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## **Potential for Sustainable Urban and Peri-Urban Agricultural Practices in Nairobi County**

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## **Abstract**

*The study examined the sustainable potential of urban and peri-urban agricultural practices in Nairobi. The study employed purposive, stratified and random sampling methods to select 149 respondents. Frequencies, means and standard deviations were used to analyse data. Findings indicate that the most popular urban and peri-urban practices were composting (221), open field farming (212), vegetable nurseries (155) and various forms of irrigation (140). Animal based practices were not found to be very popular. Majority of the practices were concentrated in the peri-urban areas. Popular practices were not found to be the most profitable. The most profitable practices were cattle rearing raising approximately Ksh.650,000, mushroom farming (Ksh.500,000), chicken rearing (Ksh.500,000), and hydroponics production (Ksh.450,000). These unpopular practices required expensive inputs, specialised technological and management skills and a controlled agricultural*

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*environment for production and efficient use of resources. These requirements qualified them to contribute towards the economic, social and environmental aspects of sustainability. There is need for a transformation from the current popular, less profitable and environmentally unfriendly practices categorized as uncontrolled environment agriculture practices to the controlled environment agriculture practices. This can be achieved through the provision of subsidised inputs and specialised technological and management skills to the farmers by the county government and other relevant stakeholders. This change with policy support will contribute to using sustainable agricultural practices that ensure food security and contribute to a sustainable food system in the city.*

**Key words:** Urban and peri-urban agriculture, sustainable agricultural practices, Nairobi County.

## **Introduction**

Global statistics indicate that 55% of world residents live in the urban areas with a projection of 68% by 2050 (United Nations (UN), 2019). In Kenya, it is estimated that 50% of Kenyans will reside in urban areas by 2050 (World Bank, 2019). Nairobi's current population according to Nairobi County Integrated Development Plan (NCIDP) stands at 4,397,073 persons (NCIDP, 2018) which poses a developmental challenge. This has led to approximately 60% of Nairobi residents to work in the informal sector (World Bank, 2019) where according to New York City Food Policy Centre (NYCFPC) they experience persistent food and nutrition insecurity (14.5%) (NYCFPC, 2019). The World Economic Forum (WEF) statistics indicates that urban poor residents spend 50-70% of their income on food (WEF, 2015) resulting to 10-25% practicing Urban and Peri-urban Agriculture (UPA) for survival (Omondi, 2018) depending on their location. Urban and peri-urban agriculture in Nairobi county covers approximately 14% of total land area with an average farm size of 0.53 acres in urban and 1.44 acres in peri-urban areas (NCIDP, 2018).

Urban and peri-urban agriculture is the production of crops, livestock and other products, processing and marketing along the value chain (Game and Primus, 2015) which may be practiced subsistent or commercial (Taguchi and Santini, 2019). Urban and peri-urban agriculture provides food and nutrition security, employment, income, and reduces food costs by approximately a third of food expenditure (Chihambakwe, Mafongoya and Obert, 2018). However, UPA experiences inadequate land, water, credit facilities and expensive inputs according to Mwasi *et al*, (2017). The county government provides limited extension services and there are no specific policies (Mbugua, 2018) that contribute to sustainability. Urban and peri-urban agriculture is not well recognised by city planners and politicians (Pauteit, Pridadi and Elwafa, 2019), and therefore receives inadequate support. Limited expensive resources and inadequate technological and management skills hinder adoption of sustainable agricultural practices (SAP) (Onyango *et al*, 2019).

Farming practices are primary dimensions of a farming system and contribute to a sustainable food system (Food and Agriculture Organisation (FAO), 2018).

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Sustainable agriculture practices maintain a balance between the economic, social and environmental dimensions to cushion the farmers from climate change impacts and food insecurity (Listiana *et al.*, 2019). Game and Primus, (2015) indicated the importance of practicing Controlled Environment Agriculture (CEA) as opposed to Uncontrolled Environment Agriculture (UEA). Uncontrolled environment entails excessive use of inputs such as fertilisers and chemicals and uneconomical use of resources such as water, land and energy (Stuchtey and Vahle, 2019). These can lead to environmental issues such as greenhouse gases, air and water pollution and zoonotic diseases, Game and Primus, (2015). Controlled environment considers controlled environmental conditions such as light, temperature and humidity and employs the use of good agricultural practices. Kenya, as a signatory to the Milan Urban Food Policy Pact (MUFPP) has a duty to work towards a sustainable food system in the cities (MUFPP, 2015).

