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Unsustainable Livelihood Interactions Between Rapid Urbanization, Environmental Pressures and Food Systems in The Sub-Saharan Region

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ABSTRACT

Urbanization is rapidly increasing with half of the human population now living in urban areas. However, urban living comes with new lifestyles, food habits, and the concentration of food varieties in a small area. Most urban places were developed on agriculturally rich lands; therefore, there is an urgent need for governments to come up with strategies for realizing a sustainable interaction between the growth of urbanization, environment ecosystem services, and food systems, especially in the sub-Saharan region of Africa. This study highlights the probable implications and impacts of the sub-Saharan urban expansion on food systems and ecosystem biodiversity functions, with special reference to the Kenyan urban food systems. The study concludes that the rapid increase in the urban population in Kenya is shifting traditional diet preferences and may in the near future, have health, and environmental implications. The drivers of this change are; lack of information or advice on nutritional needs, increased intake of livestock products, increase in the consumption of processed foods, increasing the use of pesticides, herbicides, and environmental contamination. The study emphasizes the urgency of implementing a sustainable, intensive and multifunctional agricultural system.

Keywords: Ecosystem services, Biodiversity hot spots, Multifunctional agriculture, Kenya, Agricultural Intensification and food security.

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INTRODUCTION

Although much thought has been going into how to sustainably provide food security to over 9 billion people who will be living on earth by 2050, few people have realized that at that time, 6.5 billion (over 72%) of those people will be living in urban centers (Fragkias et al., 2013). Therefore, there is a need to investigate the relationship between food systems and urbanization. Urban development includes the construction of large buildings and infrastructures like roads, sewerage and electricity supply structures. This urban growth has made more people concentrate in small areas for work and other social services. This usually increases social interactions and creates new living habits and also causes the elimination of others. Therefore, there is an urgent need to evaluate these new set of new norms and cultures in urban development so as to ensure sustainability. Furthermore, urban settings have been demanding more food varieties due to the congregation of people with different foods preferences and tastes. This necessitates urban managers to seek for long term

strategies to have food systems that can sustain these demands. The food demands are also causing more reserved ecosystems like forests and riparian areas to be encroached for agricultural food production, hence eliminating essential ecosystem services. In the sub-Saharan region, the demand for building construction is fetching more price than agricultural investment. Hence, the three parameters which affect food systems in urban areas are increasing food preferences, decreasing in agricultural lands due to infrastructural constructions and reducing ecosystem services like pollination, due to light and air pollution. By 2030, the built-up areas are expected to triple in size to occupy an area of about 1.2 million Km^2 (Seto et al., 2011). This will reduce the area for growing crops hence affecting crucial food systems (Seto et al., 2012).

This urban-growth and cropland reduction phenomenon shall be most serious in the sub-Saharan region where both are growing simultaneously. For example, Nairobi city which seems to be the model city in the region, with a population of 5 million, is growing at a rate of 3 to 4% per year and its cost of living is becoming unaffordable due to the combination of high rents, high food prices, high population, and high land prices.

The sub-Saharan region has the highest global human population growth, with exponential unplanned city growths and rural land fragmentation. The destruction of biodiversity and climate change is also reducing ecosystem services in these areas. In these tropical lands, the loss of forest to create agriculture lands is estimated at 12 million ha per year (Barber, 2004). This paper highlights this seemingly regional problem and suggests several solutions including government policies to introduce reserved agricultural lands in urban areas. Globally, a meta-analysis by Seto et al. (2011) showed that some of the largest cities worldwide were not being studied in terms of their changing urban land extent.

This is now the scenario in the sub-Saharan region which has an added complex dimension of food insecurity, demographic shift and political instability increasing the vulnerability of the urban populations (Fragkias et al., 2013). The summary of the objectives was to: identify factors affecting urban setting livelihood dynamics, determine the sustainability of food systems environment interactions, highlight, factors that can assist in reconciling urbanization, food systems and conservation and comment on the solutions for the profound effects of urbanization to food systems.

