TYPE AND DISTRIBUTION OF URBAN AND PERI-URBAN AGRICULTURE PRODUCTION TECHNOLOGIES IN NAIROBI COUNTY, KENYA

Ogendi M.N[1]*, Mukundi J.B[1] and Orege M.O[2]
[1]Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000 - 00200. Nairobi, Kenya.
[2]ROWAMO Consultants in Urban Planning, P.O. Box 19449 - 00100, Nairobi, Kenya.

***Correspondence:** Email: millicent.nyaboke@yahoo.com

Abstract

Urban and peri-urban agriculture (UPUA) has direct positive impact on farming households accounting for income-earning or food-producing activities. The type of production technology and location influences food safety and space usage. Little is known how UPUA farmers utilize different crop production technologies and their distribution in Nairobi County. The objectives of this study were therefore to identify type of production technologies utilized by UPUA farmers in Nairobi County; and to determine how the production technologies were distributed within the districts of Nairobi County. A survey study with purposive sampling utilizing a structured questionnaire was carried out in the urban and peri-urban districts of Nairobi County. Data was collected on socio-economic characteristics, crop production technologies, land tenure and land size. Data was analysed descriptively and chi-square and Fishers T- tests were performed. Farmers in peri-urban areas utilized more of the identified eleven technologies than those in urban districts except rooftop and balcony gardens. Open field was the most utilized crop production technology (25.9%) and was significantly (*P*=.033) more in use at the peri-urban areas. Multi-storey garden technology was more in use in the urban areas. Open field (24.9%), multi-storey garden (16.4%) and moist-bed garden (11.9%) were the most utilized technologies for crop production by male-headed households. Female-headed households mostly utilized open field (2.3%) and micro-garden (1.7%) technologies. Small plots (1/2 to 1 acre) were heavily relied on for crop production (41%). Institutional land constituted the most significant (*P*=.012) available land (54.2%) for utilizing most of the crop production technologies. It was available both in urban (26.5%) and Peri-urban (27.7%) areas. Personal land was also available but significantly higher (p = 0.023) in Peri-urban (14.2%) than in urban areas (2.2%). These research findings will supplement to Nairobi City planners' decision making process concerning urban and peri-urban agriculture in regard to land use allocation. . Adoption of improved crop production technologies and forming of farmer groups to bargain for idle spaces could be embraced for increased urban and peri-urban agriculture.

Key words: Urban farming households, crop production technologies, gardens, land/space availability

Introduction

Urban and peri-urban agriculture can play a crucial role in the economic, social, and dietary life of the urban poor. Urban agriculture has taken several production systems carried out on the standard, ground level farm or garden, which is either on communal land or on private property (Cofie, *et al*., 2008; Camara, 2013). Production systems range from agricultural and horticultural crops, to forestry, floriculture, aquaculture and livestock production (Ambrose-Oji, 2009). Generally, crop production systems consist of home gardening practised on household backyards and off-plot sole cropping done on spaces

like undeveloped land, river and road reserves, abandoned waste dumps, rights-of-way and aircraft buffers (Cofie *et al*., 2008, p. 4). The range of agricultural activities in urban and peri-urban areas differ according to the characteristics of available land, occurring in a multitude of locations in the city including small community gardens, personally managed allotments, home gardens, portions of parks, roadside reserves, green roofs and green walls (Pearson, 2010). According to Schmidt (2012), rapid growth and constant pressure on land for development has forced urban and peri-urban farmers to encroach on open spaces and other public lands such as cemeteries, playgrounds, roadsides and utility rights-of-way. The variation of these examples depends on the characteristics of the urban setting defined by geography and climate along with the abilities of the urban populations in terms of reaching and creating resources (Specht *et al*., 2014). Citing Dubbeling (2011), Specht *et al*. (2014) states that 'no-space or low-space technologies offer tremendous opportunities for space-confined growing'. Multi-storey gardening, a crop production technology also known as vertical gardening is practiced in some parts of Nairobi County, Kenya. Gallaher *et al*. (2013b) state that vertical gardening allows households of Kibera slums of Nairobi to take advantage of small open spaces to grow food by planting '20-30 plants of kales and spinach into sides and tops of a 50kg sack of soil'. According to Gallaher *et al*. (2013a), this type of gardening has a positive impact on household food security in Kibera, 'strengthening social capital amongst farmers'. Specht *et al*. (2014) uses the term zero acreage farming (zfarming) to refer to urban agriculture production types such as rooftop gardens, rooftop greenhouses, edible walls and indoor farms which are farming activities inside or on top of buildings to address the challenge of scarce land for farming in cities.

Today, it is expected that more than 800 million people are practicing some type of urban agriculture in or close to an urban setting providing food for themselves and their families (FAO, 2013). There is urgent need to question the current status of cities in regard to available food systems, and it is necessary to search for new methods to alleviate the current conditions of rapid increase in urban population restraining urban food security (U N System Task Team on the Post-2015 UN Development Agenda, 2012; FAO, 2013). FAO (2013) advocates focussing on urban food systems that can address malnutrition and narrates how innovations in technology for agriculture can open up opportunities for users to earn higher incomes which can be used for added attention to their family. Specht *et al*. (2014) state that urban rooftop gardens in developing countries practised on small-scale contribute to welfare of poor urban residents by supplementing their diet, family income and reduce expenditure on food to allow other purchases. Research shows that some of the Nairobi City County urban residents practice urban agriculture with a majority of the farmers using untreated sewage for irrigation (Cornish and Kielen, 2004; Karanja *et al*., 2010; Kaluli *et al*., 2011). Confronted with rapid urbanization, hundreds of families strive to improve their access to food and raise income through agricultural activities in urban and peri-urban areas (Karanja *et al*., 2010; Njenga *et al*., 2010). The type of agricultural production and location influences food safety and space usage. Little is known how UPUA farmers utilize different crop production technologies and their distribution in Nairobi County. The objectives of this study were therefore to identify type of production technologies utilized by UPUA farmers in Nairobi County; and to determine how the production technologies were distributed within the districts of Nairobi County.

