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

Eliud K. Murimi[1]*, Lucy K. Njeru[2], Bernard M. Gichimu[3] and Samuel N. Ndirangu[4]

1Kenya Agricultural and Livestock Research Organization, Food Crops Research Institute. P.O Box 27-60100, Embu.

2Department of Agricultural Economics, University of Nairobi. P.O. Box 30197-00100, Nairobi

3Department of Agricultural Resource Management, University of Embu. P.O. Box 6-60100, Embu

4Department of Agricultural Economics and Extension, University of Embu. P.O. Box 6-60100, Embu

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. 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 (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

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

* E-mail address: ekagete@gmail.com

27 reach 5 billion by 2030 [2]. Developing countries in Sub-Saharan Africa bears the brunt of
28 rapid expansion of towns into the peri-urban rural crop and animal production areas [3].
29 Among all agricultural resources, land which is the main supporter of all forms of is the one
30 that has suffered most negative consequences of the process of urbanization, particularly
31 the loss of high-quality agricultural land [4]. Agricultural land within the urban and peri-urban
32 boundaries has been reportedly reducing in the wake of urbanization as other agricultural
33 resources are also diverted to other uses [5]. A well planned and managed urban expansion
34 to peri-urban areas and consequently to rural areas is important to ensure sustainable
35 development alongside adequate growth in agriculture and food security [6].

36 Urbanization has brought economic development to many countries, with substantial
37 improvement in the provision of social services to many communities. However, it has also
38 resulted in urban and physical expansion of built environment and brought ecological and
39 socio-economic effects [7]. Conversion of croplands into urban built-up areas reduces the
40 amount of land available for agriculture [4]. An exodus of people and a resurgence of
41 populations in urban and peri-urban areas leads to competition for the existing resources
42 such as land and water [5]. Depleting available land meant for urban expansion and
43 development leads to encroachment of the surrounding land meant for agriculture. As
44 population increases, other resources like water, which are important for agricultural
45 production are more exploited and consequently become inadequate within the limits of the
46 town. Many studies have been carried out to analyze the expansion of towns and other land-
47 use and land-cover changes within urban areas. Fan *et al.* [8] studied the changes in land
48 cover with expansion of urban areas and how it impacted on land-use patterns. Jiang and
49 Zhang [9] developed a model to assess the impacts of urban expansion on agricultural land
50 conversion in China. In Kenya, however, mapping of areas under agriculture in urban and
51 peri-urban areas including irrigated land has been a challenge. Therefore, land-use changes
52 in terms of agriculture in Kenyan urban and peri-urban areas has not been adequately
53 documented.

54 In many developing countries, lack of sound policy on managing and planning for urban
55 expansion worsens the negative impact of urbanization. Samat *et al.* [10] observed that, in
56 the last three decades, many cities in developing nations were on transition from a mainly
57 agriculture based economy to an industrialized one to foster economic growth.
58 Consequently, large groups of rural people flee to urban centers in search of greener
59 pastures [10]. This massive migration has placed high pressure on existing resources and
60 has increased pollution and social problems, as many states are unable to meet the
61 demands for an ever-growing urban population [11]. In African nations, agricultural
62 production and land use in areas that surround urban centers have been affected by urban
63 expansion. In Dar es Salaam City of Tanzania for example, urbanization is the key factor
64 underpinning and catalyzing changes in land use, land transactions, increased rural-urban
65 immigration and the overall peri-urban agriculture [12]. The rapid conversion of agricultural
66 land to non-farming purposes jeopardize farming activities, which are considered the major
67 source of livelihood of people living in the peri-urban areas. As a result, these areas become
68 exposed to all sources of vulnerability, which leads to negative effects on the livelihoods of
69 smallholder farmers living in peri-urban areas [9].

