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Agricultural Transformation and Population Nexus: Some Theoretical and Empirical Lessons for Sub-Saharan Africa

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Abstract

Compared to other regions in the world, agricultural performance in sub-Saharan Africa (SSA) has for many decades been deteriorating. Theoretically, it has been argued that rapid population growth could be responsible for not only deteriorating agricultural performance but also to environmental degradation. On the other hand, the Asian Green Revolution of 1960s has been reported as a success story in terms of transforming agriculture and improving food security in the context of increasing population in countries such as China and India. This article reviews the Malthusian theoretical ideas and their relevance to agricultural transformation in the African context and sub-Saharan Africa in particular. It further discusses empirical evidence emanating from sub-Saharan Africa in relation to agricultural productivity, population growth and the integrity of the environment. Based on ensuing discussions, the agricultural sector in SSA needs to be transformed, and theoretical arguments that negate the Malthusian stance are really relevant in this sub-continent. It is further stressed that replicating the Asian Green Revolution will not work perfectly in SSA because of variations in context based on policy, institutional, and structural arrangements. Therefore, transforming agriculture in this sub-continent is not an easy and straight forward task; rather, its success will depend on the interplay between policy interventions, integrating the agricultural sector with other sectors of the economy, active participation of different stakeholders, as well as government mediations.

Keywords: *agriculture transformation, Green Revolution, population growth, environmental degradation*

1.0 Introduction

The relationship between agricultural transformation and population dynamics is of great importance in Africa in general and sub-Saharan Africa (SSA) in particular. This has raised a growing concern for integrating population variables in development on the one hand, and maintaining the integrity of natural environment on the other (Marquette, 1997a; Marquette, 1997b). Agricultural development needs to integrate population dynamics and the natural environment to ensure that what is produced is not only enough to feed the increasing population but also to stimulate sustainable broad-based growth at national, regional and international levels. This article focuses

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on agricultural transformation and population nexus in sub-Saharan Africa. It begins by discussing some theoretical arguments, and further discusses some available empirical evidence. The article argues that population growth by itself is not a problem with regard to agricultural productivity as well as environmental concerns, and that it cannot hinder agricultural transformation provided requisite policies, structural and institutional arrangements are put in place. What SSA should worry about is the structure of the population as well as rural-to-urban migration. Agricultural transformation is conceptualised in this article as a process whereby individual farms shift from subsistence oriented and highly diversified farming towards more specialised production oriented farming (Staatz, 1998). The process encompasses reliance on input and output delivery systems; integrating agriculture with other sectors of the economy nationally, regionally, and internationally; commercialisation; broad-based smallholder farmers' development; as well as intensification in terms of labour, land, capital and technology. In addition, the process occurs when a considerable number of households have moved up the poverty line, investing more heavily on the farm, and also, adopts new technologies regularly (Nindi, 1993; Seckler, 1993; Staatz, 1998).

Scholars clearly portray SSA as characterised by the fastest growing population compared with other regions in the world. Further, agriculture which employs and supports livelihoods of the majority in the sub-continent has for many decades been deteriorating. The implication is that SSA is in a food crisis. The concern of this article is whether population growth in SSA is or can be a constraint to agricultural transformation as theorised by orthodox Malthusians. The article contributes theoretically and empirically to the discussion as well as to the knowledge about agricultural transformation and population nexus. It further raises some policy, structural and institutional issues necessary for transforming agriculture in the context of increasing human population.

1.1 Classical and contemporary population theories revisited

In many instances, economists and development practitioners have attempted to establish linkages between population, food, environment and economic development. The debates on this nexus have been basically inspired by ideas from a classical economist and clergy, Thomas Malthus and later the protégés of Malthusian school of thought. The Malthusian school of thought claims that population grows at a very high pace compared to food production and thus it can more broadly outperform economic growth and development (Nafzinger, 2006). Ricardo's hypothesis here is that resources such as land are fixed and that increasing labour force through population growth would lead into low output per capita and in the long-run cause diminishing returns (Boserup, 1996; Wils, 1996; Castro, 1997). The Malthusian orthodoxy postulates that rapid population growth could exceed the earth's carrying capacity, natural resources base, and finally lead to serious environmental problems and widespread food shortages (Urdal, 2005). This would eventually lead to a subsistence standard of living among the population. Nevertheless, this postulate has been contested and history has somehow proved these arguments apocalyptic.

