International Journal of Agriculture Innovations and Research
Volume 2, Issue 6, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 20/05/2014 | Accepted on : 06/06/2014 | Published : 20/06/2014

Organic or Inorganic Agriculture: The Environmental Costs and Imperatives for African Agriculture

Oluoko-Odingo, Alice
Department of Geography and Environmental Studies, University of Nairobi, Kenya

Mutisya, Emmanuel
Graduate Program in Sustainability Science-Global Leadership Initiative, University of Tokyo, Japan

Abstract – **Unprecedented population growth accompanied by sustained high consumption of goods and services, the pursuit of economic growth and affluence at the expense of environment, high levels of urbanization, as well as the increasing demands for trade and globalization are some of the underlying factors impacting African agricultural production today. As a result, there is degradation of the land, atmosphere, and water resources arising from the increased use of the pesticides, nitrates, livestock waste and antibiotics, fossil fuels, nitrous oxide, ammonia and methane. Overuse of natural resources contribute to depletion of ground water, loss of wild foods and habitats, and the displacement and extinction of traditional varieties and breeds. Furthermore, new health hazards and deteriorating conditions for farmers and farm workers in agro-chemical and food processing industries as well as inhumane conditions for livestock are envisaged. Major culprits are urban consumers with no alternatives to these contaminated farm produce. There is therefore the need for new approaches to agricultural production with minimal environmental impacts, which is referred to as "alternative agriculture" or, "eco-agriculture". This article elaborates on the current agricultural practices, environmental costs of modern-day agriculture, and what can be done to ensure sustainability of the African agricultural systems. The article argues that despite the high population growth rates, sustainable food production could be improved by ensuring that the opportunities presented by urban agriculture are well developed and utilized, using suitable agricultural practices. The article is based on literature review and contributes to policies on environment and agriculture.**

Keywords – **Modern Agriculture, Environmental Impacts, Urbanization, Organic Farming, Sustainability.**

I. INTRODUCTION

This is a review article, examining the current global challenges such as environmental degradation, urbanization, increasing human populations and the rising demand for food, among other needs in the context of African agriculture. The status of food production, together with some contributors over the years to address the imbalance between rising population and food needs and diminishing agricultural resources, will be discussed. The article shows that sustainable development may be elusive unless the adverse environmental impacts of modern agriculture are dealt with, and which may require a change in technology. Secondly, the urban dynamics demand that efforts are made to attain sustainable food productivity and security, not only in rural areas, but also in urban and peri-urban areas. The article makes a contribution to knowledge on how sustainable food security can be achieved, with special emphasis on urban areas.

II. THE GLOBAL CHALLENGES

The global human population, estimated at 6909 million in 2010, reached 7 billion in 2011, with an annual average growth rate of 1.18 percent [1]. In 2010, 50 percent of the human population had moved to cities, with Africa and Asia recording the highest growth rates. Increased population growth leads to high consumption of raw materials and services, mainly drawn from the environment. The resulting waste is also deposited on the environment, with severe ecological consequences. Besides, demands for food and livestock products continue to rise due to population growth, urbanization and changing diets.

Urbanization has been rapid and about 50 million people are added to the population of urban areas annually. Most of the increases occur in the developing countries of Africa and Asia. Worldwide, the number of cities with a population of more than one million has increased from 75 in 1950 to 447 in 2011, with over 90 percent of the world's urban population growth taking place in developing countries. By 2030, Sub-Saharan Africa will have an urban population of 627 million (United Nations Human Settlement Programme [2]. By 2030, about 80 percent of the world's urban population will be found in developing countries. Several health and environmental problems are associated with these urban expansions, such as food insecurity, poor indoor air quality, shortage of water, housing poor sanitation facilities, deforestation, high energy use as well as outdoor air pollution, which also contribute to high rates of poverty and social inequity witnessed in these areas [2].

There are two major two major global challenges today [3]:

1. Averting dangerous and potentially unmanageable climate change and protecting the natural environment which supports life on earth.
2. Providing decent work to preserve all in the face of rapid population growth worldwide and the current exclusion of over a billion people from economic and social development.

Agriculture is one of the sectors that is highly vulnerable to climate change, and if not well managed, contributes to adverse environmental impacts. The industry sustains a majority of the poor, as small-scale agriculturalists in rural or urban and peri-urban areas. Due to their poverty status, they draw most of their resources from the environment, with minimal resources left for environmental conservation. It is therefore an important target industry for sustainable development.

