

Original Research Article

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

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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 CBD 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.

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Keywords: Urbanization, Peri-urban areas, Agricultural resources, Land use conversion

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

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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 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].

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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.

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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

74 land to non-farming purposes jeopardize farming activities, which are considered the major
75 source of livelihood of people living in the peri-urban areas. As a result, these areas become
76 exposed to all sources of vulnerability, which leads to negative effects on the livelihoods of
77 smallholder farmers living in peri-urban areas [9].

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

94 **2. MATERIAL AND METHODS**

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96 **2.1 Description of the Study site**

97 This study was carried out to find out how agricultural resources in peri-urban areas of Embu
98 town in Kenya has been affected by urban expansion. A cross-sectional survey was carried
99 out in three sub-locations of high agricultural potential lying within six kilometer radius from
100 the central business district of Embu town. The three sub-locations are Kamiu to the East,
101 Njukiri to the West and Nthambo to the North of the town. The three areas lie between Upper
102 Midland four (UM4) and Upper Midland two (UM2) agro-ecological zones with soils ranging
103 from clay loams in the upper area to sandy clay loams in the lower areas [13]. Kamiu lies
104 between UM3 and UM4, Njukiri spreads between UM2 and UM3, while Nthambo falls within
105 UM2. These areas experience bimodal rainfall with long rain falling between April and
106 August and short rains falling between October to December. Rainfall amount ranges from
107 800 mm to 1400 mm per annum. The crops grown include industrial crops such as coffee,
108 macadamia and sunflower; food crops including maize, beans, bananas, Irish potatoes,
109 cassava, sweet potatoes and arrow roots; and horticultural crops mainly pawpaws,
110 mangoes, passion fruits, tomatoes, kales, French beans and snow peas. In addition, farmers
111 in the area also keep dairy cows, sheep, goats, poultry, pigs, rabbits and some practice
112 beekeeping.

113 **2.2 Research Design and Sampling Method**

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

124 number of households in the three sub-locations who had met the required period of stay
125 (ten years) was estimated at 248.

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

129 $n = N/1 + (e)^2$ (1)

130 Where, n = total sample size

131 N = population size

132 e = acceptance error (0.05)

133 A population of 248 households estimated for the three study sites was used in the study.

134 Therefore, sample size was computed as:

135 $n = N/1 + 248(0.05)^2$ (2)

136 n = 153

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

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140 **2.3 Data Collection and Analysis**

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

161 **3. RESULTS AND DISCUSSION**

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163 **3.1 Demographic Information of the Respondents**

164 In this study, majority (57.2%) of the respondents were males while the female respondents
165 constituted 42.8%. The results thus indicated that both genders were almost equitably
166 engaged in the research and therefore the findings from the research did not suffer from
167 gender biasness. The youngest household head interviewed was 27 years and the oldest
168 was 110 years which averaged 53 years. Therefore, the respondents for the study were well
169 distributed in terms of age. The average years of settlement in the study site were 17 years
170 with the shortest period being 10 years and longest 70 years. Therefore, the information
171 which was given by respondents represented many years of experience over which the
172 respondents had lived within the study sites. The average family size was 5 people per
173 household with the smallest family size having 1 person and the largest with 13 members.
174 Majority (41%) of the respondents in the study area had secondary school education while
175 27% had post-secondary trainings. The remaining 32% had acquired primary school

176 education. The results of this study were therefore from an informed proportion of the
177 community.

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179 **3.2 Effect of Urban Development on Agricultural Resources**

