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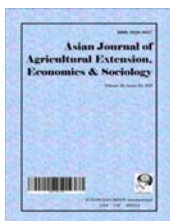
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## **Effects of Urban Expansion on Agricultural Resources: A Case Study of Embu Town in Kenya**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. This study was proposed by author EKM who together with authors LKN, BMG and SNN gave it a direction and contributed to its implementation. Author EKM led the team of enumerators who collected and collated the ground data. The data was analyzed by author BG after which all the authors jointly carried out the interpretation of the analyzed data and jointly developed this manuscript. The authors unanimously appointed author EKM to be the corresponding author. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/AJAEES/2019/v33i430186

Editor(s):

(1) Dr. Sait Engindeniz, Professor, Department of Agricultural Economics, Faculty of Agriculture, Ege University, Turkey.

Reviewers:

(1) Debraj Sarma, Gauhati University, India.

(2) Guo-ming Du, Northeast Agricultural University, China.

Complete Peer review History: <http://www.sdiarticle3.com/review-history/49937>

**Original Research Article**

**Received 28 April 2019**

**Accepted 06 July 2019**

**Published 11 July 2019**

### **ABSTRACT**

**Aim:** To determine the effect of urban development on agricultural resources in peri-urban areas of Embu town.

**Study Design:** Descriptive survey design involving observational and survey methods.

**Place and Duration of Study:** The study was carried out in three sub-locations lying within the peri-urban areas of Embu town, namely, Kamiu to the East, Njukiri to the West and Nthambo to the North of the town. The study was carried out from June to August 2018.

**Methodology:** Purposive stratified sampling was applied in this study where the three sub-locations were organized into three strata depending on their distance from the Central Business District i.e.

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2, 4 and 6 Km for Kamiu, Njukiri and Nthambo respectively. A structured questionnaire was administered to 51 households per sub-location making a total of 153 respondents. Additional data was collected using personal observations and interviews with selected institutions with key information relating the study area. The data was analyzed using Statistical Package for Social Sciences. Descriptive analysis was carried out to generate frequencies and correlations. Quantitative data was subjected to Analysis of Variance where the three sub-locations were considered as treatments and means separated using Least Significant Difference at 95% level of confidence.

**Results:** The results indicated that urban development had encroached into hitherto agricultural areas exerting pressure into available agricultural resources such as land, water and labour thus contributing to reduced farming activities in the area. Significant differences between the three sub-locations were observed in average farm sizes, proportion of land allocated to farming, proportion of farmers in the area and availability of irrigation water and agricultural labour. The study recommends policy interventions to manage peri-urbanization in Embu and other towns with similar set up, in order to reduce degradation of agricultural resources and control unsustainable land sub-division and land use changes.

**Keywords:** Urbanization; Peri-urban areas; agricultural resources; land use conversion.

## 1. INTRODUCTION

Rapid urbanization and industrialization are major determinants of economic, social and physical change which lead to an increasing pressure on agricultural resources through encroachment into productive arable land [1]. Urban population in the world increased dramatically from 200 million in 1900 to approximately 2.9 billion in 2000, and is estimated to reach 5 billion by 2030 [2]. Developing countries in Sub-Saharan Africa bears the brunt of rapid expansion of towns into the peri-urban rural crop and animal production areas [3]. Among all agricultural resources, land which is the main supporter of all forms of life is the one that has suffered most negative consequences of the process of urbanization, particularly the loss of high-quality agricultural land [4]. Agricultural land within the urban and peri-urban boundaries has been reportedly reducing in the wake of urbanization as other agricultural resources are also diverted to other uses [5]. A well planned and managed urban expansion to peri-urban areas and consequently to rural areas is important to ensure sustainable development alongside adequate growth in agriculture and food security [6].

Urbanization has brought economic development to many countries, with substantial improvement in the provision of social services to many communities. However, it has also resulted in urban and physical expansion of built environment and brought ecological and socio-economic effects [7]. Conversion of croplands into urban built-up areas reduces the amount of land available for agriculture [4]. An exodus of

people and a resurgence of populations in urban and peri-urban areas leads to competition for the existing resources such as land and water [5]. Depleting available land meant for urban expansion and development leads to encroachment of the surrounding land meant for agriculture. As population increases, other resources like water, which are important for agricultural production are more exploited and consequently become inadequate within the limits of the town. Many studies have been carried out to analyze the expansion of towns and other land-use and land-cover changes within urban areas. Fan *et al.* [8] studied the changes in land cover with expansion of urban areas and how it impacted on land-use patterns. Jiang and Zhang [9] developed a model to assess the impacts of urban expansion on agricultural land conversion in China. In Kenya, however, mapping of areas under agriculture in urban and peri-urban areas including irrigated land has been a challenge. Therefore, land-use changes in terms of agriculture in Kenyan urban and peri-urban areas has not been adequately documented.