The broad objective of this study was to examine and understand the sustainable potential of UPA practices in Nairobi County for improvement and contribution towards a sustainable food system. The objective was specifically achieved by highlighting the most popular UPA technologies adopted by the urban farmers as a social dimension, examining their profitability as an economic dimension and describing their consideration of environmental control as an environmental dimension. This information may provide initial steps towards transforming UPAs into SAPs which contribute towards a sustainable urban food system.

## **Methodology**

The study was conducted in Nairobi City County which is Kenya's capital city. The city is situated between latitudes -1.286389 S., and longitudes 36.817223 E. at an altitude of approximately 1,798 metres above sea level (Nairobi County Annual Development Plan (NCADP), 2018). Nairobi lies at a GPS of 1°17'11,0004" S. and 36° 49'2.0028" E. and has an area of approximately 700 Km<sup>2</sup>. The county experiences a temperate to tropical climate favourable for farming with two rainy seasons. The long rains are received in March to May and the short rains are received in October to December (NCIDP, 2018).

The study utilised a cross-sectional survey design to gather information at a specific point in time (Omair, 2016). The study purposively identified 13 of the 17 sub-counties in Nairobi with the highest numbers of UPA practices for sampling (Etikan, Musa and Alkassim, 2015). The sub counties included are Kasarani, Langata, Westlands, Dagoretti North and South, Embakasi West, Central and South, Kibra, Roysambu, Makadara, Starehe and Mathare.

The population of the study comprised of 1,506,888 households in Nairobi County according to (Kenya National Bureau of Statistics (KNBS), 2019). Nairobi county has an average of 200,000 households (Lee-Smith and Lamba, 2015) who farm for various reasons. However, the study considered an average of 10% (150,688) of the households who depend on urban agriculture for food security (Owuor, 2018). The County is comprised of 85 ward units which were stratified in to urban, slum and

peri-urban areas of which 75 wards with the highest numbers of farmers and farming practices were considered. Simple random sampling was used to select the respondents from the ward units.

The Cochran equation, provided an ideal sample size of 138 respondents but in order to consider the heterogeneity of the urban population, a sample size of 150 was considered (Singh and Masuku, 2014) of which 149 responded. Data was collected by use of questionnaires.

The first objective was to examine the most popular technologies adopted by farmers across the urban, peri-urban and slum areas of Nairobi. Farmers were asked the types and numbers of technologies they had adopted. Data was collected in ratio form. To calculate the mean values and the standard deviations, data was entered in Statistical Package for the Social Sciences (SPSS) where coding was done to ease the analysis process and results presented in a tabulated description. Urban areas were coded as 1, peri-urban areas as 2 while informal areas (slum) was coded as 3. Means were calculated to find the most popular areas that a practice was adopted. The most popular technologies that farmers had adopted was an indication of the social acceptability of the practice and contributes to the social dimension of sustainability.

The second objective was to examine the most profitable practices according to farmers responses on a reference land area of 8mx15m (greenhouse standard area) with other production factors kept constant. The study considered high value crops such as tomatoes, green pepper, indigenous, Asian or exotic vegetables or animals kept in a similar land area. Farmers were asked the average annual income per unit area of each technology. Data was collected in ratio form. An average annual income for each of the practices was calculated. The profitability of a technology contributes to the economic dimension of sustainability.

In order to fulfil the environmental dimension of sustainability, UPA practices were categorized according to two spheres of CEA or UEA practices (Game and Primus, 2015). This was achieved by considering the extent of control of the environmental characteristics such as light, temperature, humidity and efficient use of production resources such as land, water, labor and inputs. Categorization of UPA practices is a contribution to a comprehensive environmental assessment for innovative urban agriculture leading to a “second green revolution” (Amanda, Guinee and Tukker, 2019). This categorization represented the environmental dimension of sustainability.