MATERIALS AND METHODS

We reviewed the literature on urbanization, environment and food systems for major cities in the sub-Saharan region to enable us to have forecast data in livelihood sustainability analysis. A substantive focus was made for the Nairobi and Machakos cities in Kenya which are on the sides of an ongoing 5000 acres land for the construction of techno city site for the sub-Saharan region. This desktop research was carried out to determine the balance between livelihoods, rapid urbanization, environmental pressures and food systems in sub-Saharan region. The study involved research articles and observations on local populations. The data were synthesized to decipher the linkages between key components. The research also involved analysis of six maize varieties (DHO4, DUMA, KCB, the traditional maize varieties (A1 and A2) and Africa Yellow variety grown in the sub-Saharan region and their kernel response to *Aspergillus flavus*, the fungi which cause the development of aflatoxin. Aflatoxin is a major cause of cancer. The study also involved some sociobiological studies of light pollution on urban centers and ecosystem functions of nocturnal pollinators like moths.

RESULTS AND DISCUSSION

The Future Ecological Costs of The Increasing Present Urban Living

The economic status of most African urban dwellers has been rising in recent years. This has made them also to change their diet to more meats, dairy and poultry foods that are ecologically costly and require more land, more water and energy (McMichael, 2007). This problem is more in cities like Nairobi in Kenya, where more investments are being done by foreign companies especially from China, India, and Europe who come with different tastes, lifestyles, land demands and industrial wastes. Past studies have positively associated urbanization with diet transitions. But few studies have linked the diet transitions impact to food systems and ecosystem services and eventual environmental impact. Past generations in Africa were rural settlers who relied on complex raw grain carbohydrates and protein, fruits, nuts and tubers with little meat while the modern urban dwellers are using more animal protein, refined fats, refined sugars, processed juices and even alcohol. These changes can be attributed to higher incomes and the influence of foreign lifestyles. Although, no research has been done to show how significantly our food choices are influenced by where we live or affordable means to reach other food types if our food systems remain sustainably operational. Some towns have had birds and other species losing their habitats due to the expansion of city buildings. For example, the Nairobi city in Kenya has had lions straying to newly constructed buildings probably because the lions have for a long time been used in making long circuits in their territories but have now become ecologically confused.

Profound Effects of Urbanization to Food Systems

The staying and interactions of different cultures in one

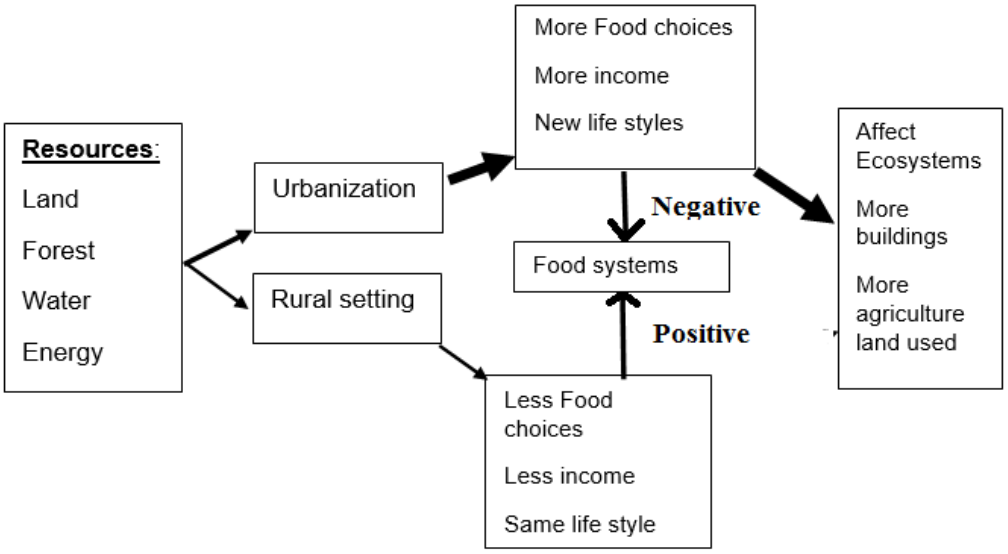

Figure 1. A Model showing the co-evolution phenomenon of urbanization and food systems. The negative and positive arrows indicate relative impacts of food systems.

place have the potential of changing people attitudes and norms towards foods. For example, people who could not in the past dare eat to some types of meats like dog meat, pork, donkey meat, and insects are now being influenced to work in factories that process them and eventually are influenced to eat the same foods with their families. The fast-food outlets in urban cities in Africa have gained pace and unquestionably more urban dwellers are eating whatever is served with little customer regulation. This is fueled by the high corruption rate amongst government officers. This so-called convenience foods outlets capitalize on the production of foods that have a high energy demand, water requirements and normally impose high environmental pressure on the land resources (Figure 1). These costs of convenience foods are higher because of the need to transport raw materials, processing, refrigeration and packaging, repackaging and distribution.