In many developing countries, lack of sound policy on managing and planning for urban expansion worsens the negative impact of urbanization. Samat *et al.* [10] observed that, in the last three decades, many cities in developing nations were on transition from a mainly agriculture based economy to an industrialized one to foster economic growth. Consequently, large groups of rural people flee to urban centers in search of greener pastures [10]. This massive migration has placed high pressure on existing resources and has increased pollution and social

problems, as many states are unable to meet the demands for an ever-growing urban population [11]. In African nations, agricultural production and land use in areas that surround urban centers have been affected by urban expansion. In Dar es Salaam City of Tanzania for example, urbanization is the key factor underpinning and catalyzing changes in land use, land transactions, increased rural-urban immigration and the overall peri-urban agriculture [12]. The rapid conversion of agricultural land to non-farming purposes jeopardize farming activities, which are considered the major source of livelihood of people living in the peri-urban areas. As a result, these areas become exposed to all sources of vulnerability, which leads to negative effects on the livelihoods of smallholder farmers living in peri-urban areas [9].

In recent past, most families residing in peri-urban areas of Embu town in Eastern Kenya depended on agriculture as their main source of economic livelihood. This therefore makes these peri-urban zones important for the local economy and community livelihoods. Embu town is the administrative headquarters of Embu County. The town is growing at a very fast rate since devolution of resources and power from the central government to the county government following the promulgation of the new constitution. Some of the notable development include establishment of institutions of higher learning such as universities and colleges and expansion of public facilities such as hospitals, commercial banks, infrastructure and various service delivery offices. These sectors of the economy have attracted both skilled and non-skilled labour either from rural areas or other urban areas thus accelerating the town's population growth. There is therefore an urgent need for proper urbanization plan in order to prevent unsustainable exploitation of natural resources including agricultural resources lying within the peri-urban zones. Therefore, comprehensive analysis of the effects of urban expansion on agricultural resources is critical for decision making and drawing policies on management of these resources hence the need for this study.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Study Site

This study was carried out to find out how agricultural resources in peri-urban areas of Embu town in Kenya has been affected by urban

expansion. Embu is a town located approximately 120 kilometers northeast of Nairobi towards Mount Kenya at a latitude of 0°31' 59.99" N and longitude of 37°26' 59.99"E. A cross-sectional survey was carried out in three sub-locations of high agricultural potential lying within six kilometer radius from the Central Business District (CBD) of Embu town. The three sub-locations are Kamiu to the East, Njukiri to the West and Nthambo to the North of the town. The three areas lie between Upper Midland four (UM4) and Upper Midland two (UM2) agro-ecological zones with soils ranging from clay loams in the upper area to sandy clay loams in the lower areas [13]. Kamiu lies between UM3 and UM4, Njukiri spreads between UM2 and UM3, while Nthambo falls within UM2. These areas experience bimodal rainfall with long rain falling between April and August and short rains falling between October to December. Rainfall amount ranges from 800 mm to 1400 mm per annum. The crops grown include industrial crops such as coffee, macadamia and sunflower; food crops including maize, beans, bananas, Irish potatoes, cassava, sweet potatoes and arrow roots; and horticultural crops mainly pawpaws, mangoes, passion fruits, tomatoes, kales, French beans and snow peas. In addition, farmers in the area also keep dairy cows, sheep, goats, poultry, pigs, rabbits and some practice beekeeping.

### 2.2 Research Design and Sampling Methods

Descriptive survey design was employed in order to investigate how urban expansion was affecting agricultural resources. This involved observational and survey methods. The design manifested the features of both qualitative and quantitative research in order to gather data on attributes and numbers as deemed necessary. Stratified purposive sampling was applied in this study. The three sub-locations were organized into three strata depending on their distance from CBD i.e. Kamiu (2 Kms), Njukiri (4 Kms) and Nthambo (6 Kms). This grouping was based on the assumption that, households nearer to the CBD had not been affected by urban development in the same way as those living further from the CBD. Purposive profiling was done to identify households that were in existence for ten years and above in each sub-location thus had experienced changes resulting from urban development. After profiling, the number of households in the three sub-locations who had met the required period of stay (ten years) was estimated at 248.