## **Results and Discussions**

### **Popular Urban and Peri-urban Practices in Nairobi County**

The study revealed 21 UPA practices which were commonly adopted by the farmers. The most popular farming practices (Table 1) among the Nairobi farmers were composting (221), open field farming (212), vegetable nurseries (155), various forms

of irrigation (140), farm yard manure (139), chicken rearing (112), multi-storey gardens (97), kitchen gardens (95), greenhouses (79) and cattle rearing (76).

**Table 1: Popular urban and peri-urban technologies practiced in Nairobi county as per Location**

UPA practices	Urban area (Frequencies)	Peri-urban area (Frequencies)	Slum area (Frequencies)	Mean	Standard deviation
Compost	80	61	80	2.00	0.853
Open field farms	80	89	43	1.83	0.743
Vegetable nurseries	49	56	50	2.01	0.802
Irrigation (Various)	52	60	28	1.83	0.739
Farm yard manure	41	58	40	1.99	0.766
Chickens rearing	35	50	27	1.93	0.744
Multi-storey garden	17	17	63	2.47	0.779
Kitchen garden	21	31	43	2.23	0.792
Green houses	24	22	33	2.11	0.847
Cattle rearing	27	11	38	2.14	0.919
Moist beds	7	44		2.05	0.530
Micro gardens	10	14	28	2.35	0.789
Rabbit rearing	10	17	23	2.26	0.777
Tree nurseries	10	10	17	2.19	0.845
Sheep and goats	10	16	7	1.91	0.723
Fish farming	12	10	7	1.83	0.805
Shade net farming	3	13	3	2.00	0.577
Hydroponics	7	2	0	1.22	0.441
Rooftop gardens	3	1	3	2.00	1.000
Mushrooms	0	3	3	2.50	0.548
Hanging gardens	0	0	3	3.00	0.000

**Source: Field Survey 2017**

Most of these practices were common probably because they required less inputs, less specialized management and technological skills and were mainly adopted from rural farming. This is with the exception of multi-storey gardening which is a more recent but quickly adopted practice due to its simplicity and popularity with slum areas. Multi-storey gardens in the city have also been promoted by several non-governmental organizations to promote food security. The least popular practices in Nairobi were hanging gardens (3), mushroom productions (6), roof top gardens (7), hydroponics (9) and shade net farming (19) and fish farming (29) which were relatively new practices and needed more intensive technological and management techniques.

Means were used to indicate the most popular areas that a practice was adopted. Results showed that the mean values ranged from 1.83 to 3.00 while the standard

deviation from 0.000 to 1.000. On a general note, most of the means could be rounded off towards 2 meaning that the UPA practices were mainly adopted in the peri-urban areas as compared to the urban and informal (slum) areas. Multi-story garden ( $\bar{x} = 2.47$ , Sd = 0.779), mushrooms ( $\bar{x} = 2.50$ , Sd = 0.548) and hanging gardens ( $\bar{x} = 3.00$ , Sd = 0.000) were the three practices most adopted in the slum areas as compared to other areas. Hydroponics ( $\bar{x} = 1.22$ , Sd = 0.441) was the only practice mostly adopted in the urban areas. Standard deviation explains the extent of variation from the mean and distribution of the data set.

The popularity of more greenhouses ( $\bar{x} = 2.11$ , Sd = 0.847), cattle rearing ( $\bar{x} = 2.14$ , Sd = 0.919), fish farming ( $\bar{x} = 1.83$ , Sd = 0.805), shade nets ( $\bar{x} = 2.00$ , Sd = 0.577) and mushroom practices ( $\bar{x} = 2.50$ , Sd = 0.548) in the slum areas than in the urban and peri urban areas could be attributed to donor funding and county government provisions that work in these areas for promotion of UPA. However, results show that the standard deviation of almost all the UPA practices could be equated to 1.000 meaning that adoption of the UPA practices in the urban, peri-urban and informal areas was almost normally distributed.

These results agree with the finding of Kurgat *et al.* (2018) that the most popular practices in peri-urban areas of Kenya, were preparations of organic manure, growing of African indigenous vegetables and open field farming practices. In Ethiopia, Abrea, Tedesse and Belayneh, (2017) presented similar findings indicating that the most popular UPA practices were open field farming, animal rearing and tree planting. These findings also agree with a review conducted by Armanda, Guinee and Tukker (2019), which indicated that popular agricultural practices were those that provided preferred food sources in the community, used available resources and avoided technological complexity.