70 In recent past, most families residing in peri-urban areas of Embu town in Eastern Kenya
71 depended on agriculture as their main source of economic livelihood. This therefore makes
72 these peri-urban zones important for the local economy and community livelihoods. Embu
73 town is the administrative headquarters of Embu County. The town is growing at a very fast
74 rate since devolution of resources and power from the central government to the county
75 government following the promulgation of the new constitution. Some of the notable
76 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. MATERIAL 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 Method

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:

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

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:

128     $n = N/1 + 248(0.05)^2$ ....(2)

129   n = 153

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

132

133 2.3 Data Collection and Analysis

134 The effects of urbanization on agricultural resources were assessed as described by Singh
135 [15] using the following indicators: rate of land sub-division, availability of agricultural,
136 availability of agricultural labour for agriculture, level of crop and livestock production and
137 environmental pollution. A structured questionnaire was used as the main tool of primary
138 data collection. A pilot study was conducted to determine reliability of the questionnaires
139 using Cronbach's alpha. In general, an alpha value (α) of more than 0.7 is usually
140 acceptable [16] and this study established a value of 0.843, indicating that the variables
141 used were reliable. Secondary data was also collected using observations and interviewing
142 selected institutions with key information relating the study area. Documented information
143 and archival data was also gathered from various sources. Data collected was coded and
144 collated into a Microsoft Excel spreadsheet. The data was then analyzed using Statistical
145 Package for Social Sciences (SPSS) version 23. The study received responses from 152
146 households out of the targeted 153 households representing a response rate of 99.3% which
147 was considered adequate for data analysis based on the threshholds recommended by
148 Mugenda and Mugenda [17] and Bell [18]. Qualitative data was analyzed through content
149 and narrative analysis. Descriptive analysis was carried out to generate frequencies and
150 correlations and presented in percentages, tables and graphs. Quantitative data was
151 subjected to Analysis of Variance where the three sub-locations were considered as
152 treatments and means separated using Least Significant Difference (LSD) at 95% level of
153 confidence.

154 3. RESULTS AND DISCUSSION

155

156 3.1 Demographic Information of the Respondents

157 In this study, majority (57.2%) of the respondents were males while the female respondents
158 constituted 42.8%. The results thus indicated that both genders were almost equitably
159 engaged in the research and therefore the findings from the research did not suffer from
160 gender biasness. The youngest household head interviewed was 27 years and the oldest
161 was 110 years which averaged 53 years. Therefore, the respondents for the study were well
162 distributed in terms of age. The average years of settlement in the study site were 17 years
163 with the shortest period being 10 years and longest 70 years. Therefore, the information
164 which was given by respondents represented many years of experience over which the
165 respondents had lived within the study sites. The average family size was 5 people per
166 household with the smallest family size having 1 person and the largest with 13 members.
167 Majority (41%) of the respondents in the study area had secondary school education while
168 27% had post-secondary trainings. The remaining 32% had acquired primary school
169 education. The results of this study were therefore from an informed proportion of the
170 community.

171

172 3.2 Effect of Urban Development on Agricultural Resources

173 <u>3.2.1 Average Land Size in the Area</u>

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

180 sizes between the three study sites. The land sizes were found to shrink as the distance
181 from CBD decreased. Kamiu sub-location had the smallest average land size of 0.48 acres,
182 followed by Njukiri with an average land size of 0.92 acres and Nthambo with an average
183 land size of 1.140 acres. Therefore, the land sizes in the peri urban areas of Embu town
184 were found to shrink as the distance from CBD decreased. This was attributed to sub-
185 division of agricultural land whose rate was found to increase as distance from CBD
186 decreased as reported in section 3.2.2. Apparently, as urban expansion occurs, the available
187 land is stretched for more uses besides agriculture and forestry. Jiang and Zhang [9]
188 reported that urbanization not only affects agricultural resources but also compromises the
189 environment since it also results in uncontrolled clearance of large pieces of land off their
190 natural vegetation. Expansion of roads, sewerage system, and creation of solid waste
191 disposal sites necessitated encroachment into agricultural areas taking up the available
192 agricultural land and its natural environment. A proper land use budget is of great necessity
193 to ensure that all land use activities are accommodated.
194