Material and Methods

Study Area

Nairobi, the capital city of Kenya, covers an area of about 696 km². The city is bounded within geographic coordinates of 1°16'S

latitude and 36°48'E longitude (Fig 1). It has an estimated population of 3,138,369 people as per the 2009 population census (Cheserem, 2011). The population growth rate of Nairobi is about 4.1 percent per annum, however about 60 percent of this population are described as urban poor and live in informal settlements. At 1,795 metres (5,889 feet) above sea level, Nairobi enjoys a moderate climate. Under the Köppen climate classification, Nairobi has a subtropical highland climate. There are two rainy seasons, with long rains falling between March and May and short rains between October and December (Foeken and Mwangi, 2000). Annual rainfall ranges between 300mm and 700mm (Wangari, 2013). Since Nairobi is in close proximity to the equator, the differences between the wet season and dry seasons are minimal, and the timing of sunrise and sunset varies little throughout the year (Kenya Travel Guide UK, 2013). This research study was carried out in the following districts of Nairobi County in Kenya: Starehe, Makadara, Kamukunji, Embakasi (urban districts), Kasarani, Njiru, Westlands and Dagoretti (peri-urban districts).

Data collection and analysis

The target population for this study comprised of the active urban farming households of Nairobi County, who were identified by the help of the district agricultural officers and the divisional agricultural extension officers. Data was collected from the purposively sampled active urban farming households using a semi-structured questionnaire administered through face-to-face interview, incorporated with field observations. A Global Positioning Systems (GPS) receiver was used to map respondents' farms and in total, 95 farmers were interviewed (Fig. 1). The information gathered during the field survey included the respondents' socio-economic characteristics, land tenure, crop production technologies in use, consumption patterns, source of production water, farming challenges, farmer's perception on public open space and land-use planning for urban and peri-urban agriculture. Data was analysed using Statistical Package for Social Studies (SPSS) version 20 and descriptive statistics and chi-square tests were performed. Excel was used to generate tables and figures to clearly display results. General analysis was done testing frequencies on land tenure, UPUA income contribution and adoption rate of productions technologies over the whole county and further tests were done to confirm whether the differences were statistically significant (at 5% level of significance) between urban and peri-urban areas.

Results and Discussion

Farmers in peri-urban areas utilized more of the eleven technologies than those in urban districts except rooftop and balcony gardening (Fig. 2A; Fig. 2B). Open field was the most utilized crop production technology (25.9%) and was significantly (P=.033) more in use at the peri-urban than urban areas. However, multi-storey garden technology was more in use in the urban than peri-urban areas. This could be attributed to lack of adequate land/space for farming in the urban areas. Since Nairobi city urban environments are highly-space constrained, farming households preferred use of multi-storey gardening technology for vegetable production as it can support growth of many plants in a very small space, by utilizing the vertical space. This concurs with the findings of Gallaher *et al*. (2015) who stated that multi-storey gardening is a sustainable livelihood strategy for poor farming households in the urban. Rooftop and balcony gardens are widely used farming technologies in developed countries like North America and Europe (Thomaier *et al*., 2015), but are only slowly becoming more common in the developing world (Nowak, 2004; Hien *et al*., 2007); thus few UPUA farmers in Nairobi County are practicing them. Characterized by non-use of land or acreage (also termed as zero acreage farming) (Specht *et al*., 2014; Thomaier *et al*., 2015), rooftop and balcony garden

technologies can be widely adopted in the urban areas to contribute towards sustainable urban agriculture. In their intensive study on rooftop gardens, Orsini *et al*. (2014) concluded that this technology can provide a crucial contribution to food accessibility in cities and be a tool for socialization and community building.