The Use of Small Holder Famers to Supply Urban Food Systems

Studies show that smallholders and indigenous knowledge play a critical role in in-situ conservation of crop genetic diversity. Local varieties have been found to be more resilient than modern hybrid varieties. For example, Studies showed that most of the modern varieties in China could not survive but most of the crop landraces were not lost during a drought in Sichuan province in China in 2010 (Swiderska et al., 2011). Indigenous local farmers had employed traditional breeding in which they selected the best maize combs and preserved them hanging them in their grass thatched smoke-filled kitchens and could have resistance crops and food security. They used to have mixed farming systems which included perennial crops like sorghum, roots (cassava, Arrowroot and sweet potatoes) and yams and traditional vegetables which could withstand much harvesting and could release much seed for the next season like amaranths. The harvest was also preserved using traditional post-harvest facilities like preserving perishables under honey and fermentation. Modernization and neglect of traditional technologies have changed these farming systems to haphazard systems geared to make seasonal profits. This has made many small-scale holder farmers to be persuaded to engage in unsustainable ventures like rabbit keeping, quail raising, Isa brown chicken, fish farming, and turkey farming which produce yields under high-input investments. Our studies showed that hybrid maize like (DHO4, DUMA and KCB) were easily attacked by *A. flavus* which causes aflatoxin poisoning in the South Eastern region in Kenya.

The traditional maize varieties (A1 and A2) showed more kernel resistance and more genomic flexibility as the kernel was thicker and the grains showed more transposon movement respectively, (Figure 2). Studies showed that these new hybrid cultivars were intended for large scale production and needed many expensive inputs to the level of precision farming in water, pest and fertilizer applications. This is beyond the capacity of sub-Saharan small-scale farmers except under customized conditions. The physical characteristics of the maize varieties in the area showed the kernel sizes

Figure 2. Kenya small scale farmers who supply food to the urban centres mainly prefer maize amongst the Big 4 staple foods [Maize, Beans, Wheat and Rice] in Kenya. The above diagram shows the common semi-arid maize varieties tested for aflatoxin and weevil resistance. A1 and A2 are the African traditional maize varieties. On the left side are the corresponding relative sizes of some of the common maize varieties grown in the south eastern region of Kenya.

Table 1. Physical analysis of the common maize varieties grown in the sub Saharan region.

	Maize Variety					
	KCB	**DUMA**	**DHO4**	**Africa Variety 1**	**Africa Variety 2**	**Africa Yellow**
Kernel size	Smallest	3rd largest	small	Largest	2nd largest	4th largest
Kernel shape	Round	flat	Round	Flat	Round	Round
kernel hardness	2nd hardest	5th hardest	6th hardest	3rd hardest	4th hardest	Hardest
Kernel cracks and fissures	2nd fewest	5th fewest	6th fewest	3rd fewest	4th fewest	Fewest
Size of comb attachment remaining	3rd largest	2nd largest	Largest	5th largest	4th largest	smallest
Proportional size of endosperm	Largest	4th largest	2nd largest	3rd largest	5th largest	Smallest
Smoothness of endosperm	Roughest	3rd rough	6th roughest	4th rough	5th rough	2nd rough
Dent	4th largest	3rd largest	6th largest	Largest	2nd largest	5th largest

and hardness of the traditional African varieties was much higher than the hybrid varieties (Table 1). Hence, bearing in mind that maize is the staple food in the sub-Saharan region, the implication is that the introduction of hybrid varieties should be done gradually after careful research on their food security sustainability capacities. This was because our study showed that hybrid seeds seemed to have less resistance to weevil attack and consequently aflatoxin contamination.