Despite the fallibility of the Malthusians' pessimistic view, they however stimulated a discourse among economists and other development thinkers regarding the synergy between population, food, agricultural technology, environment and development (Marquette, 1997a). Most of the ideas that evolved among others were succinctly those stressing that population increase exerts more pressure on land and eventually culminates into environmental degradation because even the marginal lands are cultivated to support the increasing population (May, 1993; Pimentel *et al.*, 1996; Castro, 1997; Holden & Sankhayan, 1998). To exemplify this, May (1993) presents the case of Rwanda, that its population growth of about 3.2% per year had already resulted into decreased fallow periods of agricultural lands and utilisation of marginal lands and thus causing soil degradation, and that pasture and forest lands have been converted into cropland in Rwanda.

It should be observed however that the orthodox Malthusians advanced their ideas within the European context during pre-industrial as well as pre-agricultural revolution, and at a time when there was rapid population growth coupled with great hunger. Based on this context, their arguments could probably hold water. On the other hand, the neo-Malthusians epoch was during the economic, hunger and oil crises in Africa in 1970s (Rees, 1990). These situations probably inspired them to conceptualise and cement their ideas and were seemingly correct during that particular period and context. An important point to note is that the orthodoxy and neo-Malthusians concentrated on population growth rates without considering higher dependence ratio and other population dynamics such as rural-to-urban migrations and how these could affect food and agricultural production especially in sub-Saharan Africa.

The anti-Malthusians such as Ester Boserup, Julian Simon and other classical economists who wrote during the post industrial and agricultural revolution in Europe constructively raised counter arguments against the orthodox Malthusian trap (Castro, 1997). The anti-Malthusians presented the role of science and technology in agricultural production for increased productivity (Marquette, 1997b). For example, Ester Boserup and Julian Simon maintained that increasing population leads into two important things: first, increased demand for food; and second, improved agricultural productivity through adoption to new technologies and innovations by the farmers. These two observations lead into increased food production per capita and eventually support the increasing population, thus negating the pessimistic view of the Malthusian orthodoxy (Marquette, 1997a; Chrispin & Jegede, 2000).

Put differently, population growth is a critical pre-condition for technological innovations in agricultural production. The pressure which can be created by rapid population growth on the environment and other resources such as land, acts as a development promoting factor within Boserupians' framework. Increased pressure on land for instance, may prompt farmers to adopt improved land utilisation technologies such as better cropping systems, use of irrigated agriculture, as well as use of industrial and organic fertilisers, herbicides and pesticides (Rees, 1990; Nerlove, 1995). The challenge remains on how to accommodate environmental problems such as soil degradation and environmental pollution which might emanate from intensive irrigation schemes and use of agrochemicals and other technologies.

1.2 Relevance of the theoretical ideas to Sub-Saharan Africa

Human population in LDCs and SSA in particular, is increasing rapidly. Out of more than six billion people in the world, about 80% are found in LDCs including SSA (Nafzinger, 2006). A salient feature of human population in Africa and SSA, is that the population is mainly of young people. Put differently, the dependent age group is large compared to the older ages. For example, in the 2002 population and housing census of Tanzania, 44% of the population was in the age group between 0 to 14 years (URT, 2003). Most of SSA countries have this kind of population structure. By implication, increasing fertility rates in SSA will substantially increase the dependency ratio and definitely increase demand for food and agricultural production. Marquette (1997b) wrote extensively about the Boserupian relevance in SSA. Marquette's thinking was theoretically relevant in that, like other parts of the world, the growing population in sub-Saharan Africa (SSA) managed to go through different techniques and/or systems of agricultural production to preserve and improve the fertility of the land.

Marquette (1997b) also pointed out that by 1990s, there was more land in Africa than the sparse population needed for growing crops. Until today, many societies in Africa still practise extensive land use subsistence systems including pastoralism. In addition, less than 25% of arable land in Africa is under cultivation, while large areas are used as pasture, forest or grassland (Marquette, 1997b; Collier & Gunning, 1999). It is said that population growth rates in SSA are currently higher than they were in Europe during the 19th century. This has led the region to heavily depend on food imports (Rooyen, 1997). Based on the population pyramid, food shortage is likely to accelerate in SSA. It is imperative therefore SSA adopts agricultural technologies as proposed by Boserupians, coupled with population policy and interventions to address higher dependence ratio which would result into agricultural intensification and possibly become the solution to the poor agricultural performance in SSA. Additionally, other structural and institutional arrangements such as credit provision and extension services need to be strengthened never mind drought which can be addressed through establishment of large-scale irrigation schemes.