195 **3.2.2 Rate of Land Sub-Division**
196 The rate of land sub-division was found to increase as distance from CBD decreased. In
197 Kamiu sub-location, which is located within 2 km radius from the CBD, 58.6% of the
198 respondents felt that the rate of land sub-division in their area was fast while 28.3% felt the
199 rate was moderate. Those who held the opinion that land sub-division is low in Kamiu were
200 just 13.2%. In Njukiri sub-location which lies at 4km radius from the CBD, 19.1% said that
201 land sub-division rate was fast, 50.7% indicated that it was moderate, 30.3% were of the
202 opinion that the rate of land sub-division was low. In Nthambo sub-location which is located
203 furthest from the CBD at approximately 6 km radius, majority of the respondents (77.0%)
204 perceived that the rate of land sub-division in the area was low while 13.2% said it was
205 moderate. Only 9.9% perceived land sub-division to be fast (Figure 1).
206
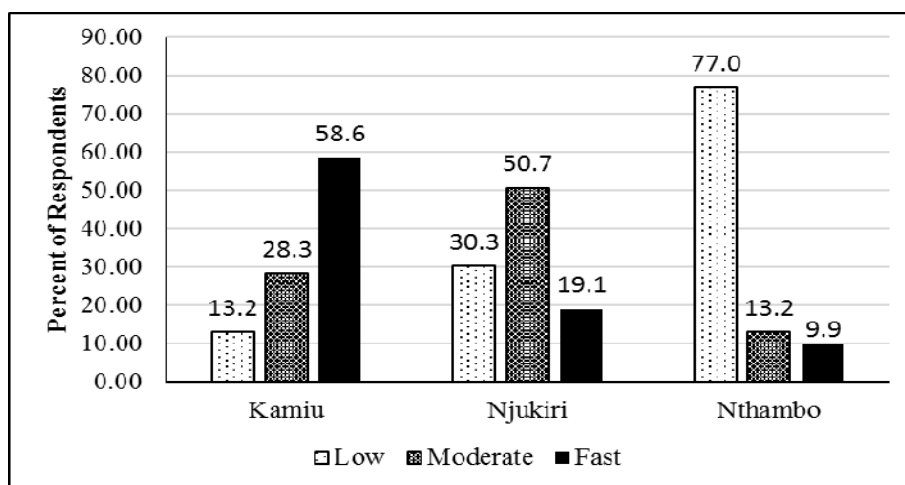
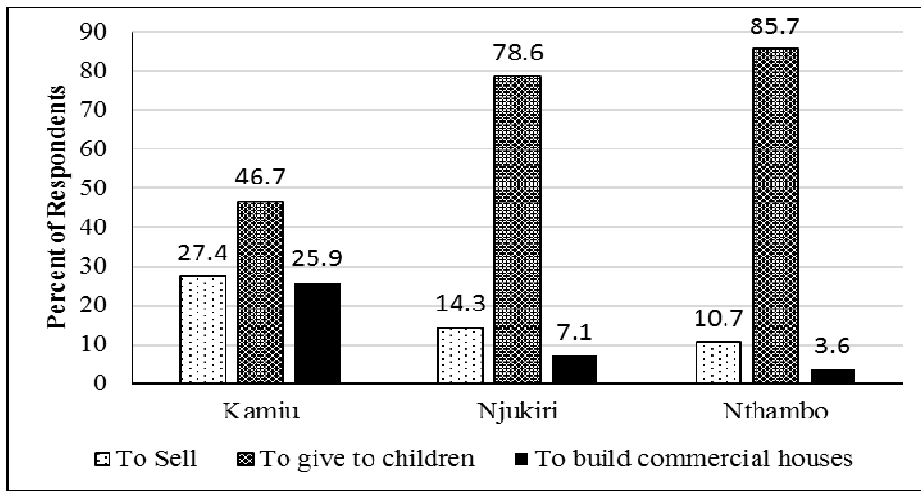208 **Figure 1**: Rate of Sub-division of Agricultural Land in the Study Areas
209

210 The high rate of land subdivision in the peri-urban areas of Embu town was attributed to the
211 increasing need for infrastructural development caused by urbanization. This was in
212 agreement with Dalil et al. [19] who noted that, urbanization process lead to outward
213 expansion of cities resulting in changes in land use, whereby urban residents buy up prime
214 agricultural land at the periphery for residential or commercial purposes. As urban population
215 increases, high demand for housing increases necessitating land owners in the peri-urban
216 areas to invest in real estate. Mandere et al. [20] also observed that, decrease in agricultural
217 land is caused by the sale of land for residential and business premises. Apparently,
218 investors go for cheaper land further from urban centre, some for immediate development