This study adopted the sampling procedure by Yamane (1967) as adopted by Israel and Hamas [14] as follows:

$$n = N/1 + (e)^2 \quad (1)$$

Where, n = total sample size

N = population size

e = acceptance error (0.05)

A population of 248 households estimated for the three study sites was used in the study. Therefore, sample size was computed as:

$$\begin{aligned} n &= N/1 + 248(0.05)^2 \\ n &= 153 \end{aligned} \quad (2)$$

The sample size of 153 households was divided equally to the three sub-location where each of the 3 strata was allocated an equal sample of 51 households.

## 2.3 Data Collection and Analysis

The effects of urbanization on agricultural resources were assessed as described by Singh [15] using the following indicators: rate of land sub-division, availability of agricultural, availability of agricultural labour for agriculture, level of crop and livestock production and environmental pollution. A structured questionnaire was used as the main tool of primary data collection. A pilot study was conducted to determine reliability of the questionnaires using Cronbach's alpha. In general, an alpha value ( $\alpha$ ) of more than 0.7 is usually acceptable [16] and this study established a value of 0.843, indicating that the variables used were reliable. Secondary data was also collected using observations and interviewing selected institutions with key information relating the study area. Documented information and archival data was also gathered from various sources. Data collected was coded and collated into a Microsoft Excel spreadsheet. The data was then analyzed using Statistical Package for Social Sciences (SPSS) version 23. The study received responses from 152 households out of the targeted 153 households representing a response rate of 99.3% which was considered adequate for data analysis based on the thresholds recommended by Mugenda and Mugenda [17] and Bell [18]. Qualitative data was analyzed through content and narrative analysis. Descriptive analysis was carried out to generate frequencies and correlations and presented in percentages,

tables and graphs. Quantitative data was subjected to Analysis of Variance where the three sub-locations were considered as treatments and means separated using Least Significant Difference (LSD) at 95% level of confidence.

## 3. RESULTS AND DISCUSSION

### 3.1 Demographic Information of the Respondents

In this study, majority (57.2%) of the respondents were males while the female respondents constituted 42.8%. The results thus indicated that both genders were almost equitably engaged in the research and therefore the findings from the research did not suffer from gender biasness. The youngest household head interviewed was 27 years and the oldest was 110 years which averaged 53 years. Therefore, the respondents for the study were well distributed in terms of age. The average years of settlement in the study site were 17 years with the shortest period being 10 years and longest 70 years. Therefore, the information which was given by respondents represented many years of experience over which the respondents had lived within the study sites. The average family size was 5 people per household with the smallest family size having 1 person and the largest with 13 members. Majority (41%) of the respondents in the study area had secondary school education while 27% had post-secondary trainings. The remaining 32% had acquired primary school education. The results of this study were therefore from an informed proportion of the community.

### 3.2 Effect of Urban Development on Agricultural Resources

#### 3.2.1 Average land size in the area

Across the three study sites, respondents were asked to reveal the average land size owned. This study revealed that 59.9% of the households in the study area owned one acre and below and only 7.2% owned five acres and above. Those who owned between 1 – 2 acres were 19.1% while the remaining 13.8% comprised of those who owned between 2 – 5 acres of land. The study went further to assess the average land sizes per each sub-location. Analysis of variance showed that there were significant differences ( $P = .05$ ) in land sizes between the three study sites. The land sizes

were found to shrink as the distance from CBD decreased. Kamiu sub-location had the smallest average land size of 0.48 acres, followed by Njukiri with an average land size of 0.92 acres and Nthambo with an average land size of 1.140 acres. Therefore, the land sizes in the peri urban areas of Embu town were found to shrink as the distance from CBD decreased. This was attributed to sub-division of agricultural land whose rate was found to increase as distance from CBD decreased as reported in section 3.2.2. Apparently, as urban expansion occurs, the available land is stretched for more uses besides agriculture and forestry. Jiang and Zhang [9] reported that urbanization not only affects agricultural resources but also compromises the environment since it also results in uncontrolled clearance of large pieces of land off their natural vegetation. Expansion of roads, sewerage system, and creation of solid waste disposal sites necessitated encroachment into agricultural areas taking up the available agricultural land and its natural environment. A proper land use budget is of great necessity to ensure that all land use activities are accommodated.