As earlier stated in this article, one of the short-term solutions to address food shortage is food importation. This is increasingly becoming a common norm in SSA. Three reasons are reported to cause food problems in the sub-continent (Marquette, 1997b). First, rural infrastructure for example roads are largely impassable, and there is inadequate use of agricultural inputs. Second, there are poor land tenure systems that often lead to disputes over land rights; and finally, there is over-dependence on food imports to feed the growing population. Further, climate variability and change in SSA, particularly frequent drought and floods, are likely to exacerbate the problem. These call for urgent agricultural transformation through, among other things, agricultural technologies as contended by the Boserupians. Nevertheless, we should hastily add that Boserupian ideals should be supported by good policy, and structural and institutional arrangements. In addition, agricultural productivity and the environment should not be left to the vagaries of free market forces currently sweeping the globe; otherwise SSA might fall into the orthodox Malthusian trap. Further, the physical environment specifically land, may become highly degraded to the extent that it might not be able to produce enough to meet the food demanded by the increasing population. In other

words, there should be checks and balances between population increase in terms of dependency ratio, environment and agricultural production in terms of policy, and structural and institutional frameworks to ensure that what is produced is not only for subsistence purposes but also for stimulating broad-based growth in a sustainable and environmentally friendly manner.

1.3 Rural-urban migration and agriculture

Agricultural productivity is decreasing in LDCs (Institute of Development Studies, 2006). Short-term solutions have included importing food from outside; nevertheless, importing food is not a rationally sustainable solution because it can exacerbate deterioration of agricultural production and lower productivity. Further, it can also intensify the loss of productive and economic active groups in rural areas through enhancing rural-to-urban migrations. Theoretical and policy implications of rural-to-urban migration on food and agriculture have been extensively researched in SSA (Harris & Todaro, 1970; Byerlee, 1974; Rooyen, 1997; Zhang & Song, 2003; Lucas 2004).

Most migrants are school dropouts, young and energetic and who constitute the large labour force in the rural sector (Byerlee, 1974). The relationship between rural-urban migration and agriculture invokes two contrasting theoretical strands. First, rural-to-urban migration leads into deterioration of per capita agricultural productivity in rural areas in SSA because it decreases the labour force (Byerlee, 1974). The deterioration of per capita productivity in turn exacerbates rural-to-urban migration and thus completing the vicious loop. This situation may negatively affect food production and the share of the agricultural sector to Gross National Product (GNP) as it is now happening in most SSA countries including Tanzania. With these observations therefore, despite the importance of the agricultural sector in SSA national economies, the sector may progressively become a risky enterprise in the region. This in turn will increasingly make the rural areas unattractive to live in, so triggering mass exodus of the young and energetic labour force to urban areas where the infrastructure and other economic opportunities are deemed to be much better. However, this theoretical strand overlooks the issue of rapid urbanisation coupled with high unemployment rates which is now a reality in most cities of Africa. Life in urban areas is not that rosy and sooner than later this might probably become a disincentive to curtail rural-urban migration.

The second theoretical strand posits that agricultural productivity is inversely related to the size of the rural labour force especially in developed countries (Harris & Todaro, 1970). Extrapolating on this thesis, it is deemed that decreasing agricultural labour force results into increasing agricultural productivity. In other words, rural-to-urban migration may result into increased agricultural productivity though the rural labour force may be decreasing. For example, Lucas (2004) observed that agricultural labour force decreased from 21% in 19th century to 2% in 20th century in Britain. Over the same period labour force decreased from 79% to 3% in the USA. In all these countries, food crop productivity increased during the same period. Although what happened in these countries was attributed to intensive adoption of new agricultural

technologies and hence improved agricultural production and productivity, it was also the case that more people became urbanites as a result of rural-urban migration and therefore left big areas of land free for large scale agriculture.

In explaining the driving forces of rural-to-urban migration, economists have used mainly the Labour Surplus Model. Based on this model, a co-existence of two sectors is considered in a developing economy: the traditional rural sector and the modern urban industrial sector. As explained by Zhang and Song (2003), Harris and Todaro (1970) and Byerlee (1974), the relationship between these sectors is that the traditional rural sector is becoming deprived of surplus labour whereas the modern urban industrial sector is gaining labour force. The driving forces of rural-to-urban migrations are theoretically mentioned to include: differences in expected income between rural and urban areas; agricultural land scarcity in the rural areas; and government policies that tend to be pro-urban and distorted public investment distribution. For example, using a Regression Model, Zhang and Song (2003) analysed both time-series and cross-section data to investigate the driving forces of rural-to-urban migration in China. In the time-series analysis, the dependent variable was the number of net migrants in the urban areas over time. Results showed that economic development in urban areas significantly contributed to rural-urban migration. On the cross-section data, the dependent variable was share of emigrants in total agricultural population. Findings revealed that rural-urban migration was positively and significantly caused by income gaps between rural and urban areas. Normally, rural areas are characterised by low income than urban areas especially in LDCs and SSA in particular. In addition, migration was higher in rural areas, in terms of physical distance to urban areas.