219 and others for prospective reasons. This is supported by the bid rent economic theory that
220 suggests that the price and demand for real estate change as the distance from the CBD
221 increases. Secondly, business opportunities closer to CBD are better than locations further
222 away due to high number of people who live or visit urban centres.
223
224 **3.2.3 Reasons for Sub-division of Agricultural Land**
225 This study also sought to find out reasons that led to land sub-division. It emerged that there
226 were three major reasons that contributed to land subdivision in the three study areas. Some
227 subdivided their agricultural land to give to their grown up children as a form of inheritance,
228 others subdivided to sell and others to build commercial houses (Figure 2). In Kamiu,
229 majority of the respondents (27.4%) were sub-dividing their agricultural land in order to sell a
230 portion of it. This was followed by 46.7% who sub-divided to give to their children as
231 inheritance and 25.9% who curved out a portion of agricultural land to build commercial
232 houses. In Njukiri sub-location, the study revealed that, majority of the respondents (78.6%)
233 were sub-dividing their agricultural land to give to their children as inheritance, 14.3%
234 subdivided to sell whereas 7.1% subdivided in order to build commercial houses. In
235 Nthambo sub-location which is the furthest from Embu town, majority of the respondents
236 (85.7%) were sub-dividing their land to give to their children as inheritance whereas the
237 remaining 10.7% were doing it to sell. Only 3.6 of the sampled respondents in Nthambo
238 reported to have subdivided their agricultural land to build commercial houses.
239

240
241 **Figure 2**: Reasons for Sub-division of Agricultural Land in the Study Areas
242
243 From these findings, it was evident that those who subdivided their land to give to their
244 grown up children as a form of inheritance decreased as the distance from the CBD
245 decreased indicating that this was much possible where urbanization pressure was minimal.
246 On the other hand, those who subdivided their land for sale and to build commercial houses
247 increased as the distance from the CBD decreased. This study established that there were
248 several drivers of land sub-division in the peri-urban areas of Embu town. First, the price of
249 land near CBD is higher because house rent is also higher nearer CBD than areas further
250 away. Therefore, a unit area of land realizes higher economic returns when put in the right
251 use. This is in agreement with Plantinga et al. [21] who observed that, there is a strong
252 relationship between land uses and land prices. Their study revealed that, the price of land
253 will equal the discounted sum of expected net returns obtained by allocating the land to its
254 most profitable use. Naab et al. [22] also reported that urbanization causes changes in price
255 of agricultural land as its value shifts from a consideration of its fertility and other favourable
256 bio-physical characteristics to that of its functions.

257
258 **3.2.4 Proportion of Land Allocated to Crops Farming and Livestock Production**
259 This study established that the proportion of land allocated to crops farming increased as
260 one moved towards heartland areas from CBD. At Kamiu and Njukiri which lies 2 and 4
261 kilometres respectively from CBD, majority of respondents (Kamiu - 65.8%; Njukiri - 42.5%)
262 revealed that the land set aside for crops farming was below 10%. Only a small proportion in
263 Kamiu (1.9%) and Njukiri (3.9%) had more than 70% of their land set aside for crops
264 farming. At Nthambo which lies approximately 6km from the CBD, majority of respondents
265 had set aside between 41 and 70% of their land for crops farming. This site also had the
266 lowest number of people with less than 10% of land set aside for crops farming (Figure 3).
267
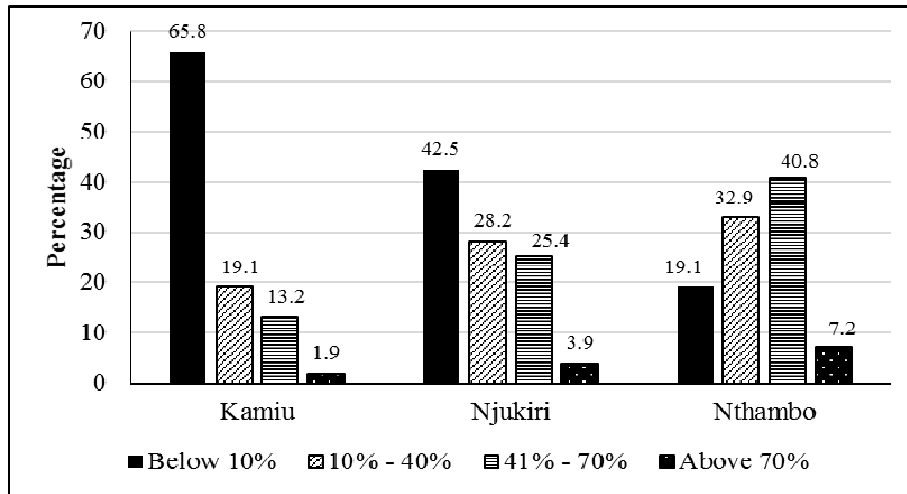
268
269 **Figure 3**: Proportion of Land allocated to Crops
270