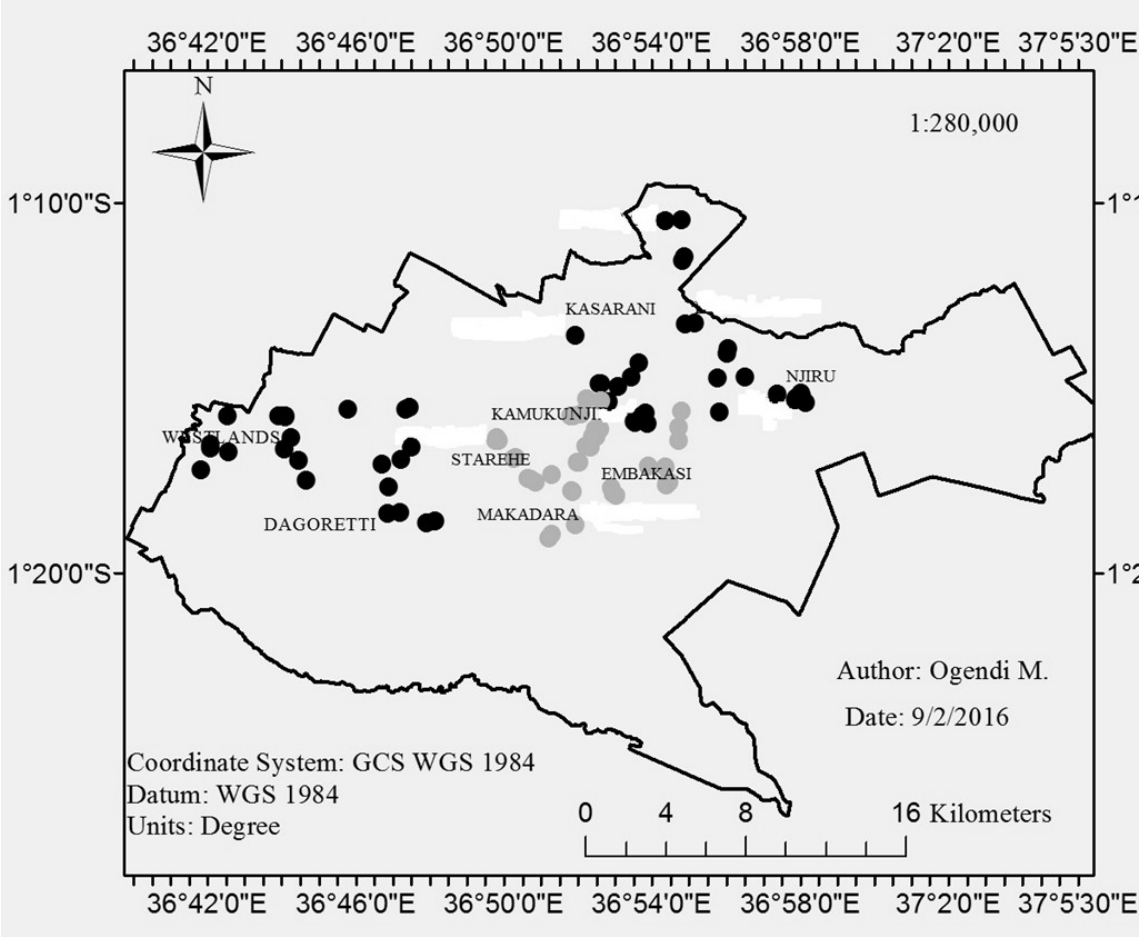

Figure 1: Map of surveyed farms on eight (8) districts of Nairobi County: Urban farms (grey circular symbols on map) - Starehe 11, Makadara 8, Kamukunji 13, Embakasi 8 and Peri-urban farms (black circular symbols on map) - Kasarani 16, Njiru 15, Westlands 12, Dagoretti 12. Total=95 farms.

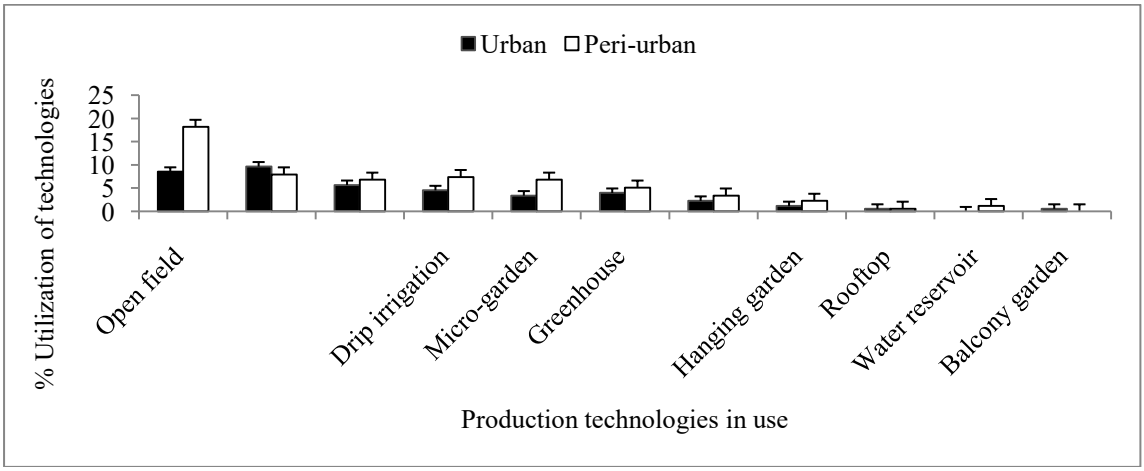

Figure 2A: Level of utilization of various production technologies for crops in urban and peri-urban areas of Nairobi County