180 **3.2.1 Average Land Size in the Area**

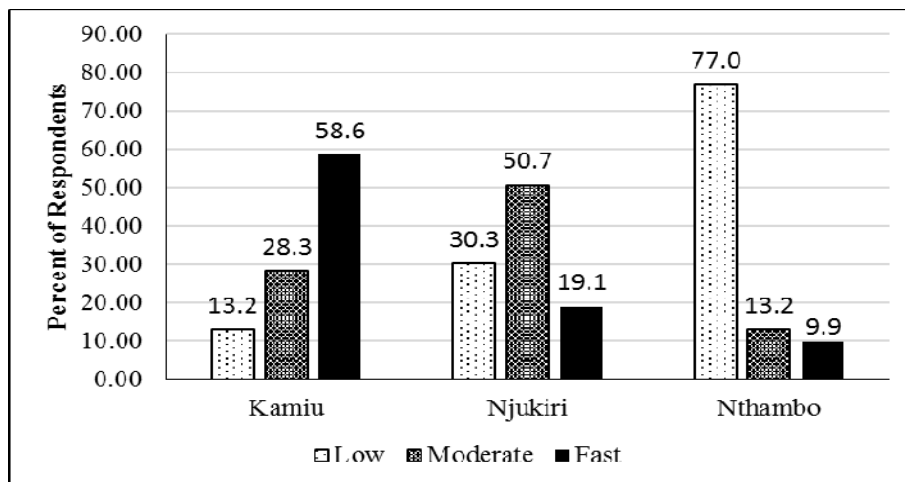
181 Across the three study sites, respondents were asked to reveal the average land size
182 owned. This study revealed that 59.9% of the households in the study area owned one acre
183 and below and only 7.2% owned five acres and above. Those who owned between 1 – 2
184 acres were 19.1% while the remaining 13.8% comprised of those who owned between 2 – 5
185 acres of land. The study went further to assess the average land sizes per each sub-
186 location. Analysis of variance showed that there were significant differences ($P = .05$) in land
187 sizes between the three study sites. The land sizes were found to shrink as the distance
188 from CBD decreased. Kamiu sub-location had the smallest average land size of 0.48 acres,
189 followed by Njukiri with an average land size of 0.92 acres and Nthambo with an average
190 land size of 1.140 acres. Therefore, the land sizes in the peri urban areas of Embu town
191 were found to shrink as the distance from CBD decreased. This was attributed to sub-
192 division of agricultural land whose rate was found to increase as distance from CBD
193 decreased as reported in section 3.2.2. Apparently, as urban expansion occurs, the available
194 land is stretched for more uses besides agriculture and forestry. Jiang and Zhang [9]
195 reported that urbanization not only affects agricultural resources but also compromises the
196 environment since it also results in uncontrolled clearance of large pieces of land off their
197 natural vegetation. Expansion of roads, sewerage system, and creation of solid waste
198 disposal sites necessitated encroachment into agricultural areas taking up the available
199 agricultural land and its natural environment. A proper land use budget is of great necessity
200 to ensure that all land use activities are accommodated.

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202 **3.2.2 Rate of Land Sub-Division**

203 The rate of land sub-division was found to increase as distance from CBD decreased. In
204 Kamiu sub-location, which is located within 2 km radius from the CBD, 58.6% of the
205 respondents felt that the rate of land sub-division in their area was fast while 28.3% felt the
206 rate was moderate. Those who held the opinion that land sub-division is low in Kamiu were
207 just 13.2%. In Njukiri sub-location which lies at 4km radius from the CBD, 19.1% said that
208 land sub-division rate was fast, 50.7% indicated that it was moderate, 30.3% were of the
209 opinion that the rate of land sub-division was low. In Nthambo sub-location which is located
210 furthest from the CBD at approximately 6 km radius, majority of the respondents (77.0%)
211 perceived that the rate of land sub-division in the area was low while 13.2% said it was
212 moderate. Only 9.9% perceived land sub-division to be fast (Figure 1).

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215 **Figure 1: Rate of Sub-division of Agricultural Land in the Study Areas**

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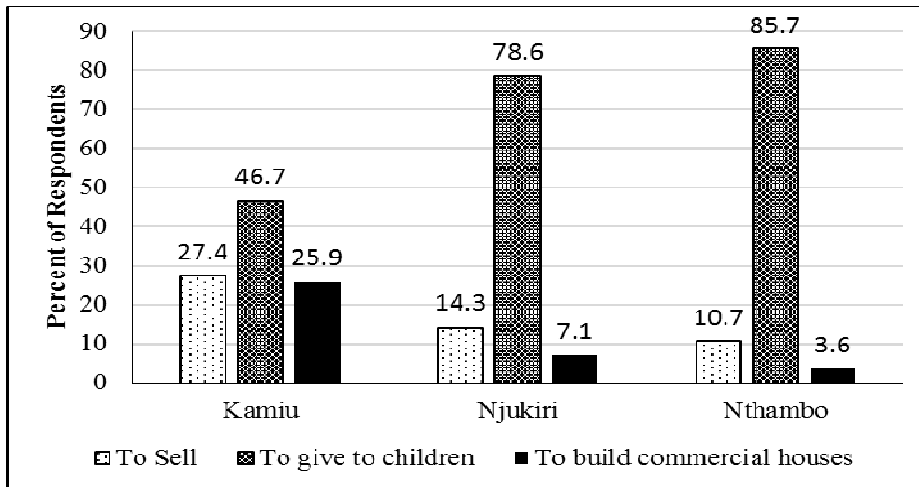
217 The high rate of land subdivision in the peri-urban areas of Embu town was attributed to the
218 increasing need for infrastructural development caused by urbanization. This was in
219 agreement with Dalil et al. [19] who noted that, urbanization process lead to outward
220 expansion of cities resulting in changes in land use, whereby urban residents buy up prime
221 agricultural land at the periphery for residential or commercial purposes. As urban population
222 increases, high demand for housing increases necessitating land owners in the peri-urban
223 areas to invest in real estate. Mandere et al. [20] also observed that, decrease in agricultural
224 land is caused by the sale of land for residential and business premises. Apparently,
225 investors go for cheaper land further from urban centre, some for immediate development
226 and others for prospective reasons. This is supported by the bid rent economic theory that
227 suggests that the price and demand for real estate change as the distance from the CBD
228 increases. Secondly, business opportunities closer to CBD are better than locations further
229 away due to high number of people who live or visit urban centres.