### 3.2.2 Rate of land sub-division

The rate of land sub-division was found to increase as distance from CBD decreased. In Kamiu sub-location, which is located within 2 km radius from the CBD, 58.6% of the respondents felt that the rate of land sub-division in their area was fast while 28.3% felt the rate was moderate.

Those who held the opinion that land sub-division is low in Kamiu were just 13.2%. In Njukiri sub-location which lies at 4km radius from the CBD, 19.1% said that land sub-division rate was fast, 50.7% indicated that it was moderate, 30.3% were of the opinion that the rate of land sub-division was low. In Nthambo sub-location which is located furthest from the CBD at approximately 6 km radius, majority of the respondents (77.0%) perceived that the rate of land sub-division in the area was low while 13.2% said it was moderate. Only 9.9% perceived land sub-division to be fast (Fig. 1).

The high rate of land subdivision in the peri-urban areas of Embu town was attributed to the increasing need for infrastructural development caused by urbanization. This was in agreement with Dalil et al. [19] who noted that, urbanization process lead to outward expansion of cities resulting in changes in land use, whereby urban residents buy up prime agricultural land at the periphery for residential or commercial purposes. As urban population increases, high demand for housing increases necessitating land owners in the peri-urban areas to invest in real estate. Mandere et al. [20] also observed that, decrease in agricultural land is caused by the sale of land for residential and business premises. Apparently, investors go for cheaper land further from urban centre, some for immediate development and others for prospective reasons. This is supported by the bid rent economic theory that suggests that the price and demand for real estate change as the distance from the CBD

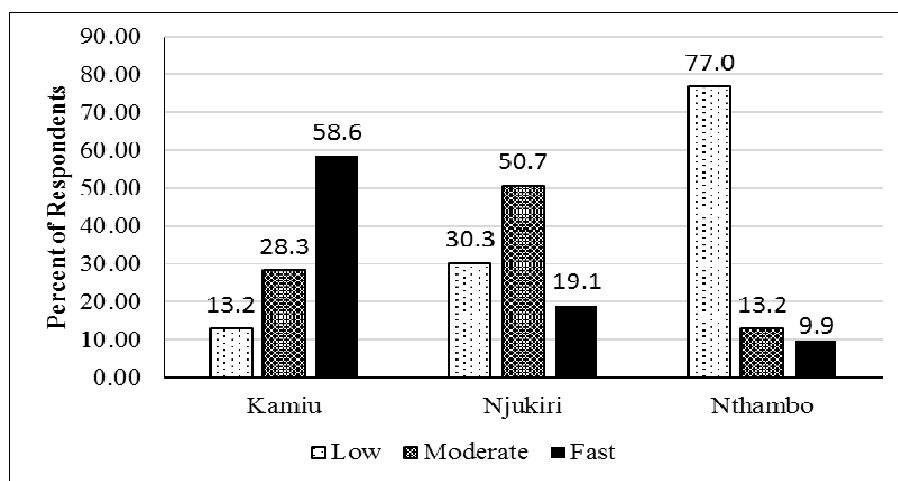


Fig. 1. Rate of sub-division of agricultural land in the study areas

increases. Secondly, business opportunities closer to CBD are better than locations further away due to high number of people who live or visit urban centres.

### 3.2.3 Reasons for sub-division of agricultural land

This study also sought to find out reasons that led to land sub-division. It emerged that there were three major reasons that contributed to land subdivision in the three study areas. Some subdivided their agricultural land to give to their grown up children as a form of inheritance, others subdivided to sell and others to build commercial houses (Fig. 2). In Kamiu, majority of the respondents (27.4%) were sub-dividing their agricultural land in order to sell a portion of it. This was followed by 46.7% who sub-divided to give to their children as inheritance and 25.9% who carved out a portion of agricultural land to build commercial houses. In Njukiri sub-location, the study revealed that, majority of the respondents (78.6%) were sub-dividing their agricultural land to give to their children as inheritance, 14.3% subdivided to sell whereas 7.1% subdivided in order to build commercial houses. In Nthambo sub-location which is the furthest from Embu town, majority of the respondents (85.7%) were sub-dividing their land to give to their children as inheritance whereas the remaining 10.7% were doing it to sell. Only 3.6 of the sampled respondents in Nthambo reported to have subdivided their agricultural land to build commercial houses.

