11,400 annually. Three out of every ten farmers made a profit of less than N8000 per plot, and six out of every ten made a profit of between N8001 and N13,000 per plot per annum. However, variations exist in profit made among farmers and this also depended on the nature of soils, amount of time devoted, type of crop grown and the season of the year under consideration. The seasonal variations in profit from urban agricultural produce, showed that 82.7% made less than N10,000 per plot during rainy season, and 71.2% made similar profit in dry season. However, 17.3% made a profit that exceeded N10,000 in the rainy season and 28.8% made similar profit in dry season (Table 6).

Labour availability indicators

Labour is an essential component of urban agricultural productivity because of the intensive nature of the activities involved and because a single farmer may not be able to provide all the needed labour especially where the farm size is relatively large. The ability of urban farmers to produce despite the myriads of challenges confronting them in the area of labour might be enhanced through the optimum combination of family labour, minimum capital and the most appropriate form of locally learned technology (Islam and Siwar, 2012). In all, 69.4% of the farmers engaged labour, while the remaining 30.6% did not for any aspect of production. In addition, 84.6% of the farmers used labour solely for land preparation and weeding, while the remaining 15.4% used labour for other aspects of farming operations such as produce harvesting and processing. The average number of labour employed per plot per annum ranged between one and two, while the average amount paid for labour daily, ranged between N2000 and N4000 per plot. The breakdown shows that 38.3% of the farmers paid N2000 per plot, 21.1% (N2500), 18.4% (N3000), 13.2% (N3500), while the remaining 9% (N4000) per plot. However, the amount paid for labour varied depending on the type of farm activity assigned to do.

Identification of factors that influence the decision to site urban agriculture

The analysis of the relationship between the average numbers of farmers in each site and the factors considered by farmers in the choice of farm site selection is central to understanding the effect of each factor on farmer's locational choice decision. Negatively significant relationship between number of farmers and the three indicators of water availability were observed (Table 7). Thus, the higher the number of farmers in each site, the lower the physical distance farmers had to travel to obtain water, and the lower the amount spent in procuring water used in farming. Urban farmers are attracted to sites where they can have ready access to water without incurring additional cost. The negative relationship may have also resulted from farmers' preference for site closer to water and because farms are linearly arranged in consonance with the drainage alignment. It is however possible that the number of farmers get so large to the extent that the distance to water will increase and, the time and cost of procuring water will increase correspondingly.

The three measures of accessibility to land showed moderately low, but significant negative relationships with the number of farmers in each site. The average number of plots per farmer had the lowest correlation coefficient among the three indicators, followed by the average amount paid per plot as rent. Thus the higher the number of farmers, the lower the average number of plots size per farmers and this could be due to increased pressure on the available space for urban agriculture. Also, the more attractive a given site, the more fragmented the farm plot is and the more difficult it is for new farmers to gain access to the site. Furthermore, the result showed that the higher the number of farmers, the lower the cost of land. This is an indication that there is a preference for cheap and affordable land among urban farmers. Hence, farmers tend to agglomerate in sites where the land cost is comparatively low. This could however explain the increasing use of setbacks and right-of-ways of utilities. Farmers assumed that such site are free because they do not pay or at best pay a small amount for its use. Similarly, there were more urban farmers on sites where the average rent paid per plot was low, whereas lower numbers were recorded on sites with comparatively higher rents. Since, farmers were always aware of how much land owners charged before they agreed to use such land for urban agriculture, it is possible that once the amount charged is higher than what the farmers could afford, they tend to abandon such site, whereas where the charges were low, more farmers showed preference for such sites. Accessibility to land indicators was therefore important in influencing farmer's locational choice behaviour. It should however be noted that the determinants of how much farmers were willing to pay for land lease and the subsequent rent may be influenced by a number of socio-economic and cultural factors which are beyond the scope of this study.

Proximity to residence indicators also showed a moderately high and negatively significant relationship with the average number of farmers. Thus, the higher the number of farmers in a site, the lower the distance between farmer's residence and the farm, and vice versa. Farmers thus preferred sites closer to their residence compared to sites that were farther away. Most importantly, farmers preferred sites that are trekable compared to fee-paying ones. It is expected that farmers live near their farms and this may have consequences on the amount incurred on transportation. Similarly, large numbers of farmers characterized sites where the transportation cost between residence and farm is lower and conversely, lower number of farmers in sites with higher transportation cost. The intensive nature of urban agricultural activities may have necessitated a situation where farmers preferred sites that minimized physical distance, travel cost and time as this would allow them to devote enough time to the various activities in their farms. The analysis of the relationship between number of farmers and distance travelled to farm showed a negatively significant correlation ($r = -0.6832$, $P \leq 0.05$). Thus, the contemporary urban agricultural practice is antithetical to the pattern advocated in the von Thünen's theory (Sinclair, 1967). A relatively long distance between farmer's residence and their farms can discourage farmers who may not be able to afford the cost of commuting to such farms. Farmers who cannot afford the cost of transportation might not have any alternative than to trek.