271 The proportion of land allocated to livestock production also increased as one moved
272 towards heartland areas from CBD. At Kamiu which lies approximately 2 km from town
273 centre, majority of respondents (48%) had set aside less than 10% of land for livestock
274 farming. At Njukiri which lies 4 km from the town, most of the respondents (46.1%) had set
275 aside between 10% and 40% for livestock farming. At Nthambo which lies approximately 6
276 km away from town, majority of the respondents (63.8%) had set aside between 41 and 70
277 percent of their farm for livestock farming as shown in figure 4.
278
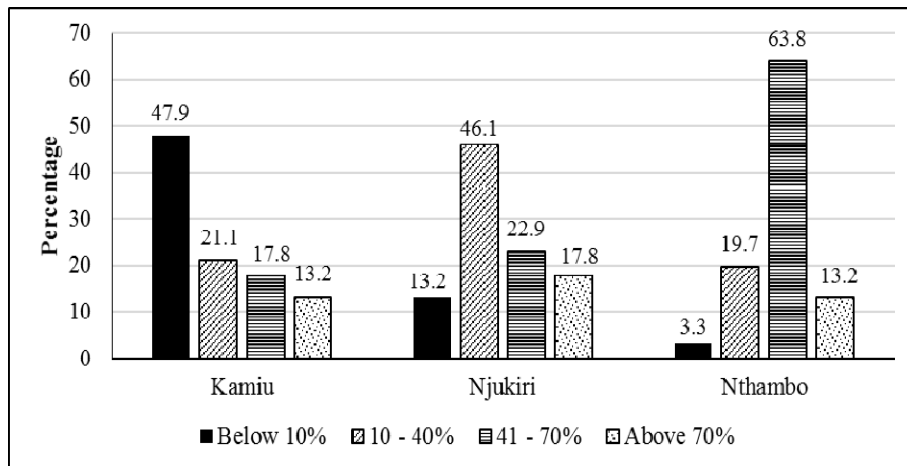
279
280 **Figure 4**: Proportion of land allocated to livestock production

281

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.

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.

Table 1: Proportion of Farmers in the Focal Area

Sub-location	Crops Farmers	Livestock Farmers
Kamiu (2km from CBD)	33.04[a]	45.78[a]
Njukiri (4km from CBD)	54.38[b]	58.83[b]
Nthambo (6km from CBD)	68.83[c]	69.42[c]
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.

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).

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**

321

322 The study established that some small-scale irrigation projects were available in Njukiri and
323 Nthambo although the service did not reach all the households in these areas. Thebo [25]
324 reported similar findings that over 60% of the world's irrigated croplands are located near
325 urban areas. At Kamiu which is nearest the CBD, there was high possibility that drinking
326 water was used for irrigation to small portions of land and since it was not enough, it
327 prompted more residents to turn to waste water to subsidize irrigation. Azuara et al. [26]
328 reported that increase in urban population and high demand in basic commodities like water
329 makes some resources to diverted from their intended use to meet the needs of urban
330 population. FAO [27] reported that, in the last one century, use of water increased to almost
331 twice than the rate of population growth.
332
333 ### 3.2.6 Main Source of Agricultural Labour
334 The respondents who were practicing farming activities were requested to reveal their main
335 source of agricultural labour. It emerged that majority of households relied on family labour
336 for agricultural production due to shortage of hired labour. In Kamiu 63.8% of the
337 respondents relied on family labour while 35.5% relied on hired labour. In Njukiri 73.7%
338 depended on family labour and 26.3% on hired labour. In Nthambo, the majority (80.3%)
339 relied on family labour, whereas only 19.7% of the farmers relied on hired labour.
340 Apparently, majority of the labour, which was initially available for agriculture in the peri-
341 urban areas was taken up by construction and businesses within town. Unavailability of
342 agricultural labour could have raised the cost of labour thus forcing many households to rely
343 on rarely available family labour for agricultural production. This was in agreement with
344 Gunabhagya et al. [28] who observed that, over the past years, the ratio of agricultural
345 workers to the total workers has been going down, while the corresponding ratio in the
346 secondary and tertiary sectors is on the rise. However, family labour alone cannot be
347 enough to support economic agricultural activities. This could therefore have contributed to
348 reduced agricultural activities in the focal area as reported earlier in this study and
349 consequently affecting agricultural productivity and hence the livelihood of the residents.
350 This theory is supported by Dalil et al. [19] who reported that, urban development impacts on
351 food production consequently affecting the livelihood of the people.
352
353 ### 3.2.7 Correlation Analysis between Distance from CBD and Agricultural Resources
354 In order to further understand the relationship between proximity to CBD and agricultural
355 resources, a Pearson correlation coefficient was carried out using SPSS software. There
356 was significant positive linear correlation between the distance from CBD and agricultural
357 resources (Table 3). Therefore, agricultural resources increased significantly as the distance
358 from CBD increased. The magnitude of the association was strong as determined by the
359 level of significance ($P < .0001$).