Copyright © 2014 IJAIR, All right reserved

Environmental degradation is progressing due to water, land and air pollution, the irreversible loss of biodiversity, the deterioration and exhaustion of natural resources like water, fertile agricultural land and fish. These cause serious threats facing economic and broader sustainable development [3]. There are also 190 million people unemployed and tens of thousands of young people without a place in the society. Decent work is therefore required to eliminate poverty and achieve equitable, inclusive and sustainable development.

In the agricultural sector, the nitrogen and phosphorus cycles have already exceeded their planetary boundaries. For example, currently, human activities convert about 120 million tonnes of nitrogen from the atmosphere annually into reactive forms (for fertilizer and from cultivation of leguminous crops), which exceeds the conversion by all land based natural processes. Further about 20 million tonnes of phosphorus is mined for agricultural and industrial use and the resulting waste is all released onto the environment [4].

Balancing economic development, climate change adaptation and mitigation and sustainable development, demand a shift towards clean development, green and low-carbon economies worldwide. Table 1 puts emphasis on the Status of Environmental challenge:

Table 1: The Environmental Challenge

Biophysical Challenge	Decent work/Social Challenge
-1.8 billion vulnerable to fresh water scarcity in Asia and Africa by 2025 -50 million potential environmental refugees in the next few years -330 million exposed to flooding -180 million currently affected by food shortages and will increase to 600 million by 2080 -2 million deaths annually due to indoor and outdoor air pollution -Loss of biodiversity – 40% global economy	-1.3 billion, earning about 2$ a day (43% global workforce) -190 million unemployed -over 500 million new job seekers in the next 10 years -5.3 billion without access to social security coverage -1.6 billion without access to modern energy (1 in 4 humans) -1 billion slum dwellers without access to clean water and sanitation

Source: Modified from UNEP [3].

There is neither widespread understanding nor global collaborative solutions on how the world shall feed the projected 9 billion people by 2050 [5]. Fresh water supply is already a problem and by 2030, there will be a gap between fresh water supply and renewable energy supply. A further 844 million people still lack access to clean drinking water. Added to other problems like sanitation (1.1 billion people have no improved sanitation), these crises are making it difficult to achieve prosperity worldwide and the Millennium Development Goals (MDGs) for reducing poverty and food insecurity.

The Global food production and food security also indicates that, in the past 50 years, food production has outpaced rising demand. Since the Second World War (WWII), food production has tripled, while the human population has doubled, leading to increases in the calories available per person from 1925 calories (1961) to 2540 calories (1992) in the developing world. The recommended calories per adult per day are 2300 [6]. The increase in food production resulted from the adoption of crop rotation, mass production and use of petroleum-based fertilizers and chemical pesticides, expanded irrigation, and introduction of genetically modified cultivars.

Irrespective of this recorded rise in food production, Africa is still producing 30 percent less food than it did in 1967. The situation is likely to become worse, unless drastic changes are taken. Per capita food production has been falling amidst rapid growth in demand in developing countries, due to higher population densities in traditional agricultural areas. Fragmentation of small farmsteads, poor land management as well as inappropriate agricultural/economic policies is responsible for the reported decline [7]. Table 2 shows some of the projected food production requirements by 2050.

Table 2: Required Food Production Increases by 2050

Continent/Region	Projected Population	Projected Increase
AFRICA	2 billion	300 percent
LATIN AMERICA	810 million	80 percent
ASIA	5.4 billion	70 percent
NORTH AMERICA	384 million	30 percent

Source: [8]

The projected increases are likely to face the challenges of increased demand for food as result of high human population growth rates, reduced supply of food due to diminishing agricultural land and farm fragmentation, soil depletion from intensive cultivation, reduced access to fresh water and pollution.

II. Merging the Past and Present Search for Food Security

There is extensive literature on attempts to find solutions for the current world food crisis [9], [10], [11], [12], [6], [12], [14], [15], [16], [17]. The literature shows inputs from various disciplines to fight hunger and food insecurity. Some of these efforts are discussed to enhance understanding of the status of World food production today. Comparisons are made on experiences, disciplines and gender issues, while also identifying success stories, pointing out the gaps, and finally, learning from existing' approaches applied in solving global food problems. In this section, a number of research works have been examined [17], [18], [12], [14], [11].