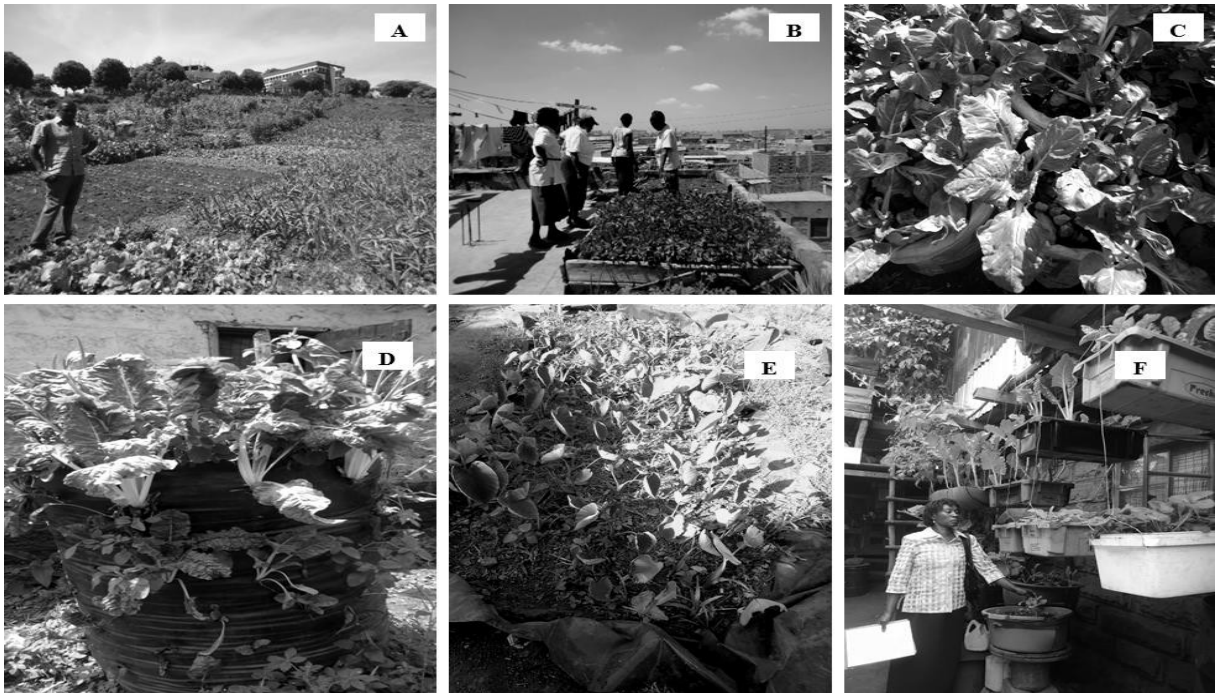

Figure 2B: Some key crop production technologies used by UPUA farmers in Nairobi County. A- Open field with lettuce, leeks, maize, B- Rooftop garden with spider plant, cowpeas and onions, C- Micro-gardens with spinach and kales, D- Multi-storey garden kales and spinach, E- Moist-bed garden with arrow roots and F- Hanging gardens with kales. Source: photos taken by author, 2014.

Male-headed households significantly (*P*=.008) utilized most crop production technologies for UPUA except hanging, rooftop and balcony garden technologies (Fig. 3). Open field (24.9%), multi-storey garden (16.4%) and moist-bed garden (11.9%) were the most utilized technologies for crop production by male-headed households. Female-headed households mostly utilized open field (2.3%) and micro-garden (1.7%) technologies. The male dominance in the practice of these crop production technologies could be probably due to the demanding farming tasks involved such as land and manure/compost preparation (in case of open field technology) and the installation of multi-storey and / or moist-bed garden technologies such as transporting and filling sacks/polythene bags with potting soil. This observation was in agreement with Cofie *et al*. (2008) who noted that one of the reasons for differential gender in farming could be due to the laboriousness of 'farm work'. The gender cultural role could also be another reason as to why male-headed households had the upper hand on the utilization of the crop production technologies. A man is usually known to be the bread winner and since most of the interviewed respondents were active farmers, it is therefore logical that the males were actively involved for their household food provision.

The most utilized crop production technologies (open field, multi-storey, micro garden and moist-bed) were significantly (*P*=.014) practiced on land/space (29.2%) which was less than a quarter of an acre (Fig. 4A; Fig. 4B). Open field technology was practiced on relatively large land size, greater than 1 acre, accounting for more than 12.4% and mainly in the peri-urban areas. Multi-storey garden technology was preferred in urban areas and was employed on small land size (less than a quarter acre of land). Other least used technologies were also practiced on small land size (less than a quarter acreage) in urban areas especially balcony garden, rooftop garden and hanging

garden technologies. Availability of land in and around cities presents the most limiting factor to crop production (Foeken and Owuor, 2008; Orsini *et al*., 2013; Simiyu, 2013). In their research work done at Bahir Dar in Ethiopia, Haregeweyn *et al*. (2012) suggested that there is a strong linkage between urban growth and agriculture, as urbanization leads to loss of agricultural land in and around cities. Foeken and Mwangi (2000) revealed that lack of access to land was a major constraint for the farming urban poor households in Nakuru town, Kenya, forcing them to depend on rural food for their livelihood. Agricultural land on the peri-urban fringe of Nairobi City is constantly and rapidly diminishing. This is doubled by the competition of agricultural land with other uses such as construction of residential and commercial buildings. Thuo (2013) noted that competition of land for residential purposes and high prices for land are some of the factors that have negatively affected on-going farming in the Nairobi peri-urban fringe; denying existing farmers an opportunity to expand their parcel of land by buying additional land from neighbours.