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231 **3.2.3 Reasons for Sub-division of Agricultural Land**

232 This study also sought to find out reasons that led to land sub-division. It emerged that there
233 were three major reasons that contributed to land subdivision in the three study areas. Some
234 subdivided their agricultural land to give to their grown up children as a form of inheritance,
235 others subdivided to sell and others to build commercial houses (Figure 2). In Kamuu,
236 majority of the respondents (27.4%) were sub-dividing their agricultural land in order to sell
237 a portion of it. This was followed by 46.7% who sub-divided to give to their children as
238 inheritance and 25.9% who carved out a portion of agricultural land to build commercial
239 houses. In Njukiri sub-location, the study revealed that, majority of the respondents (78.6%)
240 were sub-dividing their agricultural land to give to their children as inheritance, 14.3%
241 subdivided to sell whereas 7.1% subdivided in order to build commercial houses. In
242 Nthambo sub-location which is the furthest from Embu town, majority of the respondents
243 (85.7%) were sub-dividing their land to give to their children as inheritance whereas the
244 remaining 10.7% were doing it to sell. Only 3.6 of the sampled respondents in Nthambo
245 reported to have subdivided their agricultural land to build commercial houses.
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248 **Figure 2: Reasons for Sub-division of Agricultural Land in the Study Areas**

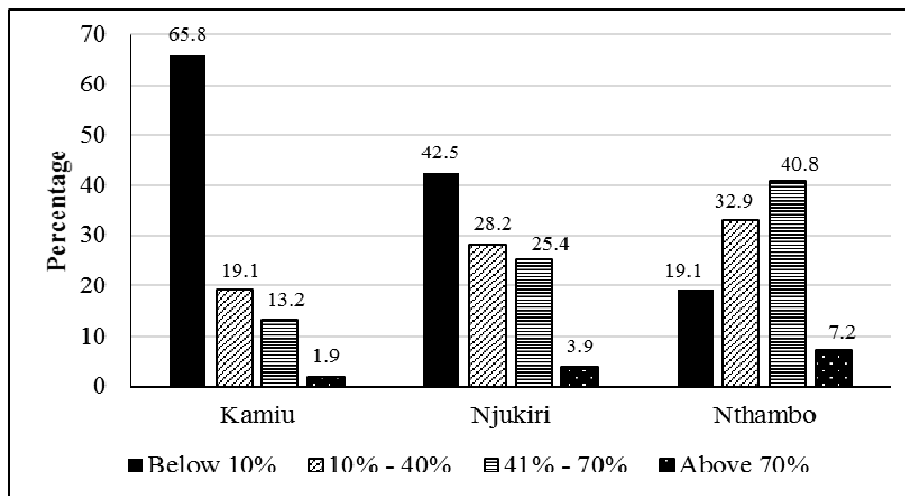
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250 From these findings, it was evident that those who subdivided their land to give to their
251 grown up children as a form of inheritance decreased as the distance from the CBD
252 decreased indicating that this was much possible where urbanization pressure was minimal.