Malthus work was fundamental in providing a basis for the study of food crises amidst population increases globally [19]. Malthus research was later followed by Schultz [17] and Ehrlich [18]. Schultz was interested on the efficient allocation of agricultural resources, harnessing production factors for economic growth and agricultural investment as steps towards food security. He

Copyright © 2014 IJAIR, All right reserved

proposed three Approaches (the Command and Market Approach and Technological advancement) as possible solutions to global food problem. Ehrlich, however, postulated that population control using incentives and penalties could provide the best answer to inevitable future food challenges. During the same period, Norman Borlaug brought in the Hands-on-Approach, whereby in the laboratory, he constructed the high yielding wheat varieties, which he also supported with new agronomic and management practices in the field, thus contributing to remarkable increases in food production (the so-called green revolution)[12]. These initial attempts to address food crises formed the basis for other research on food security worldwide, after which research focused on specific aspects of food production.

For example, in the 1980s, Boserup brought in the role of women in agricultural production and in her conclusions viewed population growth as important incentive to agricultural development [14]. There is an increasing shift from regional food security studies to household food security research, in which the physical, socio-economic and demographic factors remain vital ingredients in modelling the food security equation [11]. This research recognized food insecurity as having remained persistent over the years (despite the efforts made), the multi-faceted nature of food security (hence the need for a Multi-disciplinary approach), as well as intricate relationships between food insecurity and poverty.

Some of the gaps identified include the need for innovations that would work on small farms to increase productivity, while also conserving the environment, and urban agriculture encouraged to enable cities generate low cost food for the urban population. Additional research areas include the impact of food insecurity on urban informal settlements as well as gender-related ways of motivating farmers to put more effort on the business of food production. These gaps show that there are still many steps remaining in the journey towards the search for food security. The issue still needs re-evaluation to design workable solutions and the way forward for agricultural sustainability. Some innovations that can be used to improve urban agricultural systems to ensure sustainability have been presented.

III. The Need for Technological Change

Technology is required in the production of goods and services. Even though technologies that are less harmful to the environment and more efficient are more costly, previous technologies that were heavily dependent on fossil fuels and less efficient are currently blamed for the high pollution levels, responsible for global warming. Due to technological advancements, crops are grown in areas hitherto considered unsuitable in terms of climate and soil. For example, arid and semi-arid areas which have erratic rainfall and swamps and wetlands, which have unsuitable soils in terms of texture, structure and colour are now all being used for crop production [16].

There are several reasons for technological change:

- Due to population increase, cultivation is moving to marginal soils which are normally avoided due to lower fertility or drought conditions.
- The traditional method of bush-fallow of maintaining soil fertility is being abandoned, with a consequent decline in fertility, permanent elimination of vegetative cover and increasing erosion. This means that alternative methods of maintaining soil fertility and top soil of marginal lands and soils under intensive cultivation are required.
- Local cereal varieties originally selected for cultivation on the most favourable soil types are increasingly less well adapted to less fertile, shallower, drought prone soils now being brought under cultivation.
- The change/shift from agricultural to manufacturing activities in terms of capital and labour means that industrial crops are needed.
- More capital from non-farm employment is becoming available for reinvestment in farming, which demands profitable technologies to attract investment.
- Urban areas are increasing becoming lucrative and offering opportunities for small-scale, high value crops.

Areas that have been famous for technological change include irrigation, land and water management, mechanization/expanding cropland, genetic improvement, the use of chemical inputs, reducing post-harvest losses and improving agronomic practices. A combination of these practices between 1940s and 1960s was what was referred to as Green Revolution. Green Revolution is a term used to describe the transformation of agriculture in many developing nations that led to significant increases in agricultural production [12].

The transformation occurred as a result of programmes of agricultural research, extension infrastructural development, largely funded by the Rockefeller Foundation, the Ford Foundation and other agencies. The Green Revolution began in 1943 with the establishment of the Office of Special studies in Mexico. The projects within Green Revolution spread technologies that had already existed, but had not been widely used in developing countries. The technologies include the use of pesticides, irrigation, synthetic nitrogen fertilizers, and high-yielding varieties of maize, wheat and rice.