Locked Benefits of Urbanization in Sub Saharan Cities

Urbanization can benefit rural farmers by reducing crop wastage especially through the provision of ready markets, transport and cold storage facilities. However, in the sub-Saharan region, the infrastructural development still has not advanced in making more people travel to buy more foods and to easily determine special sites where they can eat conveniently. But some governments have noticed the challenge and are fast developing their infrastructure to the point of customers asking food from outlets via the internet though at high costs. Some food outlets entrepreneurs have also started to move out of cities to be at more convenient locations. However, the dream might not be easy to achieve if strategic and dramatic changes are not affected. This is because most literature shows that most cities in Africa are dysfunctional and their functionality hindered by corruption and political interferences. They have limited connectivity and hotchpotch land uses to make it not to be economically productive. Hence, these losses in time, manpower and food wastes are negatively impacting on the sustainability of the food systems. There are benefits of urbanization which can be tapped, for example, the concentration of people, coupled with good infrastructure and economic activity enable innovation and efficiencies (Puga, 2010). Ecological studies and strategic environmental impact should also be done to determine the ecological footprints of most of the urbanization. For example, light pollution is indirectly increasing food insecurity (Figure 3).

Improving Urban Food Systems Through Local Innovations

The population size of an urban area has been singled out as one of the most salient characteristic determinant and consequence of the socio-economic activity in a

Figure 3. A moth pollinating a flower at dawn (7:15pm) at Machakos Town, near the Nairobi city, the loss of moth diversity has been attributed to light pollution due to urbanization and use of environmentally unfriendly bulbs in the sub Saharan region. Hence, the need for scotobiology, which focuses on the benefits of minimal light and the determination of the limits for that light in urbanization.

city (Bettencourt et al., 2007). Recent studies by Mutavi et al, (2016) showed that the farm size in the South Eastern region in Kenya have become moderately small and most farmers are continuously fragmenting land units. This was be attributed to increased human population, urbanization and sub-division of agricultural lands. It was surprising that agriculture was considered less profitable. But their study showed that innovations in Artificial Insemination (AI), fodder crops and crop residue, Tumbukiza Method (TM), stall-feeding, feedstuff chopping, water harvesting, hay barn technology, hay and silage making significantly improved milk production at $p<0.05$ in the peri-urban regions (Mutavi et al., 2016). The TM innovation involved the use of water retention pits which were rectangular or circular pits, which are 60 cm deep, 60 cm wide and 60 cm apart (Orodho, 2006) for planting the fodder crops. This practice was found beneficial in ensuring a constant supply of feedstuffs and better milk yields (Mutavi et al., 2016). However, much of the current population in urban centers in the sub-Saharan region is made up of industrial workers who are non-agricultural. Therefore, they end up buying more food than the countryside supporting it can produce. This is causing the prices to escalate, pushing more to produce more food in the countryside, but the increase in population puts more demand on the cost of land and the road infrastructure to transport it. Studies in economics show that larger urban agglomerations are more productive and innovative (Lobo and Strumsky, 2008; Sedgley and Elmslie, 2011; Glaeser and Resseger, 2010). However, the kind of skills the population has, the political and value systems, infrastructural developments and food systems could be pivotal in determining this assumption in sub-Saharan cities.

Traditional Post-Harvest Technologies in Food Security

Africans had indigenous knowledge of how to survive through food shortages, drought and conserve the environment. This knowledge has been to a large extent replaced by modernization attitude of copying of foreign practices which local farmers do not understand fully the scientific basis. Our research found out several post-harvest practices which should be revived urgently again. For example, farmers in Africa used to carefully preserve every agricultural product. They hated to waste food. It was an abomination to waste food. The meat was cooked and preserved in honey and kept in big wooden containers carved from trees or they used big gourds. Every homestead used to keep a gourd full of fermented pearl millet or sorghum porridge. They also kept fermented milk. When visitors came or men came from hunting or herding cattle, they used to be given pieces of the honey-soaked meat and a calabash full of sour porridge. Then they could top up with dried