360 **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

361 ***Correlation is Significant at $P < .0001$; N = 152
362
363 ## 4. CONCLUSION
364
365 This study established that increased urban development in the peri-urban areas of Embu
366 town had contributed to decreased agricultural resources to a high extent. It was evident that
367 urbanization brought about competition against available agricultural resources such as land,
368 labour and water resulting in reduced agricultural activities in the study area. Based on the
369 key findings, the study recommends policy interventions to manage peri-urbanization in
370 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 achiving improved food production and sustainable development in Kenya.

ACKNOWLEDGEMENTS

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

This study was proposed by Eliud Kagete, who together with Lucy Karega, Bernard Gichimu and Samuel Ndirangu gave it a direction and contributed to its implementation. Eliud Kagete led the team of enumerators who collected and collated the ground data. The data was analyzed by Bernard Gichimu after which all the authors jointly carried out the interpretation of the analyzed data jointly developed this manuscript. The authors unanimously appointed Eliud Kagete to be the corresponding author.

REFERENCES

1. United Nations. World Urbanization Prospects: The 2014 Revision (United Nations, Department of Economic and Social Affairs, Population Division, New York). 2014. Accessed 6 October 2018. Available: www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html.

2. Ademola K, Takashi O. Spatial determinants of urban land use change in Lagos, Nigeria. *Land Use Policy.* 2007;24(2):502-515. DOI: 10.1016/j.landusepol.2006.09.001

3. International Food Policy Research Institute (IFPRI). Global Food Policy Report, Washington, DC, USA. 2017. Accessed 20 July 2018. Available: http://www.Ifpri.Org/publication/2017-global-food-policy-report

4. Sroka W, Mikolajczyk J, Wojewodzic T, Kwoczynska B. Agricultural Land vs. Urbanisation in Chosen Polish Metropolitan Areas: A Spatial Analysis Based on Regression Trees. *Sustainability.* 2018;10: 837; doi:10.3390/su10030837

5. Thuo ADM. Impacts of urbanization on land use planning, livelihood and environment in the Nairobi Rural-Urban Fringe, Kenya. *International Journal of Scientific & Technology Research.* 2013;2(7).

6. Gumma M, Mohammad I, Nedumaran S, Whitbread A, Lagerkvist C. Urban sprawl and adverse impacts on agricultural land: a case study on Hyderabad, India. Remote sensing. 2017;9(11): 1136.

7. Thuo AD. Community response to land use transformation in Nairobi rural-urban fringe, Kenya. University of Waikato, Field Action Report; 2010.

8. Fan C, Myint SW, Rey SJ, Li W. Time series evaluation of landscape dynamics using annual Landsat imagery and spatial statistical modeling: Evidence from the phoenix

metropolitan region. International Journal of Applied Earth Observation and Geoinformation. 2017;58: 12-25. https://doi.org/10.1016/j.jag.2017.01.009

9. Jiang L, Zang Y. Modeling Urban Expansion and Agricultural Land Conversion in Henan Province, China: An integration of land use and socioeconomic data. MPDI publishers; 2016.