Despite the fact that in China many people have migrated into urban areas, the majority of Chinese who are still living in rural areas are currently not planning to migrate into urban areas. One major reason for this interesting observation is the existing arrangement of land management in rural areas (Zhao, 1999). This land related technologies provide disincentive for rural-urban migrations in China. Based on these findings from Britain, USA and China, SSA can borrow a leaf about how to reduce rural-urban migration which is currently on the increase. One of the issues SSA needs to seriously consider in addition to land management technologies is secure tenure and ownership of land and clearly defined property rights. Furthermore, SSA needs to address the issue of unequal income gap and distorted public investment distribution between rural and urban areas so as ensure equity in growth of both areas. This is a tall order given that economic planning in most countries in SSA is under the dictate of global capital. In a nutshell, SSA needs to improve the agricultural sector by intensifying and integrating agriculture with other sectors of the economy so as to curtail rural–urban migration rather than rely on restrictive migration and population policies.

2.0 Population and agriculture: Empirical evidence

Harris (2001) reports that global population growth rate decreased from 2% in 1960s to 1.4% in 2000. Despite this marginal decrease in population growth rate, the annual world population increase was still high. Based on population growth rates,

Nafzinger (2006) categorised the world into three major groups: Developed Countries[3] (DCs), within which population grows at less than 0.8%; Newly Industrialised Countries (NICs), within which population grows between 0.8 and 1.8%; and Least Developed Countries (LDCs), within which population grows at 1.9% and above. Currently, estimates indicate that the world population is above 6 billion and LDCs including SSA constitute more than 80% of world population (Nafzinger, 2006). Projections reveal that by 2025 population growth rate in LDCs will have risen to 2.4% (Nafzinger, 2006).

What accelerates population growth rate in SSA includes high fertility rate and decreasing infant and under-five mortality, and so resulting into a big number of dependant children aged 0 to 14 years (URT, 2003). As stated elsewhere in this article, a small proportion of labour force in SSA supports too many dependants. This kind of population structure creates serious problems as resources such as food, health services, education and other social services have to be allocated to the young (dependants). By implication, this may negatively affect the amount of resources and budget allocated to the agricultural sector for the purpose of agricultural transformation.

More than 70% of the population in LDCs, Africa and SSA in particular, live in rural areas (Rooyen, 1997; Gabre-Madhin & Haggblade, 2001), and depend on agriculture for food and general livelihood. Those who live in urban areas also substantially depend on agricultural productivity for their survival. In some countries such as Tanzania, about 80% of the population in rural areas depend on agriculture (DTU, 2003). Following these observations, it is obvious that agriculture is a very important sector for improving the standard of living in SSA. However, agricultural growth, per capita food output and contribution of the sector to the Gross Domestic Product (GDP) in Sub-Saharan Africa have for many decades stagnated. For instance, for about three decades between 1960s and 1990s agricultural growth marginally increased by 0.1% (Cleaver, 1995). Further, Sautier *et al.* (2006) reported that the share of agriculture to GDP in SSA decreased from 38.1% in 1965 to 17.0% in 2005. Despite these decreasing trends, population growth was skyrocketing at about 3% per annum (Seckler, 1993; Cleaver, 1995) and by implication, increasing dependency ratio and many mouths to feed. For instance, in 1990s, estimates showed that about 786 million people in the world were hungry and the majority were found in Africa particularly in SSA (Rosset, 2000). This means that SSA needs to do a lot in terms of agricultural transformation through intensification, improved technologies, appropriate policy, structural/institutional arrangements and also creating a functional agricultural-industrial continuum so as to become food secure. Literature shows that one of the viable options in improving agricultural productivity and eliminating food shortage could be adoption of the Green Revolution technologies coupled with population policies that will in future work towards reducing the dependency ratio.

[3] Developed Countries include: European countries, North America, Australia, New Zealand and Japan; Newly Industrialised Countries include: countries in East and South East Asia, Latin America, Argentina, Chile, China, Taiwan, South Korea, Thailand, Vietnam, Indonesia and Sri-Lanka; and Least Developed Countries include: most of African Countries, Asia and Latin America (Nafzinger, 2006).