253 On the other hand, those who subdivided their land for sale and to build commercial houses
 254 increased as the distance from the CBD decreased. This study established that there were
 255 several drivers of land sub-division in the peri-urban areas of Embu town. First, the price of
 256 land near CBD is higher because house rent is also higher nearer CBD than areas further
 257 away. Therefore, a unit area of land realizes higher economic returns when put in the right
 258 use. This is in agreement with Plantinga et al. [21] who observed that, there is a strong
 259 relationship between land uses and land prices. Their study revealed that, the price of land
 260 will equal the discounted sum of expected net returns obtained by allocating the land to its
 261 most profitable use. Naab et al. [22] also reported that urbanization causes changes in price
 262 of agricultural land as its value shifts from a consideration of its fertility and other favourable
 263 bio-physical characteristics to that of its functions.
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265 **3.2.4 Proportion of Land Allocated to Crops Farming and Livestock Production**

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

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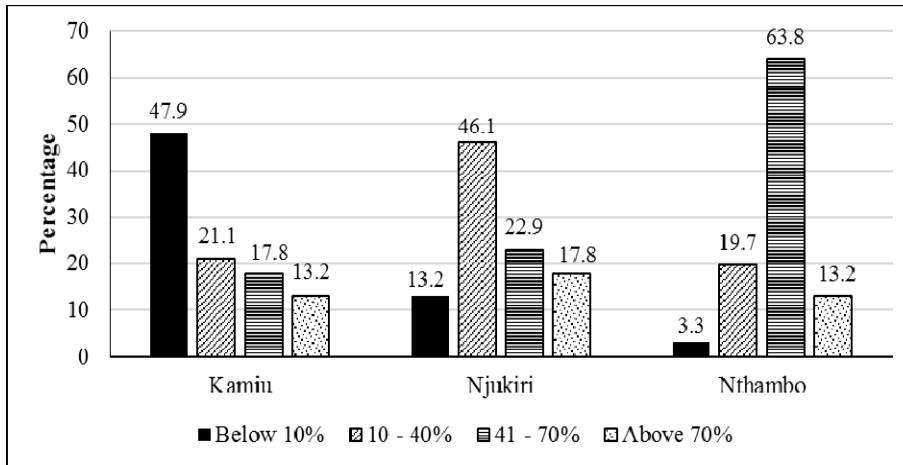


Figure 4: Proportion of land allocated to livestock production

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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 subdivision 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
Kamii (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 $P = 0.05$.

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3.2.5 Main Source of Agricultural Water

319 The study further sought to find out the main source of agricultural water in the three focal
 320 areas. It emerged that although majority of the households relied on rainfall for agricultural
 321 production, some level of irrigation was being practiced in all the three sub-locations. Njukiri
 322 had the highest number of households who had access to irrigation at 43.1% followed by
 323 Nthambo at 36%. Kamiu had the lowest access to irrigation at 23.5%. This study also
 324 established that waste water was also being used for irrigation and the practice was more
 325 nearer to CBD than further away (Table 2).
 326

327 **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

328 The study established that some small-scale irrigation projects were available in Njukiri and
 329 Nthambo although the service did not reach all the households in these areas. Thebo [25]
 330 reported similar findings that over 60% of the world's irrigated croplands are located near
 331 urban areas. At Kamiu which is nearest the CBD, there was high possibility that drinking
 332 water was used for irrigation to small portions of land and since it was not enough, it
 333 prompted more residents to turn to waste water to subsidize irrigation. Azuara et al. [26]
 334 reported that increase in urban population and high demand in basic commodities like water
 335 makes some resources to diverted from their intended use to meet the needs of urban
 336 population. FAO [27] reported that, in the last one century, use of water increased to almost
 337 twice than the rate of population growth.
 338

340 **3.2.6 Main Source of Agricultural Labour**

341 The respondents who were practicing farming activities were requested to reveal their main
 342 source of agricultural labour. It emerged that majority of households relied on family labour
 343 for agricultural production due to shortage of hired labour. In Kamiu 63.8% of the
 344 respondents relied on family labour while 35.5% relied on hired labour. In Njukiri 73.7%
 345 depended on family labour and 26.3% on hired labour. In Nthambo, the majority (80.3%)
 346 relied on family labour, whereas only 19.7% of the farmers relied on hired labour.
 347 Apparently, majority of the labour, which was initially available for agriculture in the peri-
 348 urban areas was taken up by construction and businesses within town. Unavailability of
 349 agricultural labour could have raised the cost of labour thus forcing many households to rely
 350 on rarely available family labour for agricultural production. This was in agreement with
 351 Gunabhagya et al. [28] who observed that, over the past years, the ratio of agricultural
 352 workers to the total workers has been going down, while the corresponding ratio in the
 353 secondary and tertiary sectors is on the rise. However, family labour alone cannot be
 354 enough to support economic agricultural activities. This could therefore have contributed to
 355 reduced agricultural activities in the focal area as reported earlier in this study and
 356 consequently affecting agricultural productivity and hence the livelihood of the residents.
 357 This theory is supported by Dalil et al. [19] who reported that, urban development impacts on
 358 food production consequently affecting the livelihood of the people.
 359