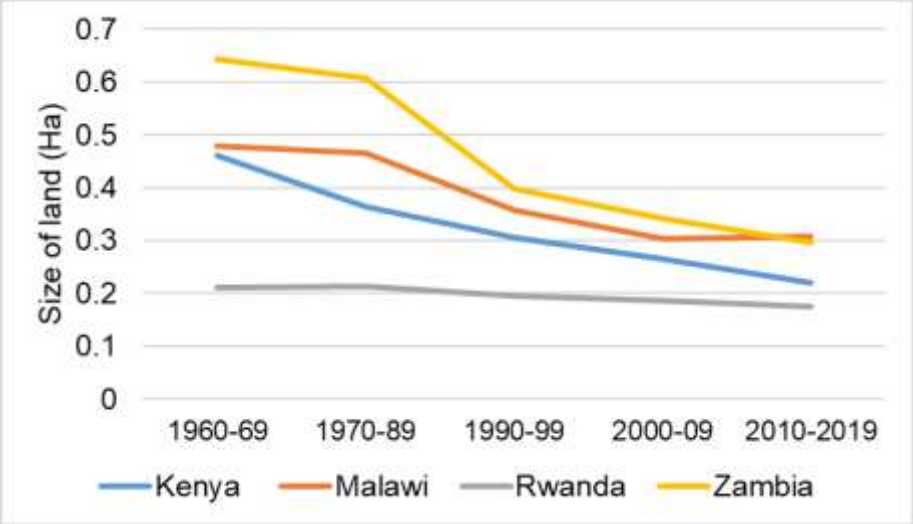

Figure 4. A projected general downward trend of the size of arable land (ha) per person in agriculture of four sub-Saharan countries showing an inevitable decline. (Source, FAO STA, 2010).

wild fruits, nuts or fermented milk. This needed no lighting of fire and thus conserved the environment. The nomads used to carry the same foodstuffs wherever they went. All sun-dried grains were preserved in dry sealed gourds and special storage houses which were reinforced with a mixture of cow dung and clay. This kept the weevils away. Modernization brought about other forms of food preservation which involved chemicals of denaturalization of the foods. This has largely not been safe and sustainable.

The Ecological Implications of The Land Value Costs

Most of the big towns in the sub-Saharan region were built on the most fertile soils or on major roads. This has made “corridor agribusiness” to flourish in these urban centers as the agricultural products they produce is mainly perishable and must be produced and consumed locally (Hummel et al., 2004). However, there has been a rapid increase in the price of land in the sub-Saharan region, especially in major towns. Therefore, climate change and costs of farming are inducing farmers to sell their land so as to get the high prices compared to the income, they get from the farming activities (Banse et al., 2014). This has made house rents and the food prices to increase and the cost of living to be very high. This is compounded by a high population of young people who do not have cultural values being congregated in a small area causing a high rate of crime and insecurity. Furthermore, studies have shown that as cities grow, supermarkets dominate the retail food market and this affects the small-scale farmers who cannot supply to the big supermarkets. This affects the whole food supply chain as other middlemen increase the costs of production and discourage small-scale farmers. The size of arable land has also been decreasing at a fast rate in the sub-Saharan region (Figure 2). There is an urgent need to research on having resilient sustainable agricultural intensification (SAI), land use and environmental factors affecting ecosystem services contributing to food security. Projections show that in the next two decades we shall have more urbanized populations. This shall definitely put more pressure on the little agricultural land and the environment, this shall increase pollution, ecosystem degradation, food insecurity and poverty. Interestingly, the increase in land prices in Kenya has also been correlated positively with slum reduction. Slum dwellers survived on free government or private undeveloped land where they constructed temporal structures. However, as the city expanded, the slums are being converted to formal residential houses and new slums are constructed at the edges of the city. This is the trend in most of the countries in the sub-Saharan region (Figure 4). However, the land is almost reaching the saturation stage where the poor cannot expand.