The proximity to market indicators also returned negatively significant relationships with the average number of farmers in each farm site. The three factors used in measuring the relationship between distance from farm and market and the average number of farmers in each site also showed significantly negative correlation coefficients. This implies that there are more farmers in locations where the average distance between farm and market are shorter as compared to those with longer average distances. In addition, the time and cost of transportation between farm and markets exhibited similar trends. Generally, there was preference for locations that minimizes the physical distance, transportation time and cost of movement between farm and market. Guaranteed ready market for farmers' produce always informed the need to stay close to market, while at the same time being able to produce in the face of a stiff competition from other urban agricultural sites in the city.

Out of the two variables used to measure soil suitability, one showed a high positively significant relationship, while the other showed a moderately low negatively significant relationship with the average number of farmers. The average amount spent on purchase and transportation of manures and fertilizers to farm reduced significantly with increasing average number of farmers, while it increased with reduced number of farmers. This showed that in most of the sites where there were large numbers of farmers, the amount spent on manures and fertilizers was minimal as compared to where there were fewer farmers. Thus, reduced soil fertility could discourage farmers from chosen a given site, while improved fertility could encourage agglomeration at such sites. This is because manure and fertilizers represent cost items that impinges on the profit margin of farmers and could determine how much farmers make as profit or incurred as loss. The estimated profit per plot was another indicator used although, soil quality alone does not determine profitability, but contribute to it. There is a significantly high positive relationship between the average number of farmers and the average profit per plot and thus, the more the number of farmers per site, the more the average profit recorded for the site. Hence, the drive to make comparatively good profit could also be one of the driving forces responsible for the increasing clustering of farmers in some of the urban agricultural sites in Lagos State. While urban expansion has been blamed for the increasing mobility of urban agricultural site (Islam and Siwar, 2012), the results of this study revealed that the shifting could also be as a response to reduced profit from some sites which has necessitated relocation to other existing urban agricultural sites perceived to be more profitable.

Relatively low negatively significant correlation coefficient observed between the average number of farmers and the average amount of labour employed (−0.411) implies that the higher the number of urban agricultural farmers, the lower the amount of labour employed. The reduction in number of labour engagement could be due to reduction in available plot size per farmer arising from the over fragmentation of plot size. Additionally, it could also be due to agglomeration advantage whereby farmers share agricultural inputs such as herbicides with other farmers within the cluster and thereby reducing the number of labour employed. The result also showed that there was a negative significant relationship between the average number of farmers and the cost of labour incurred by farmers per plot (−0.341). This was surprising since the amount of labour employed decreased with increased number of urban farmers' consequent of the increasing fragmentation of farmland. It therefore follows that the cost of labour declines with increasing number of farmers due to the fragmentation of farm plots. Thus, the small farm holding per farmer resulting from scarcity of lands might exert considerable influence on the labour related factors.

Despite the observed relationships between the dependent variable (average number of farmers per sites) and the sixteen (16) independent variables, only ten out of the sixteen independent variables were important in explaining the pattern of locational choice behaviour of urban farmers in Lagos State. The factors that influenced farmers' decision on urban agriculture included the perceived overall profitability of a given site as compared to others as indicated by a standardized beta coefficient of 1.459 (Table 8).

Table 8
Determinants of urban agricultural locational choice behaviour among arable farmers.