The search for new technologies should remain an on-going exercise, encompassing, for example, ways in which smallholder farms can be made more productive while also considering the health of agricultural labour. Secondly, innovations are required to deal with post-harvest losses, not only from pests, but due to poor storage in the rural areas, which make farmers dispose of their harvest at throw-away prices. For example, the national cereals boards must be decentralized to the community level to enhance access, conservation, and reduce bottlenecks from poor infrastructure.

Food security should also be examined alongside human security, as regions lagging behind in human security often experience severe food insecurity. Communities need to be actively engaged in efforts towards both human and food security. For example, there have been devastating

Copyright © 2014 IJAIR, All right reserved

food losses from conflict fires, either in the farm or homesteads due to insecurity.

Further attempts are required, that would direct research on more nutritious, drought resistant crops, and indigenous to specific areas and make them more palatable, particularly, to the younger generation to reduce dependence on single crops, susceptible to some known pests and diseases.

Strategic early warning systems, for outlooks of a whole year are important for planning of food security in terms of availability, access, stability and quality and safety over the period to avoid surprises that subject communities to inhuman conditions of begging for food aid, a basic human right. Such early warning information should be accessible to communities for early response to reduce hazards and disasters. The early warning information should be accompanied by financial mechanisms that would encourage households to increase their productivity and/ or source for food to avert a looming pre-determined famine condition.

Special attention should be given to urban areas that are expected to absorb a large number of human populations over the years from rural to urban migration. Urban planning, that demarcates regions for food production in the peri-urban and food storage, with adequate capacity and accessibility are needed, first to provide food and employment to surplus job seekers in urban areas and secondly to regulate food price in urban areas to minimize urban unrest.

IV. The Impacts of Modern Agriculture

Ecologically, the global system is very inefficient in a world of limited natural resources that are to be distributed among the approximately 6.5 billion inhabitants of the planet and the 9 billion people projected in 2050. Currently, the productive area available per person amounts to 1.89 hectares, while the average consumption per person is 2.18 hectares [20][4]. For example, consumption per inhabitant in various countries is as follows:

Country/Region	Consumption per Inhabitant
North America	9.7 hectares
France	5.6 hectares
Mozambique/Pakistan	0.6 hectares

Global Footprint Network [21]

Today humanity uses the equivalent of 1.5 planets to provide the resources we use and absorb our waste. This means it now takes the Earth one year and six months to regenerate what we use in a year. Agriculture is no exception and it is one of the anthropogenic activities that has immensely utilized and altered the natural ecosystem, with severe short-term and long-term effects on human health.

Some of the effects of Modern Agriculture include: contamination of water (by pesticides, nitrates, & soil and livestock wastes), food and fodder (by residues of pesticides, nitrates and antibiotics) and Atmosphere (by ammonia, nitrous oxide, methane and the products of burning). Damage has been done to farm and natural resources by pesticides, thus harming farm workers and consumers. The over-use of natural resources has contributed to reduced ground water, loss of wild food and habitats. Many traditional varieties and breeds have been either displaced or extinct accompanied by new health hazards and deteriorating conditions for workers in agro-chemical and food processing industries, including inhuman conditions for animals [10].

In order to address these negative impacts of agricultural development, it is important to evaluate the short- and long-term development agenda vis-à-vis the available resources to enable sustainable feeding of the present generation without compromising the ability of the future generations to feed themselves. The vice of poverty and food insecurity in developing countries, particularly in Africa require an evaluation of the Millennium Development Goals in line with the success and gaps to chart the way forward.

For example, agriculture should mitigate negative impacts on ecosystems, reduce poverty, support livelihoods, and ensure food safety and animal welfare, while also increasing yields and reducing losses along the supply chain. To meet the MDG 1: eliminate extreme hunger and poverty, global food production will have to increase and food distribution improved. This means more stress on the environment (allocating more land to agriculture and dealing with effects of climate change) and increases in carbon dioxide (CO_2) emissions due to food miles. Further, to meet the MDG 7: environmental sustainability, the current environmental impacts of agriculture must be reduced and /or eliminated by controlling excessive reliance on non-renewable resources, inefficient use of agrochemical inputs and livestock wastes from large feedlots.