This is causing an increase in conflicts and court battles because of mainly local politicians who want the people because of their votes and international standards which demand operational cities. Studies have shown that an increase in urbanization in the sub-Saharan region would result in considerable loss of habitats in key biodiversity hotspots in the face of climate changes. This is expected to grow at a high rate in Kenya where a new constitution is being implemented. This constitution has a devolved system of governance with 47 counties being developed competitively and largely ecologically unadvisedly. This development is expected to take place in regions that were relatively undisturbed by urban development before 2010. This puts much

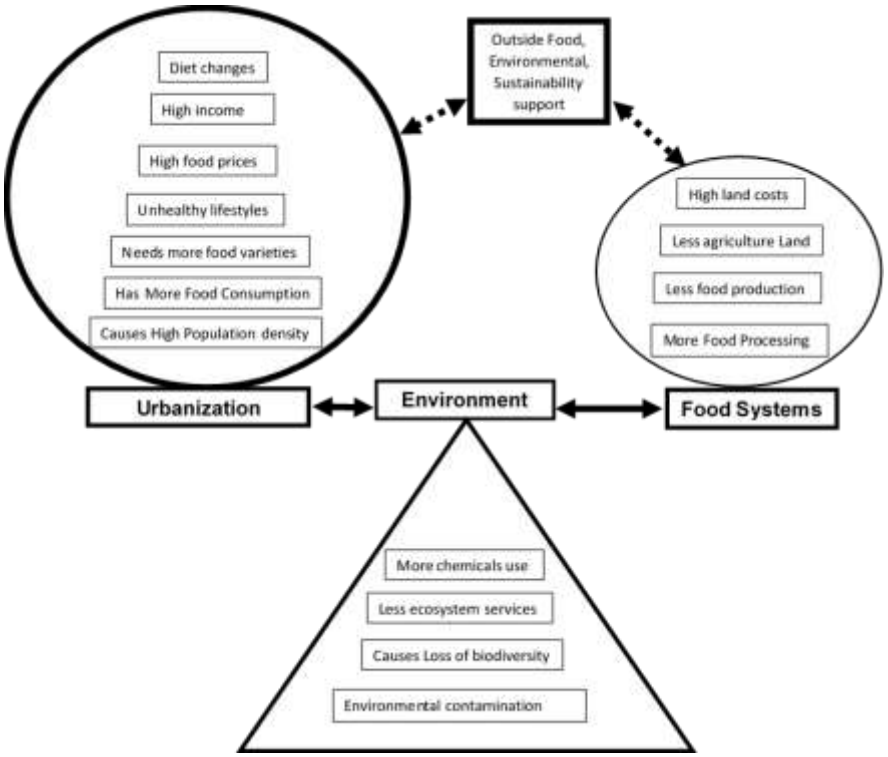

Figure 5. A summary of the prevailing relationship between effects of urbanization, the environmental burden and unsustainable food systems balance in the sub Saharan region and the unpredictable external support. The chart show that deliberate efforts must be made to make ecosystem services an integral part of a multifunctional agriculture.

Eastern Afromontane biodiversity to be at a higher risk of extinction. Some might argue that the cities in sub-Saharan region are small but, previous studies show that urban areas drive global environmental changes (Grimm et al., 2008). This relationship is of significant consideration in areas with high population growth, food insecurity, and poor governance. In the case of Nairobi and other cities around it, much of the buildings are being done using sand, much water and cement. These are collected in riparian and hot spot areas which are causing great losses in biodiversity (Pimm and Raven, 2000). The roofing of the building needs much timber, which as of now, most of its former sources have almost been exhausted and traders in construction timber have now resulted to importing from a neighbouring country called Tanzania due to the governmental agreement of a common market and open border policy in the East African region.

Reconciling Urbanization, Food Systems and Conservation

Cities have been recognized as the new hot spots of global environmental change due to their high population, insatiable consumption of all kinds of foods, unreplaceable resource usage and enormous ecologically dangerous wastes" (WWF, 2013). This study suggests that agricultural reserve areas and biodiversity conservation zones be set aside during urban expansion (Figure 5). These conservation zones can target flagship species and representatives for specific environmental conditions including keystone species with strong impact ecosystem functions. The identifications of such species require collaborative ecological, cultural, political and agricultural localized consultations. This because the ecosystem services are in diverse categories like: provisioning services: which include nutrition, water, timber, genetic resources, regulating services: which include, Climate, water quality, etc., cultural services: which include aesthetic landscapes, tourism, supporting services: which include nutrition circle, soil re-creation, herbal medicine, pollination, protection from natural catastrophes. Environmental stochasticity species migration and habitat fragmentation due to buildings and infrastructural constructions are also factors to be considered. But generally open land urban agricultural spaces can improve ecosystem services (Hassan et al., 2005), urban biodiversity (Lin et al., 2015) and reduce urban ecological footprint.