2.1 *Agriculture and Green Revolution technologies*

Improving food production through agriculture has been practised by the human population for many decades the world over. This effort culminated into what is called the Green Revolution during the 1950s and 1960s starting from the United States of America to Southwest Mexico and then spreading to Asia, Latin America and later on to some parts of Africa (Rosset, 2000). Green Revolution makes intensive use of high yielding varieties (HYV) such as improved seeds, fertilisers, pesticides and irrigation in order to increase production per unit area of food crops. The success stories have been reported in countries including China, India, Malaysia, Vietnam and Indonesia. By 1980s, countries such as India had become self-sufficient in food as well as net food export (Singh, 2000). Ironically, there are many people who are still hungry in India not because of little food but because of poverty; they are unable to purchase food which is readily available due to their poor purchasing power.

Arguably, the Chinese Green Revolution of the 1960s was probably the most effective in transforming agriculture as well as addressing the question of hunger to the rural poor than other parts of the world. China is currently able to feed her 1.3 billion people (URT, 2006a). This could be attributed partly to the fact that in line with the Green Revolution, China adopted broad-based changes in terms of land tenure systems. Communal land ownership became a strategy for transforming agriculture in China. This largely created a better environment for agricultural mechanisation.

Development practitioners are currently debating about the fact that Africa needs an alternative Green Revolution rather than adopting experiences from Asia and Latin America. The reason is that diversities exist between and within SSA countries based on poor infrastructure, immense size, and reliance on rain-fed agriculture (IDS, 2006). Other pertinent issues include lack of credit provision and fertiliser subsidisation to smallholder farmers. Further, smallholder farmers in SSA own very small pieces of land not efficient for mechanisation. Land grabbing by private investors is another serious concern regarding agricultural transformation, and it is likely to exacerbate the problem. It is cautioned that the Green Revolution alone, as it was practised in Asia and Latin America, will not transform agriculture in SSA, unless the approach is accompanied by many other cross-cutting interventions. Some of such interventions might include improving:

- access to land and purchasing power to the poor;
- access and adoption of agricultural technologies, addressing the question of high dependency ratio and poverty;
- partnerships among producers, suppliers, marketers, policy makers and farmers;
- access to markets and credit;
- access to new technologies including environmental sound technologies and natural resources management;
- empowerment to women because they provide most of the labour force in agriculture; and
- government budgets to agriculture to the tune of not less than 10% per annum (Rosset, 2000; IDS, 2006).

Smallholder farmers in Africa are affected by many factors compared to big farmers in developed countries. For example, during the harvesting period, farmers sell their produce at very low prices, but during food shortages they buy food at very high prices. This reflects poor commodity price and market arrangements in Africa (Goletti *et al.,* 1995). Further, poor farmers in Africa cannot afford to buy enough fertilisers and other agricultural inputs in big volumes compared to farmers in developed countries who are subsidised by their governments. Water is also limited and the problem is likely to exacerbate given the impact of climate variability and change. African poor farmers cannot access irrigated agriculture; and agricultural credit though essential, is not readily available to the poor farmers in the sub-continent. As such, the adoption of agricultural technologies has for many decades stagnated compared to other regions in the world (Nindi, 1993; Seckler, 1993; Cleaver & Donovan, 1995; Singh & Hossain, 1995; Mwangi, 1995; Karshenas, 1999; Kherallah *et al.,* 2000). Following these observations, in order to transform agriculture the Green Revolution in SSA should in the first place address economic as well as political issues regarding adoption and use of agricultural fertilisers. Of much importance, free-market policies on agriculture should be minimised or avoided through government intervention. Put differently, SSA governments should intervene by, among other things, subsidising farmers as developed countries do; and providing or improving access to agricultural credit as well as supporting farmers in terms of improving irrigation infrastructure. Data from Karshenas. 1999) indicate a significant decrease in fertiliser application from 1980s to about mid-1990s (Table 1 and 2). This can partly be explained by the agricultural reforms occurring in SSA over those specific decades, even though the situation modestly improved by 1997 (Kherallah *et al.,* 2000).

Table 1: Adoption of agricultural technologies in SSA. 1965-1994)

Year	Mean fertiliser consumption (Kg/ha)	Change (Kg/ha)	Mean tractors in use (per 10,000 ha of arable land	Change(per 10,000 ha of arable land	% of irrigated land (mean)	Change in % of irrigated land
1965	4.8	-	14.5	-	2.2	-
1980	12.9	8.1	19.9	5.4	3.8	1.6
1994	12.7	-0.2	22.3	2.4	4.6	1.2

Source: Karshenas, 1999.