The paradox between the need to increase agricultural production to match the increasing human population and the diminishing resources for expansion of agriculture provide agriculturalists with two main choices. Either, to continue with business as usual, High input, intensive agricultural methods to increase yields at the expense of long-term soil fertility/modern industrial agriculture; or adopt location specific approaches to achieve sustainable land use based on biophysical and socio-economic considerations/green agriculture. Given the consequences of modern agriculture, green agriculture would be the natural approach. However, there are trade-offs which the farmer must deal with as are explained in the rest of the article.

Green agriculture is defined as a variety of integrated farming practices that emphasize the use of naturally and sustainable produced soil nutrients and cultivation of diversified crops and livestock husbandry in a manner that enhances overall farm productivity in balance with local, regional and global environmental resources [9].

Green agriculture is also referred to as sustainable, regenerative, low external input, low input sustainable agriculture, resource conserving, biological, natural, eco-agriculture, agro-ecological, organic, biodynamic and

Copyright © 2014 IJAIR, All right reserved

permaculture. The term sustainable refers to resource-conserving, low input and regenerative agriculture with greater use of local resource and knowledge.

Green or sustainable agriculture improves water use efficiency as well as minimizing soil erosion. The practice produces minimal disturbance of top soil and maintains adequate ground covers of organic carbon matter [22]. Through these practices, agricultural resilience and adaptability to climate variability and change and reduced dependence of agro-ecosystems to fossil fuel hydrocarbon resources has been demonstrated. Sustainable agriculture should improve the farmer's livelihood and guarantee consumers adequate and nutritional foods while also maintaining the valuable ecological services.

Altieri [1] and Nilmi [10] gave some principles behind sustainable agriculture such as:

- Increasing the recycling of biomass and achieving a balance in nutrient flows
- Assuring favourable soil conditions, keeping the soil covered with mulch or cover crop, guaranteeing high level of soil organic matter and an active soil biology
- Minimizing nutrient losses from the system, through relatively close, rather than open system design. Promoting the functional diversity of the system, including within and between species diversity, above and below-ground and landscape level biodiversity.
- Promoting increased biological interactions and synergisms among system components that can sponsor system services like regenerating soil fertility and providing pest management without resorting to external inputs.

It is evident that there is no single strategy that can be used to deliver all these requirements. The method or combination of techniques to be used is dependent on the farmer and the available agricultural resources. Each farmer should be determined to limit the negative effects of agriculture on the environment while also reducing food insecurity and poverty.

The following are some of the suggestions that have been provided in literature as way forward:

- Organic farming - what about the cost element/ affordability and which crops should be targeted?
- Improvements in food production and trade-how? (land reform?, new Green Revolution?, appropriate technology?-wells and small dams for drip irrigation, organic fertilizers, simple farm tools and mixed farming with crop rotation)
- Timely climatic information to farmers accompanied by Improvement of Socio-economic, demographic factors and health factors – age, experience, health, household size
- Development of the 15 crops of most international or regional importance–sorghum, millet, potatoes, sugarcane, sugar beet, soybean, sweet potatoes, beans, bananas, plantains, cassava, groundnuts, pigeon pea, lentils, and cowpea together with Infrastructure and communication improvement (roads, banking facilities, markets), Food price controls that incorporate production, consumption and development, as well as Subsidy and grants to farmers
- Urban agriculture

All the above proposed solutions are important in increasing food security and reducing poverty but seriously require innovations from the farmer on how to address environmental impacts. The most challenging is urban agriculture, due to increasing food needs in cities from human populations in urban areas, diminishing resources (land, water, energy, among others), and climate variability and change.

V. Imperatives for African Urban Agriculture for Agricultural Sustainability

Urbanization in many developing countries has given rise to concentration of urban poor in cities who migrate from rural areas. It has been established that currently, over fifty percent of the world's population reside in urban areas, with 800 million of them engaged in some form of agriculture for income-generation, food security, or recreation.

Urban agriculture refers to the practice of cultivating, processing and distributing food within and around a town. Urban and peri-urban agriculture can be defined as: "Agriculture practices within and around cities, which compete for resources (land, water, energy and labour), that could also service other purposes to satisfy the requirements of the urban population" [23].

Other forms of urban agriculture include horticulture, livestock, fodder and milk production, aquaculture and forestry.