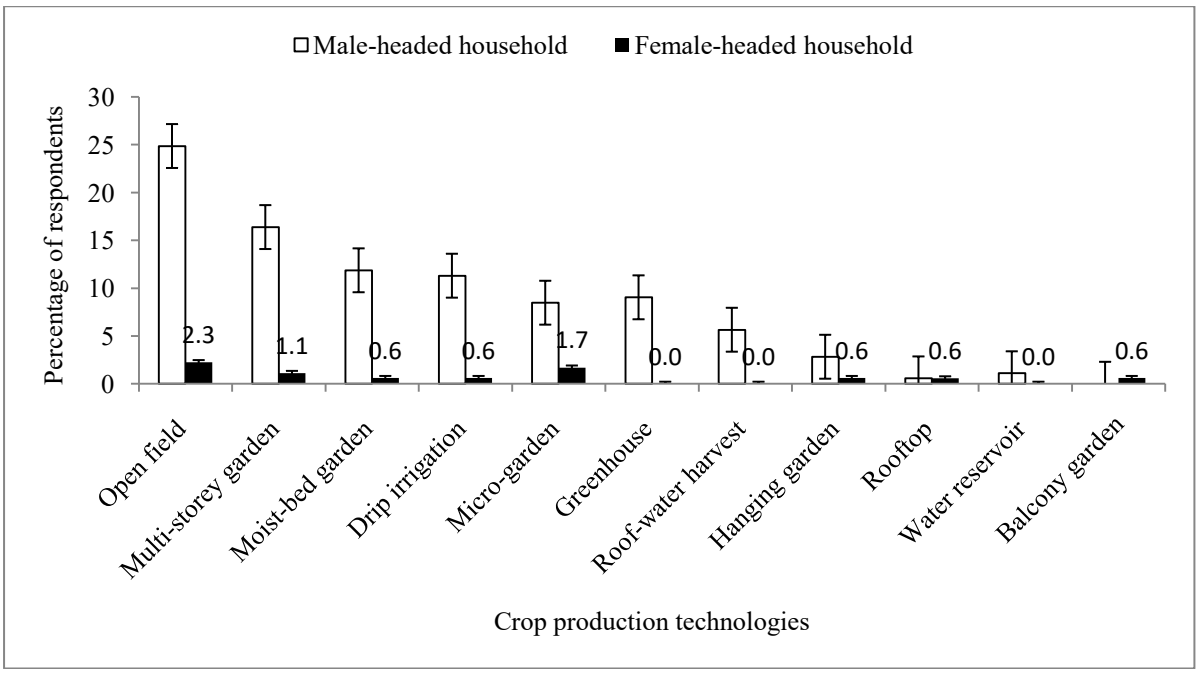

Figure 3: Utilization of crop production technologies for UPUA by male and female headed households in Nairobi County

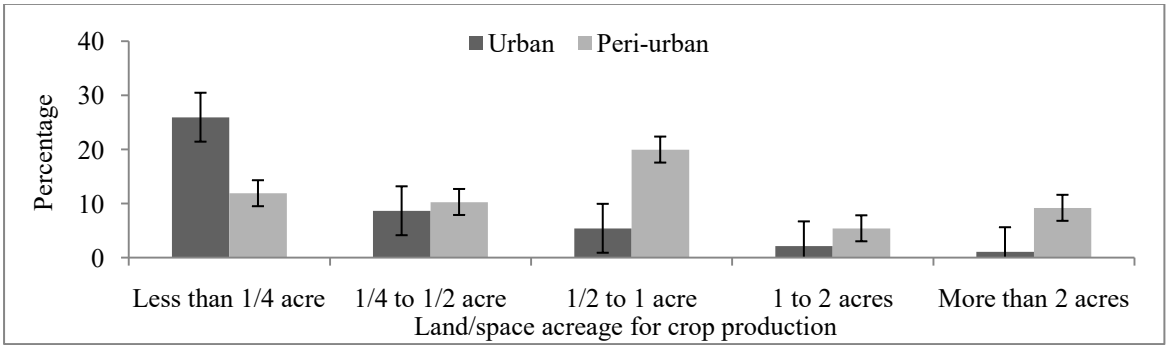

Figure 4A: Proportion of farmers utilizing different land acreages for crop production in urban and peri-urban areas of Nairobi County.

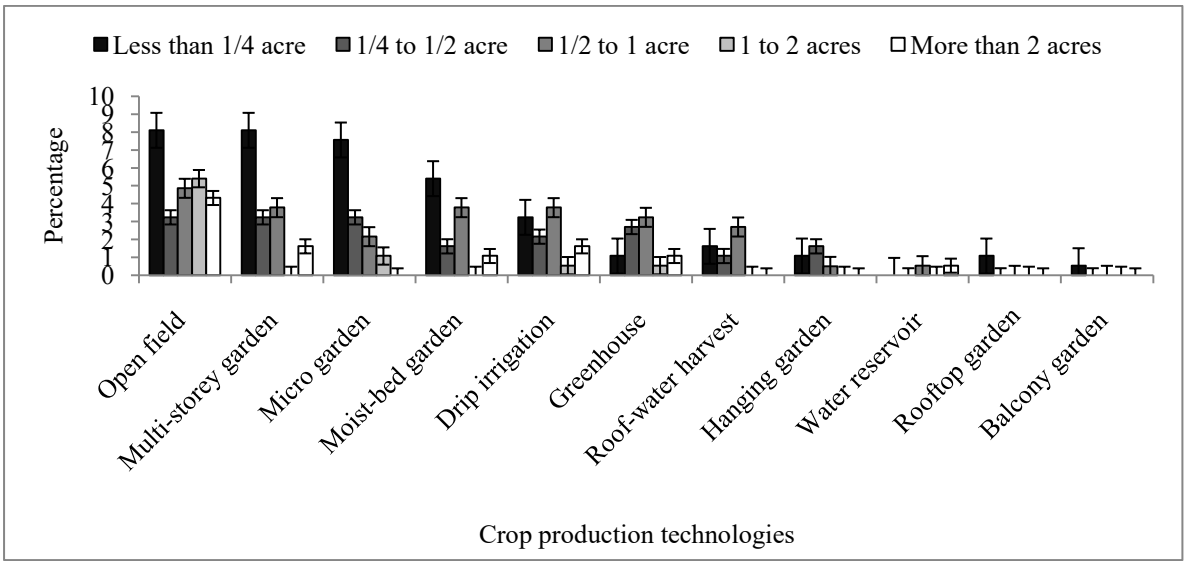

Figure 4B: Proportion of crop production technologies utilized under various land/space sizes in Nairobi County.