360 **3.2.7 Correlation Analysis between Distance from CBD and Agricultural Resources**

361 In order to further understand the relationship between proximity to CBD and agricultural
 362 resources, a Pearson correlation coefficient was carried out. There was significant positive
 363 linear correlation between the distance from CBD and agricultural resources (Table 3).
 364 Therefore, agricultural resources increased significantly as the distance from CBD

365 increased. The magnitude of the association was strong as determined by the level of
366 significance ($P < .0001$).

367 **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

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

369

370 **4. CONCLUSION**

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372 This study established that increased urban development in the peri-urban areas of Embu
373 town had contributed to decreased agricultural resources to a high extent. It was evident that
374 urbanization brought about competition against available agricultural resources such as land,
375 labour and water resulting in reduced agricultural activities in the study area. Based on the
376 key findings, the study recommends policy interventions to manage peri-urbanization in
377 Embu and other towns with similar set up, with a view of reducing degradation of agricultural
378 resources and controlling unsustainable land sub-division and land use changes. This will be
379 important to enable attainment of the twin goals of achieving improved food production and
380 sustainable development in Kenya.

381

382 **ACKNOWLEDGEMENTS**

383

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386 Alfred Micheni for providing the necessary financial and administrative support during data
387 collection. All university students together with county and national government officials
388 involved in the collection of ground data are also greatly appreciated.

389

390 **COMPETING INTERESTS**

391

392 Authors have declared that no competing interests exist.

393

394 **AUTHORS' CONTRIBUTIONS**

395

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

402

403

404 **REFERENCES**

405

- 406 1. United Nations. World Urbanization Prospects: The 2014 Revision (United Nations,
407 Department of Economic and Social Affairs, Population Division, New York). 2014.
408 Accessed 6 October 2018. Available:
409 [www.un.org/en/development/desa/publications/2014-revision-world-urbanization-](http://www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html)
410 [prospects.html](http://www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html).
- 411 2. Ademola K, Takashi O. Spatial determinants of urban land use change in Lagos,
412 Nigeria. *Land Use Policy*. 2007;24(2):502-515. DOI: 10.1016/j.landusepol.2006.09.001