Urban agriculture creates several opportunities, which are important for sustainability of agriculture in Africa. For example, there is less need for packaging, storage and transportation of food required. High potential for agricultural jobs and income exist, together with non-market access to fresh food for poor consumers. Urban centres also offer proximity to services, including waste treatment facilities, recycling, with possibilities for re-use. Increased use of urban land for agriculture is important in mitigating many of the ecological problems associated with urban development. It is beneficial to the natural environment, humans and urban sustainability. The use of urban land for agriculture enables water to filter into the soil, reduces the effect of urban heat island and increases evapo-transpiration, thus improving the ambience. The vegetation helps in filtering the air, while raised gardens or frequently monitored urban gardens have minimal soil pollution and therefore produce healthy foods for the urban population. The urban areas are also known for increased biodiversity 15][24].

However, it is important to note that urban areas are quite often susceptible to high temperatures (due to minimal green spaces) and flooding (as a result of poor drainage or blockage of waterways), which when not mitigated, can contribute to high frequency of hazards and disasters in cities. The section below shows how urban agriculture in Africa can be harnessed to take advantage of the opportunities offered by cities, while also encouraging sustainable agricultural practices.

Copyright © 2014 IJAIR, All right reserved

Organic compost fertilizers can be produced from the neighbourhood by collecting biomass wastes, crop residues, tree litter, livestock manures and other photosynthetically produced matter and turning it to compost fertilizer. The use of organic nutrients would enable the urban farmers to return soil nutrients and organic humus to farm to reduce dependence on inorganic fertilizers. The use of organic compost fertilizer would increase soil organic carbon levels, improve soil structure, enhance water percolation and retention capacities and sequester significant amount of carbon dioxide, thus reducing significant amounts of greenhouse gases in the atmosphere. Processing of organic fertilizers would create job opportunities for the urban youth and those living in informal settlements and enable the re-use of organic wastes that would otherwise accumulate and raise environmental concerns.

One of the greatest threats to urban agriculture is contamination from chemical inputs and heavy metals. In cases where inorganic fertilizer is used, the urban farmer should avoid over-use of chemical inputs that degrade freshwater resources, enhance greenhouse gas emissions and pose health risks to the household and urban consumers. Excessive use of pesticides and herbicides interfere with the functioning of biodiversity while also reducing other benefits of agricultural production.

Reduce till or no till practices should be used, particularly around river catchments, where most informal settlements exist to reduce top soil disturbance, protect the soil surface and gradually return organic nutrients and carbon to the soil. The practice also reduces labour costs to the farmer.

Degraded land in urban and peri-urban areas can be restored through integration of vegetative and riparian buffers, field terracing on steep sloped terrain and agroforestry inter-cropping to capture rainwater and reduce run-off. The excavation of shallow depressions to capture and concentrate water can provide adequate water for horticulture, which is common and very lucrative in most cities.

Where possible the urban farmer should diversify the agricultural operations by integrating crop and livestock production for improved soil fertility, biodiversity, nutrition as well as incomes. The urban agriculture must be integrated with the wider rural agricultural production through appropriate policy framework for sustainability.

Besides the sustainable agricultural practices, efforts should be made to deal with demographic issues, though proper planning of cities, maintaining sustainable population growth rates and managing consumption patterns. Research, education and capacity building should be key when determining the technological approaches that increase food productivity, while also conserving the environment, particularly in urban areas. Education and capacity building enable populations to expand their knowledge base, take advantage of the opportunities and make the right choice, including those of reproductive health.

Efforts should be directed to assisting countries attain their Millennium Development Goals to reduce both urban and rural poverty and food insecurity. Poor people view reproduction as an investment activity and an insurance against high infant mortality, crowd in urban informal settlements (which are difficult to plan) and are vulnerable to disasters in urban areas. Innovations for wealth creation are urgently needed that would convert the mass population living below poverty line to middle income individuals to enhance sustainability.

VI. Conclusion

One of the gaps identified in this study was the need for innovations that would contribute to enhanced agricultural productivity, particularly, among small-scale farmers. For instance, agricultural intensification, though important practical choice among small farmers, would require re-evaluation to minimize adverse environmental impacts and ensure sustainability. The study revealed that scholarly articles in the area of sustainable agricultural practices are still quite sporadic, yet it is a fundamental aspect of sustainable development. Further research on eco-agriculture remains very relevant as the world must feed the increasing human populations alongside the diminishing environmental resources. On all these approaches, urban areas should be viewed as vital opportunities to develop and expand high value, smallholder, and sustainable agricultural practices.