		R-squared	Adjusted *R*-squared	Standard error of estimate	*F*	Significance level
		0.535	0.535	0.1463	7.213	0.000
		Standardized coefficient bets	*t*	Sig	Zero order correlation	Partial correlation
1	Average number of plot per farmer	−0.256	−9408789.21	0.000	−0.403	−0.090
2	Average time distance from residence to farm	0.599	7559420.74	0.000	−0.617	−0.072
3	Average physical distance from residence to farm	−0.026	−1252721.62	0.000	−0.684	−0.012
4	Average physical distance from farm to market	0.135	2784967.40	0.000	−0.437	−0.027
5	Average cost distance from farm to market	−0.059	−2412220.11	0.000	−0.603	−0.023
6	Average cost incurred on water purchased	−0.609	−7163957.86	0.000	−0.462	−0.069
7	Average cost of manure and fertilizers	−0.002	−62600.37	0.000	−0.569	−0.000
8	Average profit per plot	1.459	0.000001	0.000	0.939	0.018
9	Average rent paid per plot	0.507	7215814.50	0.000	−0.551	0.069
10	Average cost of labour spent per plot	0.248	5486709.59	0.000	−0.414	0.053

The estimated cost incurred in water usage and also the average time distance to farm were the next important variables identified in the model. The standardized coefficients indicated the relative importance of each variable. Variables such as average cost of transportation to farm, average time distance to farm, average distance to water points, average cost of initial land acquisition, and average number of labour employed per plot of land were however not significant in explaining the locational choice behaviour of urban farmers.

Factors, which were important in the locational choice behaviour of farmers identified in the model included; average plot ownership, average physical and time distance to farm, average physical and cost distance to market, cost of water usage, cost spent on manure and fertilizers, average profit per plot, average rent per plot and average cost of labour. The results brought to the fore the importance of these identified variables. The average number of plots per farmers was a measure of land availability, site preference and site competitiveness, which could discourage farmers especially those that want a relatively large plot of land from choosing site with lower plot holdings per farmer for urban agriculture. The more the attractive a site is, the higher the numbers of farmers that will like to locate in such site. However, this will result into plot size per farmer, and reduction in the land available for agriculture. The model identified the role of physical and time distance in influencing locational choice behaviour of urban farmers and it underscores the importance of distance between farmer's residence and farm location. It thus implied that farmers considered distance and time it took to reach their farm in their locational choice decision. These two factors were important because they impinge on farmer's profit and frequency of visits to farm. This factor is important because urban agriculture takes place mostly in the peri-urban neighbourhoods where majority of low-income people resides.

The model also identified the importance of location close market. It identifies the physical and cost distance between farm and market as crucial to urban farmer's locational choice decision. These factors were important because of the perishable nature of urban agricultural produce. Sites that did not optimize the physical and cost distance were not preferred because of the additional cost incurred by farmers coupled with the likely produce loss arising from delay in getting transportation to markets. At an extreme case, they may have no alternatives than to sell farm produce at lower prices. Urban farms should therefore be located at sites that optimize distance to markets to guaranteeing farmers remain in business. Water is also essential in urban agricultural production and the inclusion of this variable suggests the importance that farmers attached to it in influencing their locational choice behaviour. To minimize cost incurred on water, there should be water throughout the year. Thus, farmers assess water availability before choosing a site to farm and this factor is important in view of the global and local climate change phenomenon, which may affect urban agricultural productivity especially in most African cities without sufficient resilience and adaptive or copping strategies to militate against the negative impact of climate change. This therefore requires an extensive study of climate change adaptation for urban farmers who might be affected.

The amount incurred on manure and fertilizers influence the locational choice behaviour of urban farmers. It represented an additional cost that reduced the profit of farmers. Farmers thus are attracted to sites where the costs of manure and fertilizers were minimal and such sites are likely to be fertile. The continuous and intensive use of sites repeatedly can reduce the soil fertility, thereby necessitating the need for fertilizers and manure. In the absence of fund needed to procure manure and fertilizers, farmers may relocated to another farm sites where the soil is comparatively better and where better yield is guaranteed. Government and research agencies and extension workers can help urban farmers through guided education on land management. Urban agricultural land rent was also a major determinant. Rents can either encourage or discourage farmers from a site and the higher the rent, the lower the number of farmers. However, there is a greater preference for sites perceived to be free, especially government setbacks of utilities such as road and power lines. Encouraging more investments in urban agriculture will therefore require that government through regulations, free up 'idle' lands in the cities and its periphery for urban agriculture. Achieving this requires the adoption of the concept of usufruct, which will help to allay the fear that landowners may eventually lose their land to farmers if leased. The legal principle of usufruct allows anyone to use land, which is idle as long as the utility of the land to the owner does not diminish. The institutionalization of this concept will guarantee farmer's access to idle lands especially within the city and peri-urban neighbourhoods. Government in countries like Peru and Indonesia have used the approach to free idle public and private land and makes them freely available to farmer (Panduan, 1991). Besides the need to provide for the immediate family, the perceived expected return on investment could influence the locational choice behaviour of urban farmers. The expected profit however depended on a number of interacting factors including soil quality and type of input used. Finally, the cost of labour was also influential in farmer's locational choice behaviour. The type of farm assignment allocated to labour and the relative availability of labour determined the cost of labour. The cost of labour may reduce if farmer's use herbicides and other related agro-chemicals in their farms. This however, might subsequently leads to increasing unemployment because the aggregate cost of labour is always the highest cost element in farm production (Yilmaz et al., 2005; Beltran et al., 2012). The results obtained are similar to the one obtained by Kellerman (1989) where he argued that the spatial allocation of agricultural crops is dependent on rent pattern. The results also showed that both the site factors and situational factors are important in influencing the location choice decision of farmers (Katzman, 1974).