On land ownership, institutional land constituted the most significant (*P*=.012) available land (54.2%) utilizing all except 3 technologies (water reservoir, rooftop garden and balcony garden (Fig.5A; Fig.5B). It was available both in urban (26.6%) and peri-urban (27.7%) areas. Personal land was also available but significantly higher (*P*=.023) in peri-urban (22.6%) than in urban areas (5.6%). Unscheduled land/spaces were used almost in equal proportions both in urban areas (7.3%) and peri-urban areas (6.2%). Family land was the least and mainly available in peri-urban area (3.4%). From interview with officers from the District Physical Planning department, it was revealed that colonial land ownership in Nairobi City contributed to land scarcity; as only a few individuals and institutions owned vast tracks of land within the city. This concurred with our findings whereby institutional and personal (private) owned lands were mostly in use by the city farmers. For instance, Moi Nairobi Girls High School in Dagoretti District (which is peri-urban) had more than five acres of undeveloped land lying idle, in addition to another five acres which was under agricultural production (open field). Commenting on land use in Nairobi fringe (peri-urban), Thuo (2013) noted that dual legal systems (customary and formal) of land ownership constrain the control of land use. He further noted that sub-division of land for inheritance, a common habit in customary land use, has led to fragmentation of landholdings into uneconomical parcels for agricultural purpose.

Riparian land was more utilized for crop production in urban areas (25%), whereas in the peri-urban areas, road reserves (15%) and spaces under electrical power lines (15%) were used for agriculture, though these were not significantly different (*P*>0.05) from the other types of unscheduled spaces (Fig. 6). In their findings, Njenga *et al*. (2010) observed that agriculture in Nairobi City is practiced on open spaces under power lines, along river banks, roadsides and railway lines. Simiyu (2012) noted that the need for farming space by the urban poor in Eldoret town, Kenya, forced them to invade vacant public spaces such as underdeveloped lands belonging to Kenya Railways and Eldoret Municipal Council.

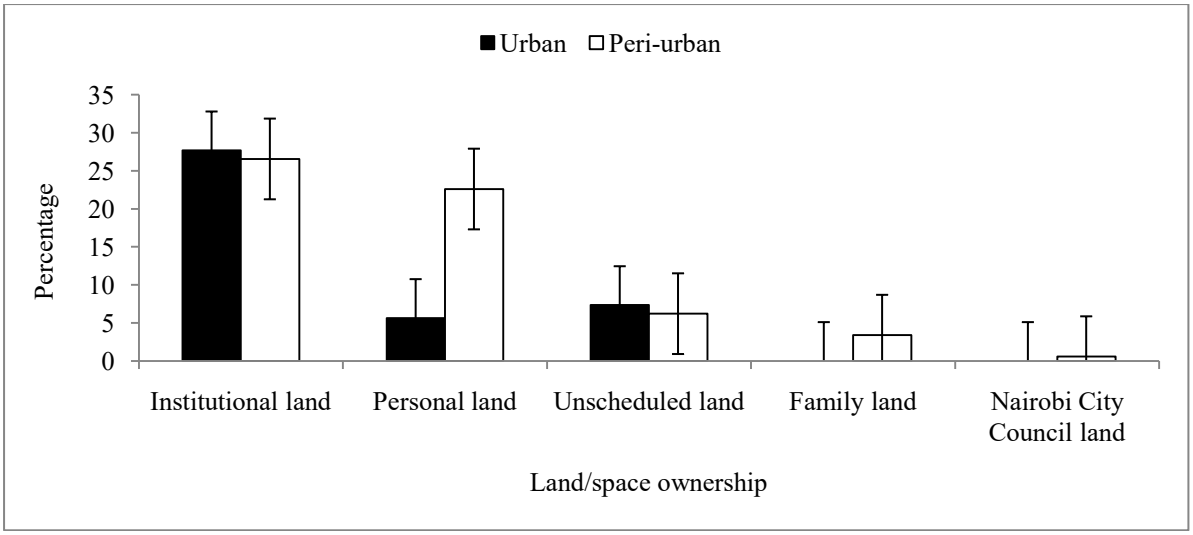

Figure 5A: Proportion for type of land/space ownership for crop production in urban and peri-urban areas of Nairobi County.