Decoupling Food Production and Consumption

The studies show that in some cities the increase in

supermarkets which have refrigerators and cooling systems for vegetables and dairy products, canning of fruits, meats and vegetables have had a greater impact in decoupling production, diet diversity and consumption in urban centers. The introduction of small-scale intensification of agricultural production and minimal wastage of produce shall be crucial in creating a spatial reduction of the direct relationship between production and consumption. Although it has been recognized that a rise of the globalized food system involved some kind of standardization. But this can result in the loss of local varieties (Khourya et al., 2014), as was observed in Kenya where Chinese fish was being sold in Kenya at a price far less than the local varieties. Therefore, as urbanization in the sub-Saharan region is not going to be less, the demands for investment in local food processing industries should become a priority. Furthermore, governmental policies to increase the productivity of smallholder farms shall enhance their contribution to the economy, reduce food insecurity and poverty.

The sustainability of this smallholder farming practices should be supported by functioning ecosystems, including pollination, soil fertility by soil microorganisms, fresh air-water delivery, and ecologically friendly control of pests which can positively influence the condition of ecosystems in the long term. This should be like a green revolution in the sub-Saharan region but with a sustainability and ecosystem sensitive approach. This is because the green revolution in agriculture which swept and made significant but costly gains in production in Asia and Latin America during the 1960s and 1970s had very little impacts in sub-Saharan Africa (Ellis, 2005). Governments and donor-funded extension services catalyzed the smallholder farmers to boost agricultural output. The green revolution brought about high-yielding crop varieties, more irrigation, use of agrochemicals and improved management techniques, farmers' grain production increased from 800 million to more than 2.2 billion tons from 1961 to 2000 (World Bank 2007; FAO, 2011). The investment to catapult a sub-Saharan green revolution should include an institutionalization of government agencies with the capacity to make all sectors involved in economic development to have sustainable ecological responsibility.

CONCLUSIONS

Urban settings are demanding more food varieties. They are congregating many cultures of people with different foods preferences and tastes. Urban food demands are also causing more reserved ecosystems like forests and riparian areas to be encroached for agricultural food production. The demand for building construction is fetching more price than agricultural investment.

Urban centers are decreasing in agricultural lands due to infrastructural constructions and are reducing ecosystem services like pollination, due to light and air pollution. This urban-growth and cropland reduction phenomenon shall be most serious in the sub-Saharan region where both are growing simultaneously. As cities grow, supermarkets dominate the retail food market and this affects the small-scale farmers who cannot supply to the big supermarkets.

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REFERENCES

Ackerman K, Conard M, Culligan P, Plunz R, Sutto M, Whittinghill L (2014). Sustainable Food Systems for Future Cities: The Potential of Urban Agriculture; in: The Economic and Social Review, 45(2):189-206.

Angel S, Parent J, Civco DL, Blei A, Potere D (2011). The dimensions of global urban expansion: Estimates and projections for all countries, 2000–2050. Prog Plann 75:53-107.

Banse M, Brouwer F, Palatnik RR, Sinabell F (2014). The Economics of European Agriculture under Conditions of Climate Change; in: GJAE, 63(3):131-132.

Bettencourt LMA, Lobo L, Helbing D, Ku¨hnert C, West GB (2007). Growth, innovation, scaling, and the pace of life in cities. PNAS 104: 7301-7306.

Ellis F (2005). Small farms, livelihood diversification, and rural-urban transitions: Strategic issues in sub-Saharan Africa.IFPRI In IFPRI. Pp.2-18.

Eppler U, Fritsche U, Laaks S (2015). Urban-Rural Linkage affecting Global Land Use; GLOBALANDS Issue Paper prepared by IINAS; Berlin, Darmstadt.

FAO (2011).The State of the World's Land and Water Resources for Food and Agriculture (SOLAW) – Managing systems at risk. Rome: Food and Agriculture Organization of the United Nations; London: Earthscan.