The issue of fertiliser subsidisation to farmers is undeniably crucial in transforming agriculture in SSA, despite the fact that it has exceptionally been debated and discouraged. It is essential to emphasise fertiliser subsidies because about 83% of the arable land in Africa has poor soil fertility (IDS, 2006); and in addition, fertiliser use is extremely low compared to other parts in the world. Therefore, the idea is that subsidies would encourage fertiliser application by reducing costs to smallholder farmers, thereby increasing productivity per unit area of arable land. On the other hand, one of the arguments against the introduction of fertiliser subsidies in SSA is to discourage farmers from investing in marginal lands hoping that fertilisers could significantly improve soil productivity and hence improve crop production. Also, subsidies strain foreign exchange and government budgets, which may in turn lead to delayed and inadequate supplies (Goletti *et al.,* 1995). Moreover, it is thought that

fertilisers can be expensive and therefore subsidies may distort local markets. Some strategies to increase fertiliser use in SSA is to subsidise its prices to farmers, secure market for the produce, as well as improve transport infrastructure to facilitate easier transport of fertilisers.

Table 3: Fertiliser application in SSA compared with other regions in the world [1980-1997 (Kg per Hectare)]

Region	1980-81	1990-91	1996-97
Sub-Saharan Africa	8	10	9
Developed Countries	120	112	86
Developing Countries	57	89	107
Latin America & Caribbean	64	63	71
World	88	100	98
East & Southeast Asia	121	179	238
South Asia	37	80	93

Source: Kherallah *et al.*, 2000.

2.2 Green Revolution and environmental degradation

Improving agricultural production through a Green Revolution requires concerted use of high yield crop varieties (HYV) through adoption of appropriate technologies. These often require heavy irrigation and agrochemical inputs such as fertiliser, pesticides, and herbicides. HYV respond positively to chemical fertiliser than traditional varieties. The heavy use of agrochemicals in countries that have undergone a Green Revolution have often resulted into soil degradation (Singh, 2000) and loss of biodiversity (IDS, 2006). After prolonged use of agrochemicals, the soil loses its productive capacity eventually resulting to declining harvests. The implication of this is that a Green Revolution may be only a temporary measure to feed the ever increasing African population, but in the long-run, agricultural productivity may be decreasing following soil degradation. It would be sustainable only if the question of environmental management becomes an integral part of the entire approach from the early conception of the agricultural revolution. This situation has been reported in some countries including China, Philippines, India, North Korea, Indonesia, Thailand, Pakistan, Sri Lanka and Myanmar (Marquette, 1997; Singh, 2000). Put differently, one would be sceptical to vouch for the Green Revolution as a panacea to address food shortage in the world and sub-Saharan Africa (SSA) in particular. Given the need for adoption of a Green Revolution in SSA the challenge then should be the adoption of appropriate technologies that do not compromise the integrity of the environment.

The solution to environmental problems emanating from the Green Revolution technologies may lie on two trajectories: internalising the anti-Malthusians theoretical arguments, and deliberate efforts by governments and other stakeholders to adopt sustainable agriculture which already has increased yield in industrialised countries. Sustainable agriculture is any system of agricultural production that systematically incorporates natural processes,[4] reduces the use of agrochemicals that are potential for

[4] Natural processes include: nutrient recycling, nitrogen fixation and pest-predator relationship (Petty, 1995).

environmental damage, increases use of biological and genetic technologies, and also stresses the use of local knowledge and practices in agriculture (Petty, 1995). Based on the anti-Malthusian theory, environmental degradation emanating from intensive application of agrochemicals may prompt farmers to adopt anti-environmental degradation technologies. In addition, governments must intervene by putting in place appropriate interventions that would emphasise organic farming for sustainable agriculture. According to Mwangi (1995) and Ching (2009), a combination of Green Revolution and sustainable agriculture can enhance food production in SSA, provided policies and institutional frameworks are in place to address environmental and soil degradation that might originate from intensive use of the Green Revolution technologies. While improving food production, sustainable agriculture can also help to reduce emission of Greenhouse Gases[5] from agriculture, estimated to account for 30% of entire global emission leading to climate change (Ching, 2009). Sustainable agriculture can therefore mitigate climate change through carbon sequestration as well as increasing organic matter content in the soils. It is argued here that to ensure environmental sound technologies, the African Green Revolution should integrate and make use of good practices of sustainable agriculture.