From these findings, it was evident that those who subdivided their land to give to their grown

up children as a form of inheritance decreased as the distance from the CBD decreased indicating that this was much possible where urbanization pressure was minimal. On the other hand, those who subdivided their land for sale and to build commercial houses increased as the distance from the CBD decreased. This study established that there were several drivers of land sub-division in the peri-urban areas of Embu town. First, the price of land near CBD is higher because house rent is also higher nearer CBD than areas further away. Therefore, a unit area of land realizes higher economic returns when put in the right use. This is in agreement with Plantinga et al. [21] who observed that, there is a strong relationship between land uses and land prices. Their study revealed that, the price of land will equal the discounted sum of expected net returns obtained by allocating the land to its most profitable use. Naab et al. [22] also reported that urbanization causes changes in price of agricultural land as its value shifts from a consideration of its fertility and other favourable bio-physical characteristics to that of its functions.

### 3.2.4 Proportion of land allocated to crops farming and livestock production

This study established that the proportion of land allocated to crops farming increased as one moved towards heartland areas from CBD. At Kamiu and Njukiri which lies 2 and 4 kilometres respectively from CBD, majority of respondents (Kamiu - 65.8%; Njukiri - 42.5%) revealed that the land set aside for crops farming was below 10%. Only a small proportion in Kamiu (1.9%) and Njukiri (3.9%) had more than 70% of their

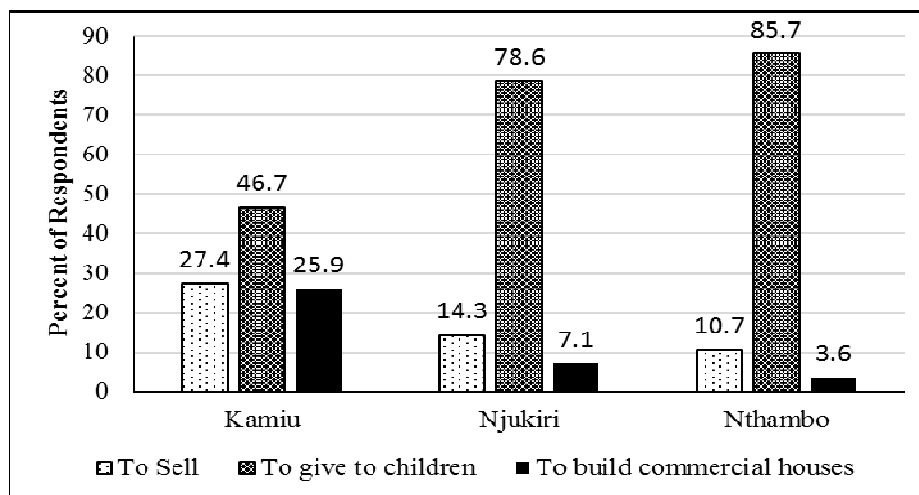


Fig. 2. Reasons for sub-division of agricultural land in the study areas

land set aside for crops farming. At Nthambo which lies approximately 6km from the CBD, majority of respondents had set aside between 41 and 70% of their land for crops farming. This site also had the lowest number of people with less than 10% of land set aside for crops farming (Fig. 3).

The proportion of land allocated to livestock production also increased as one moved towards heartland areas from CBD. At Kamiu which lies approximately 2 km from town centre, majority of respondents (48%) had set aside less than 10% of land for livestock farming. At Njukiri which lies 4 km from the town, most of the respondents (46.1%) had set aside between 10% and 40% for livestock farming. At Nthambo which lies approximately 6 km away from town, majority of the respondents (63.8%) had set aside between 41 and 70

percent of their farm for livestock farming as shown in Fig. 4.

From the above findings, it was evident that the proportion of land allocated to agriculture continued to shrink especially as one moved closer to the CBD. This indicated that farming as an enterprise was quickly being replaced by other enterprises. The respondents reported that conversion of land from crop production to other uses was as a result of low returns from farming. They indicated that construction of rental residential and commercial houses was more lucrative than farming. Where household heads could not raise money for construction, they sold a piece of land and used the money to develop the remaining land. This finding concurs with Kiita [23] who listed resource scarcity as one of the causes of land-use conversions leading to further pressure on production resources.