Fragkias M, Lobo J, Strumsky D, Seto KC (2013). Does Size Matter? Scaling of CO2 Emissions and U.S. Urban Areas. PLoS ONE 8(6): e64727.

Fritsche U, Eppler U (2013). Global Land Use Scenarios: Key findings from a review of international level studies and models; GLOBALANDS Working Paper 1.3; Darmstadt, Berlin.

Glaeser EL, Resseger MG (2010). The complementarity between cities and skills. Journal of Regional Science, 50: 221-244.

Grimm NB, Faeth SH, Golubiewski NE, Redman CL, Wu J, Bai X, Briggs JM (2008). Global change and the ecology of cities. Science 319:756–760.

Hummel D (2004). Supply systems as subject of social-ecological research: nutrition and water; demons working paper 2; ISOE; Frankfurt. Journal. Pone.0064727.

Hassan R, Scholes R, Ash N (eds.) (2005). Ecosystems and Human Well-Being: Current, Vol 1. State and Trends: Findings of the Condition and Trends; Millennium Ecosystem Assessment Series; Washington DC. Pp.6-47.

Kearney J (2010). Food Consumption Trends and Drivers. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554): 2793-2807.
Khourya CK, Bjorkmanc AD, Dempewolfd H, Ramirez-Villegasa J, Guarinof L , Jarvisa, A, Riesebergd LH, Struikbet PC (2014). Increasing homogeneity in global food supplies and the implications for food security; in: PNAS 111(11): 4000-4006.
Lin B, Philpott S, Jha S (2015). The future of urban agriculture and biodiversity-ecosystem services: Challenges and next steps. Basic and Applied Ecology, 16(3):189-201.
Lobo J, Strumsky D (2008). Metropolitan patenting, inventor agglomeration and social networks: A tale of two effects. J Urb Econ 63: 871–884.
Mason N, Jayne TS, Shiferaw B (2012). Wheat Consumption in Sub-Saharan Africa: Trends, Drivers, and Policy Implications. International Development Working Paper 127, Michigan State University, East Lansing, jointly published by CIMMYT, Nairobi, Kenya.
Minde I, Mkandawire R, Ojijo N, Mwangi T, Yaye A, Osiru M, Bashaasha B, Kabasa J, Mugisha J, Mugisha A, Ejobi F, Kirsten J, Hendriks S, Madakadze C, Meyer F, Traub L, Kaneene J, Tschirley D, Haggblade S, Boughton D (2011). Food System Dynamics in Africa: Anticipating and Adapting to Change. Report, Michigan State University, East Lansing.
Mutavi SK, Kanui TI, Njarui DM, Musimba NR, Amwata DA (2016). Innovativeness and Adaptations: The Way forward for Small scale Peri-Urban Dairy Farmers in Semi-Arid Regions of South Eastern Kenya. International Journal of Scientific Research and Innovative Technology, 3(5):1-14.
Orodho AB (2006). *Tumbukiza* Technology: Alternative method of napier grass production.pp.4-16.
Parnell S, Walawege R (2011). Sub-Saharan African urbanization and global environmental change. Global Environmental Change. 21(1):S12-S20.
Pimm SL, Raven P (2000). Biodiversity. Extinction by numbers. Nature, 403:843–845.
Puga D (2010). The magnitude and causes of agglomeration economies. J Urban Econ 50: 203–219.
Sedgley N, Elmslie B (2011). Do we still need cities? Evidence on rates of innovation from count data models of metropolitan statistical area patents. Am J Econ Sociol 70: 86 –108.
Seto KC, Fragkias M, Gu¨neralp B, Reilly MK (2011). A Meta-Analysis of Global Urban Land Expansion. PLoS ONE 6(8): e23777.
Seto, Karen C, Güneralp Burak, Hutyrac LR (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. PNAS,109(40): 16083–16088.
Swiderska K, Song Y, Li J, Reid H, Mutta D (2011). Adapting agriculture with traditional knowledge. IIED Briefing Papers. London: International Institute for Environment and Development.
Tansey G, Worsley T (1995). The food system - a guide; London. Elsevier, 21(3):340-342.
World Bank (2007). World Development Report 2008: Agriculture for development. Washington, DC.
WWF (2013). Urban solutions for a living planet - Learning cases; Stockholm.