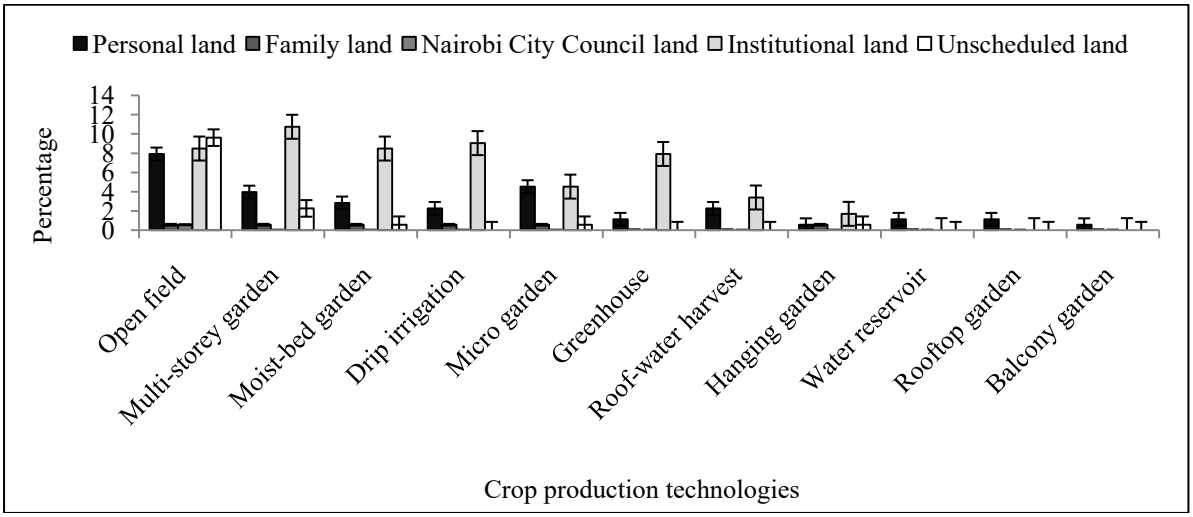

Figure 5B: Distribution of type of land/space ownership utilized for different crop production technologies in Nairobi County.

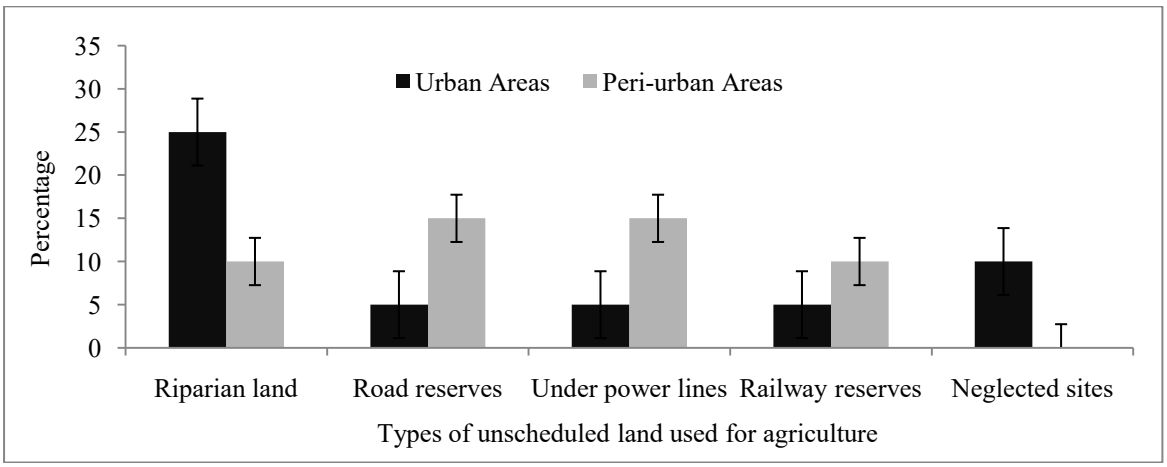

Figure 6: Extent of utilization of different types of unscheduled spaces for crop production in urban and peri-urban areas of Nairobi County.

Conclusion

The type and distribution of urban and peri-urban agriculture production systems in Nairobi County were influenced by underlying factors like land size and ownership status, proximity to the Central Business District, availability of land as governed by urban planning and zoning, gender and access to clean environment. Eleven types of production technologies were identified for crop production in the urban and peri-urban areas of Nairobi City County. Open field was the most utilized crop production technology and was more in use at the peri-urban than urban areas by 10%. Multi-storey gardening practice was significantly utilized in the urban than peri-urban areas. Male-headed households were significantly more than female-headed ones by 84% and were more dominant in the utilization of the various crop production technologies. Land size of less than quarter of an acre was most prevalent in urban areas. Institutional and private ownership of land were the most common in urban and peri-urban areas, respectively. Unscheduled spaces such as riparian land and neglected sites were more utilized by urban farmers (35%). These research findings will supplement to Nairobi City planners' decision making process concerning urban and peri-urban agriculture in regard to land use allocation. Adoption of improved crop production technologies and forming of farmer groups to bargain for idle spaces could be embraced for increased urban and peri-urban agriculture.

Acknowledgement

The authors thank the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for funding this study (Grant No. RU/2012/GRG-80) and the Ministry of Agriculture staff, in Nairobi County for their collaboration.

References

Ambrose-Oji, B., 2009. Urban Food Systems and African Indigenous Vegetables: Defining the Spaces and Places for African Indigenous Vegetables in Urban and Peri-Urban Agriculture Urban food systems and trends in vegetable production in urban. In *African indigenous vegetables in urban agriculture* (pp. 33-66).

Camara, B., 2013. The dynamics of land tenure systems in the Niger basin, Mali. *Africa*, *83*(1), pp.78-99.Cheserem, M., 2011. Kenya: County fact sheets. *Nairobi, Kenya: Commission on Revenue Allocation*.

Cofie, O., Larbi, T.O., Danso, G.I., Abraham, E.I., Kufogbe, S.K. and Obiri-Opareh, N., 2008. Urban Agriculture in Accra Metropolis: Dimensions and Implications for urban Development. In: In: Parot, L. Njoya, A. Assogba-Komlan. F. Kahane, R. Ba Diao M, Havard, M. Editors: Agricultures et dévelopment urbain en Afrique subsaharienne. Governance et approvisionnement des villes.

Cornish, G.A. and Kielen, N.C., 2004. Wastewater irrigation—hazard or lifeline? Empirical results from Nairobi, Kenya and Kumasi, Ghana. *Wastewater use in irrigated agriculture*, pp.69-79.

FAO, 2013. The State of Food and Agriculture: Food systems for better nutrition. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome.

Foeken, D.W.J. and Mboganie-Mwangi, A., 2000. Increasing food security through urban farming in Nairobi.