3.0 Agriculture and the green revolution in Tanzania

Tanzania's agriculture like other sub-Saharan African countries is still on a subsistence level (Mattee, 1994; Deng *et al.*, 1995). This is characterised by smallholder farmers who occupy about 85% of the arable land in the country and account for about 75% of food production, while using traditional farming practices (Mattee, 1994). Smallholder farmers in Tanzania cultivate not more than 2 hectares. Agricultural production and its share to the GDP have been decreasing over the years (Table 3). For about a decade (from 1996 to 2006), the share of agriculture to the GDP in Tanzania decreased by 2.3% (URT, 2005; 2006b). This suggests that agricultural transformation is truly relevant in the country and should focus on smallholder farmers who are the main producers through, among other things, improving agricultural husbandry with the aim of increasing agricultural productivity as well as improving output per capita.

Table 3: Agricultural growth and contribution to GDP in Tanzania (2004–2007)

Year	Contribution to GDP (%)	Change in GDP contribution over time (%)	Agricultural growth rate (%)	Change in agricultural growth (%)
2004	46.3	-	5.8	-
2005	45.6	- 0.7	5.2	- 0.6
2006	44.7	- 0.9	4.1	- 1.1
2007	25.8	-18.9	4.0	- 0.1
2008	24.0	- 1.8	NA	NA

Source: Economic Surveys (2005, 2006, 2007).

[5] These are gases which cause global warming. Some of the Greenhouse Gases include carbon dioxide, nitrous oxide, and methane (Ching, 2009).

For many years, agriculture has been perceived to be the backbone of Tanzania's economy; nevertheless, this perception has remained just rhetoric as the agricultural sector has remained stagnant. The challenge facing Tanzania is how to ensure that the country is self-sufficient in terms of food production (DSI, 2008). Cognisant of this, the government has been striving to transform agriculture in order to ensure that it is supporting the growing population. Among the actions taken by the government include promulgation of the sector specific policies and programmes anchored on agricultural transformation, e.g. the 1972 Iringa Declaration of *Siasa ni Kilimo*; *Kilimo Cha Kufa na Kupona*; Arusha Declaration of 1967; Tanzania Development Vision 2025; Agricultural Sector Development Programme (ASDP);[6] and the very current one *Kilimo Kwanza* (DSI, 2008; TNBC, 2009).

With the exception of *Kilimo Kwanza* which was launched in 2009, the other programmes mentioned have not yet been able to transform and improve the agricultural sector as expected. This is a serious problem given that Tanzania's population has continued to grow at a rate of 2.9% (URT, 2006a) per annum, exerting great demand on improved agricultural and food production. In 2006, the United Republic of Tanzania reported that Tanzania's population growth had increased by 28.8 million people over the period of about 57 years since 1948. This suggests that Tanzania's population is one of the fastest growing populations in the world and that it would double in approximately 25 years from 36.3 million in 2005. A considerable increase in the population was noted between 1988 and 2002 when agricultural production had substantially stagnated (Table 4 and Fig. 1). The notable increase in the population could partly be explained by some improvements in the health sector followed by decreasing trends in mortality especially of infants and children.

Table 4: Population trend in Tanzania (1948-2010)

Period	Population (in millions)	Change of the population (in millions)
1948	7.5	-
1957	9.1	1.6
1967	12.0	2.9
1978	17.0	5.0
1988	22.5	5.5
2002	33.5	11.0
2005	36.3	2.8
2010		

Source: URT, 2006a.

Data from Mattee's (1994) study and (TNBC, 2009) revealed that for more than two decades since 1986, production of major food crops in the country has not been

[6]ASDP has many priorities all of them aiming at Tanzania's agricultural transformation, they include: irrigation and water management, livestock development, animal health; better land husbandry, crop production and protection, mechanisation, storage and post-harvest, agro-processing, community empowerment, client-oriented research, animal and plant multiplication, market development and infrastructure, research, extension and advisory services to farmers, training and education and marketing and rural finance (TNBC, 2009).

smooth and that it has only marginally improved (Fig 1). Of recent, cereals have been above non-cereal crops production per annum. Even if cereal crops production has been above that of non-cereal crops, patterns have not been uniform as they have oscillated up and down. Wobst and Mhamba (2003) as well as Morrissey and Leyaro (2007) add that such periods of poor agricultural performance were also characterised by increasing poverty especially in rural areas where the livelihood of the people mainly depends on agriculture.