References

[1] Altieri, M. (2002) Agroecology: the science of natural resource management for poor farmers in marginal environments, *Agriculture, Ecosystems and Environment* 93, 1-24.

[2] UN-HABITAT (2011), Global Report on Human Settlements 2011: Cities and Climate change; Earthscan, Nairobi, Kenya

[3] UNEP (2008) *Green Jobs: Toward decent work in a sustainable, low-carbon world*, UNEP, Nairobi, Kenya.

[4] Pengra B, (2012) *One Planet, How Many People? A Review of Earth's Carrying Capacity: A discussion Paper for the year of Rio+20, Nairobi, UNEP.*

[5] UNEP (2011) *Towards a Green Economy: Pathways to sustainable development and poverty eradication. A synthesis for policy makers*, UNEP, Nairobi, Kenya.

[6] FAO (2006) Food Security and Agricultural Development in Sub-Saharan Africa: Building a case for more Public Support: Main Report, Policy Assistance Series 2, Rome, Italy.

[7] FAO (1996) International Technical Conference on Plant Genetic Resources held in Leipzig, Germany, 23 June.

[8] FAO (1997) Highlights. Population Reports, Vol. XXV, No 4, The Johns Hopkins School of Public Health, Baltimore, United States of America.

[9] Binns, P. (2012), *Perspectives: opportunities and challenges facing farmers in Transition to Green Economy Agriculture Practice*, UNEP, Nairobi, Kenya.

[10] Hilmi, A. (2012) *Agricultural Transition: a different logic*, The More and Better Network, Rome, Italy.

[11] Oluoko-Odingo, A.A. (2011) Vulnerability and Adaptation to Food Insecurity and Poverty in Kenya. *Annals of the Association of American Geographers* 101, January 2011. (http://dx.doi.org/10.1080/00045608.532739)

[12] Monsanto (2010) KUZA: Advancing Agriculture in Africa 21.

[13] Eicher, C. and Staatz, J.M. (1990) *Agricultural Development in the Third World*, London, John Hopkins University Press.

[14] Boserup, E. (1990) Population, the status of women and rural development, in McNicoll and M. Cain (eds) *Rural and Development Review* 15, The Population Council, New York, United States of America, 45-60.

Copyright © 2014 IJAIR, All right reserved

[15] Mollison, B. (1988) *Permaculture: A Designer's Manual*, Tagari Publications, Sisters Creek, Australia.
[16] Mellor, J.W., Delgado, C.L. and M.J. Blackie (1987) *Accelerating Food Production in Sub-Saharan Africa*, The John Hopkins University Press, Baltimore, United States of America.
[17] Schultz, T.W. (1964) *Transforming Traditional Agriculture*, Yale University Press, London, United Kingdom.
[18] Ehrlich, P. and A. Ehrlich (1990) *The population Explosion*. Simon and Schuster, New York, United States of America.
[19] Malthus, T.R. (1798) *An Essay on the Principle of Population as it affects the Future of Improvement of Society, with the Remark and Speculation of Mr. Godwin, M Condorcet and other writers*, London, (ldt Ubers von CM. Barth, Munchen F177).
[20] UNEP (2007) Global Environment Outlook 4, www.unep.org/geo4_report_full_en.pdf. Accessed 1 April 2014.
[21] Global Footprint Network (2005) Global Footprint Network 2005 Annual Report. www.footprintnetwork.org/images/article_uploads/2005_Annual_Report.pdf.
[22] UNEP (2012) GEO5: Environment for the future we want, UNEP, Nairobi, Kenya.
[23] Food and Agriculture Organization of the United Nations (FAO) (2013) FAO Regional Workshop to increase urban and peri-urban Agriculture. www.fao.org/asianpacific/rap/afts/news/detail/en/?no_cache=1&news_nid=168862. Accessed 1 April 2014.
[24] Gittleman, M.; Tufts University and American Studies, 2009. The Role of Urban Agriculture in Environmental and social sustainability: Case of Boston, ase.tufts.edu/polsci/faculty/portney/gittlemanThesisFinal.pdf. Accessed 25-04-2014
[25] FAO (1981) Agriculture: Toward 2000. FAO, Rome, Italy.

Copyright © 2014 IJAIR, All right reserved