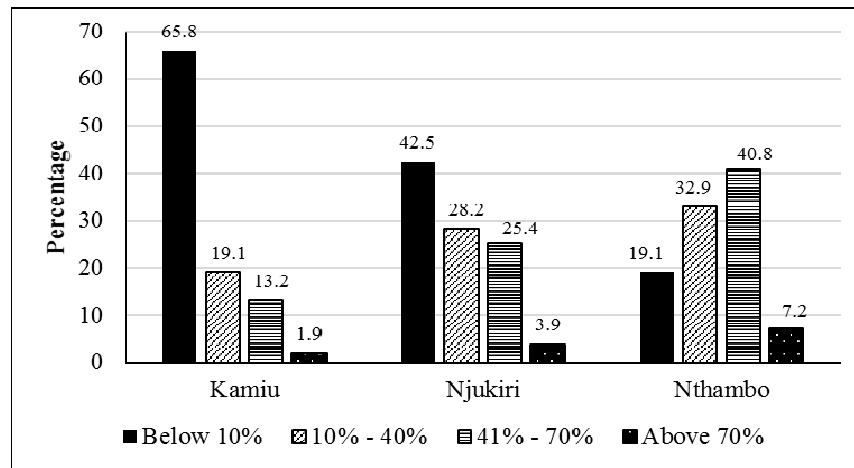


Fig. 3. Proportion of land allocated to crops

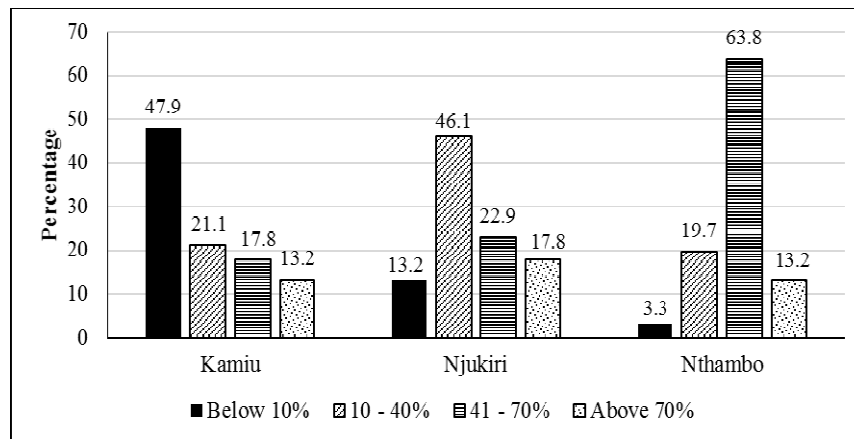


Fig. 4. Proportion of land allocated to livestock production



This study further analysed the proportion of respondents in the area that were practicing crops and livestock farming. Analysis of variance showed that there was significant ( $P = .05$ ) differences between the three locations in the proportion of people that were engaging in farming (Table 1). It was observed that, the proportion of farmers in the focal areas increased significantly as one moved away from CBD. This was attributed to land sub-division and changes in land use as observed in this study. This meant that as urbanization expands towards formerly agricultural areas, it brings about new economic opportunities including new jobs and businesses that are more lucrative than agriculture. According to Overman and Venables [24], urbanization sometimes compel farmers to new innovations on land utilization to realize maximum benefits from their small sizes of land. The relatively fewer number of farmers near the CBD than far away was attributed to the fact that formal jobs and business opportunities were more available nearer the town centre than further away. This is in line with Mandere et al. [20] who noted that, infrastructural developments brought about by urban development, together with emerging business enterprises are the main factors that enhance the household engagement in high income activities.

### 3.2.5 Main source of agricultural water

The respondents in the three focal areas were requested to disclose their main source of agricultural water. It emerged that although majority of the households relied on rainfall for agricultural production, some level of irrigation was being practiced in all the three sub-locations.

Njukiri had the highest number of households who had access to irrigation at 43.1% followed by Nthambo at 36%. Kamiu had the lowest access to irrigation at 23.5%. This study also established that waste water was also being used for irrigation and the practice was more nearer to CBD than further away (Table 2).