Foeken, D.W. and Owuor, S.O., 2008. Farming as a livelihood source for the urban poor of Nakuru, Kenya. *Geoforum*, *39*(6), pp.1978-1990

Gallaher, C.M., Kerr, J.M., Njenga, M., Karanja, N.K. and WinklerPrins, A.M., 2013a. Urban agriculture, social capital, and food security in the Kibera slums of Nairobi, Kenya. *Agriculture and human values*, *30*(3), pp.389-404.

Gallaher, C.M., Mwaniki, D., Njenga, M., Karanja, N.K. and WinklerPrins, A.M., 2013b. Real or perceived: the environmental health risks of urban sack

gardening in Kibera slums of Nairobi, Kenya. *EcoHealth*, *10*(1), pp.9-20.

Gallaher, C.M., WinklerPrins, A.M., Njenga, M. and Karanja, N.K., 2015. Creating space: Sack gardening as a livelihood strategy in the Kibera slums of Nairobi, Kenya. *Journal of agriculture, food systems, and community development*, *5*(2), pp.155-173.

Haregeweyn, N., Fikadu, G., Tsunekawa, A., Tsubo, M. and Meshesha, D.T., 2012. The dynamics of urban expansion and its impacts on land use/land cover change and small-scale farmers living near the urban fringe: A case study of Bahir Dar, Ethiopia. *Landscape and urban planning*, *106*(2), pp.149-157.

Hien, W.N., Yok, T.P. and Yu, C., 2007. Study of thermal performance of extensive rooftop greenery systems in the tropical climate. *Building and Environment*, *42*(1), pp.25-54.

Kaluli, J.W., Githuku, C., Home, P. and Mwangi, B.M., 2011. Towards a national policy on wastewater reuse in Kenya. *Journal of Agriculture, Science and Technology*, *13*(1).

Karanja, N.N., Njenga, M., Prain, G., Kangâ, E., Kironchi, G., Githuku, C., Kinyari, P. and Mutua, G.K., 2010. Assessment of environmental and public health hazards in wastewater used for urban agriculture in Nairobi, Kenya. *Tropical and Subtropical Agroecosystems*, *12*(1), pp.85-97.

Kenya Travel Guide UK, 2013. Kenya travel guide UK [WWW Document]. URL http://www.kenyatravelguideuk.com/nairobi.htm (accessed 8.13.14).

Mutisya, E. and Yarime, M., 2011. Understanding the grassroots dynamics of slums in Nairobi: the dilemma of Kibera informal settlements. *Int Trans J Eng Manag Appl Sci Technol*, *2*(2), pp.197-213.

Njenga, M., Romney, D., Karanja, N., Gathuru, K., Kimani, S., Carsan, S. and Frost, W., 2010. Recycling nutrients from organic wastes in Kenya's capital city. In *African urban harvest*(pp. 193-212). Springer, New York, NY.

Nowak, M., 2004. *Urban agriculture on the rooftop* (Doctoral dissertation, Cornell University).

Orsini, F., Gasperi, D., Marchetti, L., Piovene, C., Draghetti, S., Ramazzotti, S., Bazzocchi, G. and Gianquinto, G., 2014. Exploring the production capacity of rooftop gardens (RTGs) in urban agriculture: the potential impact on food and nutrition security, biodiversity and other ecosystem services in the city of Bologna. *Food Security*, *6*(6), pp.781-792.

Orsini, F., Kahane, R., Nono-Womdim, R. and Gianquinto, G., 2013. Urban agriculture in the developing world: a review. *Agronomy for sustainable development*, *33*(4), pp.695-720.Pearson, C.J., 2010. Urban agriculture: diverse activities and benefits for city society. *International Journal of Agricultural Sustainability*, *8*(1/2), pp.3-126.

Schmidt, S., 2012. Getting the policy right: urban agriculture in Dar es Salaam, Tanzania. *International Development Planning Review*, *34*(2), pp.129-145.

Simiyu, R.R., 2012. *I Don'T Tell My Husband about Vegetales Sales: Gender Aspects of Urban Agriculture in Eldoret, Kenya*. African Studies Centre.

Simiyu, R.R., 2013, September. Gendered access to and utilization of land by food producers in urban Kenya. In *Urban Forum* (Vol. 24, No. 3, pp. 325-342). Springer Netherlands.

Specht, K., Siebert, R., Hartmann, I., Freisinger, U.B., Sawicka, M., Werner, A., Thomaier, S., Henckel, D., Walk, H. and Dierich, A., 2014. Urban agriculture of the future: an overview of sustainability aspects of food production in and on buildings. *Agriculture and human values*, *31*(1), pp.33-51.

Thomaier, S., Specht, K., Henckel, D., Dierich, A., Siebert, R., Freisinger, U.B. and Sawicka, M., 2015. Farming in and on urban buildings: Present practice and specific novelties of Zero-Acreage Farming (ZFarming). *Renewable*

Agriculture and Food Systems, *30*(1), pp.43-54.

Thuo, A.D.M., 2013. Exploring Land Development Dynamics in Rural-Urban Fringes: A Reflection on Why Agriculture is Being Squeezed Out by Urban Land Uses in the Nairobi Rural–Urban Fringe? *International Journal of Rural Management*, *9*(2), pp.105-134.

UN System Task Team on the Post-2015 UN Development Agenda, 2012. Realizing the Future We Want for All. Report to the Secretary-General.

Wangari, K.M., 2013. Urban Agriculture as an Authentic Urban Land Use in Kenya: A Case Study of Komarock Estate.

Blank Page