Conclusion

Von Thünen's agricultural location theory postulated the patterns of agricultural land use that will emerge where transportation cost to market is the sole determining factor of land use dynamic. Under this condition, the increasing transportation cost will ultimately results in reducing agricultural land use intensity from market/city location (Sinclair, 1967). Today, the basic agricultural pattern presented by Von Thünen is outdated due to urbanization- rapid population growth and migration, changes in technology-reducing cost of transportation and improved means of transportation and communication, and human organization–cooperative farming, which reduces cost of inputs, produce, and transportation to markets (Sinclair, 1969). Thus, costs of transportation have declined greatly in relation to the agricultural production costs and transportation costs are not necessarily directly proportional to distance and bulkiness of produce (Sinclair, 1969). In addition, transportation cost does not increased linearly from the city centre, but rather in a sigmoidal form because of the reduction in cost of transportation. However, the fact that most produce from urban farms are perishable goods ensure that they are produce adjacent to the city or within the city.

Therefore, apart from transportation cost, other factors such as urban expansion, competition between urban agriculture and urbanization, availability of vacant plots, accessibility to waters, and nearness to markets combined to produce the emerging pattern of urban agriculture in modern cities. Thus, rather than a ring-like (circular) pattern predicted by von Thunen model, the

interaction of these multiple factors produced haphazard urban agriculture landscape, with urban agriculture characterising some "opportunistic" locations such as setback of major utilities within urban enclaves as well as vacant lands within and adjacent to cities. This has resulted in increasing urban agricultural intensity with reducing distance from the city and in some opportunistic locations, quite the reverse of the pattern advocated by Von Thünen's theory (Sinclair, 1969). The basic force upon which von Thunen model was developed, namely transport cost to the market, is no longer the primary determining factor in the patterning of agricultural land uses around cities (Sinclair, 1969).

Despite that the economic return on urban agriculture may not guarantees its presence adjacent to or within cities; nevertheless, they are found within urban enclaves because of the increasing realization of the importance of urban agriculture socially, economically and politically. This is further encouraged by landowners who need to preserve their land from the activities of trespassers by encouraging people to farm such land. The existence of urban agricultural sites adjacent to urban builtup areas and also in some of the vacant plots of lands (opportunistic locations) within cities however suggests that the Von Thunen structure is still valid despite that the factors that produced such structural pattern has significantly changed in modern society.

This study contributes to the growing literature on urban agriculture by looking at factors that influence the locational behaviour of urban farmers. The study showed that urban farmers prefer sites closer to water, free with minimal lease and rental cost, with fertile soil closer to farmer's residence, where aggregate costs of production is minimal and labour relatively available. In all, the analysis identified that ten out of the sixteen factors considered are important in determining farmer's locational choice behaviour. These factors shaped farmer's decision regarding where they eventually practice urban agriculture.

Understanding the factors that shapes the locational choice behaviour of urban farmers in site selection for urban farming would help in adequately addressing the contradiction between urbanization and urban agriculture. The factors identified in this study integrated through multi-criteria analysis to identify the most profitable and attractive sites that can be designated as urban agricultural site in the periphery of cities. Hence, this approach will help in mainstreaming urban agriculture into city planning especially in developing countries where the challenge is most grave. The approach employed in this study can also help in enhancing urban agricultural activity since it provided a means of identifying important factors that shaped decision to embark on urban agriculture. To expand and encourage more investment in urban agriculture would require government and other allied agencies to provide an adequate environment where all or almost all the identified factors are present. The study would therefore help in reducing urban poverty while at the same time help in increasing farmer's income while reducing physical planning related conflict between urbanization and urban development and city sustainability. Areas for further research include the determination of carrying capacity of urban agricultural land as well as the socio-economic and spatial determinants of urban agricultural lease pattern.

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