The study established that some small-scale irrigation projects were available in Njukiri and Nthambo although the service did not reach all the households in these areas. Thebo [25] reported similar findings that over 60% of the world's irrigated croplands are located near urban areas. At Kamiu which is nearest the CBD, there was high possibility that drinking water was used for irrigation to small portions of land and since it was not enough, it prompted more residents to turn to waste water to subsidize irrigation. Azuara et al. [26] reported that increase in urban population and high demand in basic commodities like water makes some resources to diverted from their intended use to meet the needs of urban population. FAO [27] reported that, in the last one century, use of water increased to almost twice than the rate of population growth.

### 3.2.6 Main source of agricultural labour

The respondents who were practicing farming activities were requested to reveal their main source of agricultural labour. It emerged that majority of households relied on family labour for agricultural production due to shortage of hired labour. In Kamiu 63.8% of the respondents relied on family labour while 35.5% relied on hired labour. In Njukiri 73.7% depended on family

**Table 1. Proportion of farmers in the focal area**

Sub-location	Crops farmers	Livestock farmers
Kamiu (2km from CBD)	33.04 <sup>a</sup>	45.78 <sup>a</sup>
Njukiri (4km from CBD)	54.38 <sup>b</sup>	58.83 <sup>b</sup>
Nthambo (6km from CBD)	68.83 <sup>c</sup>	69.42 <sup>c</sup>
p-value	0.0001**	0.0077
LSD	7.8548	6.3163

*Means followed by the same letter within the column are not significantly different at  $P = 0.05$*

**Table 2. Main source of agricultural water**

Main source of agricultural water	Kamiu		Njukiri		Nthambo		Mean
	Freq	%	Freq	%	Freq	%	
Rainfall	24	47.1	24	47.1	26	52.0	48.7
Irrigation	12	23.5	22	43.1	18	36.0	34.2
Waste water	15	29.4	5	9.8	6	12.0	17.1
Total	51	100	51	100	50	100	100

**Table 3. Correlation analysis between distance from CBD and agricultural resources**

Variables	Distance from CBD	Agricultural resources
Distance from CBD	1	0.224***
Agricultural Resources	0.224***	1

\*\*\*Correlation is Significant at  $P < .0001$ ;  $N = 152$

labour and 26.3% on hired labour. In Nthambo, the majority (80.3%) relied on family labour, whereas only 19.7% of the farmers relied on hired labour. Apparently, majority of the labour, which was initially available for agriculture in the peri-urban areas was taken up by construction and businesses within town. Unavailability of agricultural labour could have raised the cost of labour thus forcing many households to rely on rarely available family labour for agricultural production. This was in agreement with Gunabhagya et al. [28] who observed that, over the past years, the ratio of agricultural workers to the total workers has been going down, while the corresponding ratio in the secondary and tertiary sectors is on the rise. However, family labour alone cannot be enough to support economic agricultural activities. This could therefore have contributed to reduced agricultural activities in the focal area as reported earlier in this study and consequently affecting agricultural productivity and hence the livelihood of the residents. This theory is supported by Dalil et al. [19] who reported that, urban development impacts on food production consequently affecting the livelihood of the people.

### 3.2.7 Correlation analysis between distance from CBD and agricultural resources

In order to further understand the relationship between proximity to CBD and agricultural resources, a Pearson correlation coefficient was carried out using SPSS software. There was significant positive linear correlation between the distance from CBD and agricultural resources (Table 3). Therefore, agricultural resources increased significantly as the distance from CBD increased. The magnitude of the association was strong as determined by the level of significance ( $P < .0001$ ).

## 4. CONCLUSION

This study established that increased urban development in the peri-urban areas of Embu town had contributed to decreased agricultural resources to a high extent. It was evident that urbanization brought about competition against available agricultural resources such as land,

labour and water resulting in reduced agricultural activities in the study area. Based on the key findings, the study recommends policy interventions to manage peri-urbanization in Embu and other towns with similar set up, with a view of reducing degradation of agricultural resources and controlling unsustainable land sub-division and land use changes. This will be important to enable attainment of the twin goals of achieving improved food production and sustainable development in Kenya.

## ACKNOWLEDGEMENTS

The authors are grateful to the Center Director, Kenya Agricultural and Livestock Research Organization, Food Crop Research Institute, Dr. Patrick Gicheru and his Deputy Dr. Alfred Micheni for providing the necessary financial and administrative support during data collection. All university students together with county and national government officials involved in the collection of ground data are also greatly appreciated.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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[ISSN: 2320-7051]

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