- 413 3. International Food Policy Research Institute (IFPRI). Global Food Policy Report,
414 Washington, DC, USA. 2017. Accessed 20 July 2018. Available:
415 <http://www.ifpri.org/publication/2017-global-food-policy-report>
416 4. Sroka W, Mikolajczyk J, Wojewodzic T, Kwoczynska B. Agricultural Land vs.
417 Urbanisation in Chosen Polish Metropolitan Areas: A Spatial Analysis Based on
418 Regression Trees. *Sustainability*. 2018;10: 837; doi:10.3390/su10030837
419 5. Thuo ADM. Impacts of urbanization on land use planning, livelihood and environment in
420 the Nairobi Rural-Urban Fringe, Kenya. *International Journal of Scientific & Technology*
421 *Research*. 2013;2(7).
422 6. Gumma M, Mohammad I, Nedumaran S, Whitbread A, Lagerkvist C. Urban sprawl and
423 adverse impacts on agricultural land: a case study on Hyderabad, India. Remote
424 sensing. 2017;9(11): 1136.
425 7. Thuo AD. Community response to land use transformation in Nairobi rural-urban fringe,
426 Kenya. University of Waikato, Field Action Report; 2010.
427 8. Fan C, Myint SW, Rey SJ, Li W. Time series evaluation of landscape dynamics using
428 annual Landsat imagery and spatial statistical modeling: Evidence from the phoenix
429 metropolitan region. *International Journal of Applied Earth Observation and*
430 *Geoinformation*. 2017;58: 12-25. <https://doi.org/10.1016/j.jag.2017.01.009>
431 9. Jiang L, Zang Y. Modeling Urban Expansion and Agricultural Land Conversion in Henan
432 Province, China: An integration of land use and socioeconomic data. MPDI publishers;
433 2016.
434 10. Samat N, Raddad S, Salleh G. Determinants of Agriculture Land Use Change in
435 Palestinian Urban Environment: Urban Planners at Local Governments Perspective.
436 *American-Eurasian Journal of Sustainable Agriculture*. 2012; 4(1): 30-38.
437 11. Selod H. Opportunities and Challenges of Urbanization, Planning for an Unprecedented.
438 DEC Policy Research Talk. 2017. Accessed 19 December 2018. Available:
439 <https://ubdocs.worldbank.org>
440 12. Simon D, McGregor D, Nsiah-Gyabaah K. The changing urban-rural interface of African
441 cities: definitional issues and an application to Kumasi, Ghana. *Environment and*
442 *Urbanization*, 2004; 16(2): 235-248. <https://doi.org/10.1177/095624780401600214>
443 13. Jaetzold R, Schmidt H, Hornetz B, Shisanya, C. Farm Management Handbook. Vol. II,
444 Eastern Kenya; 2006.
445 14. Zanotti J, Migdalovitz C, Sharp JM, Addis CL, Blanchard CM, Margesson R. Israel and
446 Hamas. Conflict in Gaza (2008-2009). Congressional research service. 2009. Accessed
447 2 December 2018. Available: <https://fas.org/sgp/crs/mideast/R40101.pdf>
448 15. Singh K. Environmental Degradation and Measures for Its Mitigation with Special
449 Reference to India's Agricultural Sector. *Ind. Jn. of Agri. Econ*. 2009;64(1): 40-61.
450 16. Sekaran U. Research methods for business. John Wiley & sons, Inc; 2015.
451 17. Mugenda OM, Mugenda AG. Research methods: Quantitative and qualitative
452 Approaches. Nairobi: African Centre for Technology Studies; 2003. ISBN 9966411070,
453 9789966411075
454 18. Bell J. Doing your research project: A guide for first-time researchers in education and
455 social sciences. Zed Books; 2005), 286 p.
456 19. Dalil M, Yaman U, Omeiza I. The Impact of Urban Development on Food Security in
457 Peri-Urban Areas of Minna, Niger State, Nigeria. *International Journal of Humanities and*
458 *Social Science Invention*. 2013; 2(4): 26-31
459 20. Mandere NM, Barry N, Stefan A. Peri-urban development, livelihood change and
460 household income: A case study of peri-urban Nyahururu, Kenya. *Journal of Agricultural*
461 *Extension and Rural Development*. 2010;2(5): 73-83.

- 462 21. Plantinga A, Lubowski R, Stavins R. The effects of potential land development on
463 agricultural land prices. *Journal of Urban Economics* 2002; 52:561-58.
- 464 22. Naab FZ, Dinye RD, Kasanga RK. Urbanization and Its Impact on Agricultural Lands in
465 Growing Cities in Developing Countries: A Case Study of Tamale in Ghana. *Modern*
466 *Social Science Journal*. 2013;2(2): 256-287; ISSN 2051-5499. Available online at
467 <http://scik.org>
- 468 23. Kiita M. An investigation into causes and effects of agricultural land use conversions in
469 the urban fringes: A case study of Nairobi - Kiambu interface. 2013. Accessed 19
470 December 2018. Available: <http://erepository.uonbi.ac.ke/handle/11295/52391>
- 471 24. Overman HG, Venables AJ. "Cities in the Developing World," CEP Discussion Paper No
472 695. Centre for Economic Performance, LSE. 2005. Accessed 14 August 2018.
473 Available: http://eprints.lse.ac.uk/19887/1/Cities_in_the_Developing_World.pdf
- 474 25. Thebo AL, Drechsel P, Lambin EF. Global assessment of urban and peri-urban
475 agriculture: Irrigated and rainfed croplands. *Environ Res Lett*. 2014;9(11):114002.
- 476 26. Azuara J, Vergati J, Sumner D, Howitt R, Lund J. Analysis of effects of reduced supply
477 of water on agricultural production and irrigation water use in Southern California.
478 University of California Agricultural Issues Center; 2012. Accessed 12 January 2019.
479 Available: https://aic.ucdavis.edu/publications/water%20socal_final_0822.pdf
- 480 27. FAO. Water for Sustainable Food and Agriculture. A report produced for the G20
481 Presidency of Germany; 2017.
- 482 28. Gunabhagya, Joshi AT, Wali VB, Loksha H. Labour Scarcity – Its enormity and
483 Influence on Agriculture. *Int. J. Pure App. Biosci*. 2017;5(6): 1597-1603. ISSN: 2320-
484 7051.