10. Samat N, Raddad S, Salleh G. Determinants of Agriculture Land Use Change in Palestinian Urban Environment: Urban Planners at Local Governments Perspective. American-Eurasian Journal of Sustainable Agriculture. 2012; 4(1): 30-38.

11. Selod H. Opportunities and Challenges of Urbanization, Planning for an Unprecedented. DEC Policy Research Talk. 2017. Accessed 19 December 2018. Available: https://ubdocs.worldbank.org

12. Simon D, McGregor D, Nsiah-Gyabaah K. The changing urban-rural interface of African cities: definitional issues and an application to Kumasi, Ghana. Environment and Urbanization, 2004; 16(2): 235-248. https://doi.org/10.1177/095624780401600214

13. Jaetzold R, Schmidt H, Hornetz B, Shisanya, C. Farm Management Handbook. Vol. II, Eastern Kenya; 2006.

14. Zanotti J, Migdalovitz C, Sharp JM, Addis CL, Blanchard CM, Margesson R. Israel and Hamas. Conflict in Gaza (2008-2009). Congressional research service. 2009. Accessed 2 December 2018. Available: https://fas.org/sgp/crs/mideast/R40101.pdf

15. Singh K. Environmental Degradation and Measures for Its Mitigation with Special Reference to India's Agricultural Sector. *Ind. Jn. of Agri. Econ.* 2009;64(1): 40-61.

16. Sekaran U. Research methods for business. John Wiley & sons, Inc; 2015.

17. Mugenda OM, Mugenda AG. Research methods: Quantitative and qualitative Approaches. Nairobi: African Centre for Technology Studies; 2003. ISBN 9966411070, 9789966411075

18. Bell J. Doing your research project: A guide for first-time researchers in education and social sciences. Zed Books; 2005), 286 p.

19. Dalil M, Yaman U, Omeiza I. The Impact of Urban Development on Food Security in Peri-Urban Areas of Minna, Niger State, Nigeria. *International Journal of Humanities and Social Science Invention.* 2013; 2(4): 26-31

20. Mandere NM, Barry N, Stefan A. Peri-urban development, livelihood change and household income: A case study of peri-urban Nyahururu, Kenya. Journal of Agricultural Extension and Rural Development. 2010;2(5): 73-83.

21. Plantinga A, Lubowski R, Stavins R. The effects of potential land development on agricultural land prices. *Journal of Urban Economics* 2002; 52:561-58.

22. Naab FZ, Dinye RD, Kasanga RK. Urbanization and Its Impact on Agricultural Lands in Growing Cities in Developing Countries: A Case Study of Tamale in Ghana. Modern Social Science Journal. 2013;2(2): 256-287; ISSN 2051-5499. Available online at http://scik.org

23. Kiita M. An investigation into causes and effects of agricultural land use conversions in the urban fringes: A case study of Nairobi - Kiambu interface. 2013. Accessed 19 December 2018. Available: http://erepository.uonbi.ac.ke/handle/11295/52391

24. Overman HG, Venables AJ. "Cities in the Developing World," CEP Discussion Paper No 695. Centre for Economic Performance, LSE. 2005. Accessed 14 August 2018. Available: http://eprints.lse.ac.uk/19887/1/Cities_in_the_Developing_World.pdf

25. Thebo AL, Drechsel P, Lambin EF. Global assessment of urban and peri-urban agriculture: Irrigated and rainfed croplands. Environ Res Lett. 2014;9(11):114002.

26. Azuara J, Vergati J, Sumner D, Howitt R, Lund J. Analysis of effects of reduced supply of water on agricultural production and irrigation water use in Southern California.

471   University of California Agricultural Issues Center; 2012. Accessed 12 January 2019.
472   Available: https://aic.ucdavis.edu/publications/water%20socal_final_0822.pdf
473 27. FAO. Water for Sustainable Food and Agriculture. A report produced for the G20
474   Presidency of Germany; 2017.
475 28. Gunabhagya, Joshi AT, Wali VB, Lokesha H. Labour Scarcity – Its enormity and
476   Influence on Agriculture. *Int. J. Pure App. Biosci.* 2017;5(6): 1597-1603. ISSN: 2320-
477   7051.

478