### **Average Annual Income and Environmental Considerations of Adopted Urban and Peri-urban Practices**

The top 10 most profitable practices were cattle rearing raising an average of Ksh.650,000, (Table 2), chicken rearing (Ksh. 500,000), mushroom production (Ksh. 500,000), hydroponics (Ksh. 450,000), rabbit keeping (Ksh. 400,000), sheep and goats rearing (Ksh. 400,000), fish ponds (Ksh. 350,000), green houses (Ksh. 300,000), shade nets Ksh. 250,000 and multi-storey gardens (Ksh. 250,000). The results indicate that high technology and high management practices had the highest income per unit area. Urban and peri-urban farmers who used these practices got above average income from their investments with the advantage of readily available of markets.

**Table 2: Average annual income (Kenya Shillings) per practice on a standard area of 8m by 15m and categorization on environmental control.**

<b>Farming practice</b>	<b>Average annual income (Kshs)</b>
<b>High value vegetables</b>	
Open field	50,000*
Vegetable nursery	250,000**
Open Irrigated area	150,000*
Multi stories	250,000*
Kitchen gardens	150,000*
Greenhouse	300,000***
Moist beds	200,000*
Micro gardens	200,000*
Shade nets	250,000**
Roof top gardens	200,000*
Hanging gardens	200,000*
Hydroponics	450,000***
<b>Livestock</b>	
Chicken(broilers)	500,000***
Zero grazed Cattle	650,000***
Rabbits	400,000**
Sheep and goats (shoats)	400,000**
Fish pond	350,000**
<b>Others</b>	
Farm Yard Manure	150,000**
Compost	150,000**
Mushrooms	500,000***
Tree Nursery	200,000**

**Source: Field Survey 2017**

**\*=Uncontrolled environment practices, \*\*= partially controlled environment practices, \*\*\* = controlled environment practices.**

In order to qualify UPA practices to environmental sustainability, the study categorised the practices according to extent of environmental control by use of a methodology borrowed from Game and Primus, (2015). The categorisation of the practices to Uncontrolled Environment Agriculture Practices (UAEP) and Controlled Environment Agriculture Practices (CEAP) (Table 2) indicated that most UPA practices (43%) were undertaken under uncontrolled environment, 38% were partially controlled, with only 19% practiced were practiced on a fully controlled environment. Majority of the UPA practices are either uncontrolled or partially controlled environmental practices accounted for at 81%.

The findings also indicate that UPA crop production technologies of green houses,

hydroponics and mushroom production and animal production methods of zero grazed cattle and broiler chicken were high income and controlled environment practices. It can therefore be concluded that CEAPs produced higher yields and subsequently higher incomes. This finding agrees with that of Barbosa *et al*, (2015), that lettuce produced on a hydroponic system in a greenhouse environment produced 41-47kg/M<sup>2</sup>/year while lettuce produced in conventional method produced 3.9 - 4Kg/M<sup>2</sup>/year.

The results concur with the findings of a review by Armanda, Guinee and Tukker, (2019), who stated that hydroponic systems produced 11 times more lettuce than open field farming. Greenhouses were found to produce 13 times more strawberry and 1.5 times more tomatoes per acre per year which would translate to very high incomes. According to Stuchtey and Vahle (2019), controlled environment farming is high yielding and environmentally friendly as compared to open field farming thus qualifying for sustainability.

## Conclusions and Recommendations

Most popular urban and peri-urban practices in Nairobi County were practiced under uncontrolled environment, did not utilise skilled management and technological techniques and were not highly profitable. In the long run they will be less economically viable, negatively affect the environment and therefore be less socially acceptable. These practices are unsustainable and do not contribute towards a sustainable food system which is the expected objective of the Millan Urban Food Policy Pact. Controlled environment agriculture practices were found to be the most profitable but were however, not the most popular among the UPA farmers in Nairobi county.

There is need for a transformation from the use of uncontrolled environment agriculture practices to controlled environment agriculture practices or improvements of the practices through innovations. This can be achieved by provision of subsidised inputs, provision of credit facilities, policy improvements and capacity building the UPA farmers by the county government and relevant stakeholders in order to empower them to adopt sustainable agricultural practices.

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