Low agricultural production and poor performance of the agricultural sector in the country could partly be attributed to a number of issues apart from drought. First, like in SSA, new agricultural technologies and/or innovations have not significantly been adopted by the farmers and so subsistence agriculture remains traditional (Mattee, 1994). For instance, fertiliser use per hectare of arable land is very low in Tanzania compared to other countries in Africa and the world at large (Fig. 2). Part of the reason may include poor rural infrastructure and high price of fertilisers. In addition, only 1% out of 44 million hectares of arable land in the country is under irrigation, compared to 2.8% of the cultivated land in Africa which is under irrigated agriculture (Deng *et al.*, 1995; TNBC, 2009). These figures suggest that adoption of agricultural innovations and technologies is very low in Tanzania and this could probably be one of the reasons for the poor agricultural performance in the country.

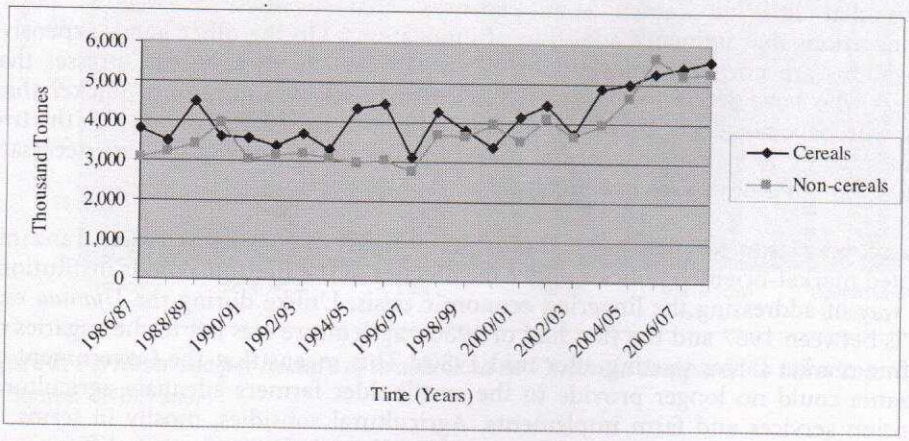

Figure 1: ***Patterns of production of cereals[7] and non-cereal food crops in Tanzania. 1986/87– 2007/08)***

Source: TNBC, 2009

Taking a close look at Figure 1, one notes that between 2003/04 and 2007/08 major food crops production in the country rose a little bit. Such an increase could partly be attributed to the decision by the government to subsidise smallholder farmers by using

[7] Cereals are crops that produce grain, they include in this analysis: maize, millet, rice and sorghum. Non-cereals on the other hand included in this analysis are those crops which do not produce grain, e.g. cassava, bananas, potatoes and pulses (TNBC, 2009).

a Voucher System in the rural areas (IDS, 2006; DSI, 2008). Despite the fact that the government had re-introduced subsidies to the smallholder farmers, it was still not well established whether both farmers and crop transporters needed to be subsidised. The sources of funds as well as the processes to subsidise agriculture were also still unclear besides the challenges of the free market forces (DSI, 2008).

Mattee (1994) admits that the factors influencing adoption of new agricultural innovations are numerous but for clarity, they could be classified into five distinct categories. These include:

- individual farmer characteristics such as age, education and income;
- innovation or technology characteristics such as cost, complexity and suitability;
- institutional characteristics such as quantity and quality of research, extension services, availability of credit and input supply agencies;
- environmental characteristics such as soil type, rainfall patterns and topography; and
- policy characteristics such as income and trade and land tenure policies.

In most of sub-Saharan African countries particularly Tanzania, researchers have not paid adequate attention on farmers' characteristics; so is on policy characteristics. This means that little is known about farmers' characteristics, as well as policy considerations that influence adoption of innovations. On the other hand, expensive innovations are normally poorly adopted by farmers. Further, Mattee stresses that farmers who have access to extension services may adopt innovations quicker than those who have no access. However, findings indicated no difference between the two in Tanzania by 1990s. Environmental characteristics on the other hand, are necessary for adoption of innovations in agriculture.

The second reason for poor agricultural performance is that from 1980s, Tanzania adopted market-oriented policies under the dictates of the Bretton Woods institutions as a way of addressing the lingering economic crisis. Unlike during the *Ujamaa* era, that is between 1967 and the first half of 1980s, agriculture was left to the vagaries of the free market forces starting after mid 1980s. This means that the Government of Tanzania could no longer provide to the smallholder farmers adequate agricultural extension services and farm implements. Agricultural subsidies, mostly in terms of agricultural inputs on credit basis were cut off; and facilitation of diffusion of agricultural technologies to the smallholder farmers was also remarkably reduced. These collectively might have contributed to the lowering of agricultural production patterns in the country.

Wobst and Mhamba (2003) argued that in order to improve and totally transform the agricultural sector in Tanzania, the focus should be on lowering the prices of farm inputs; increasing productivity through enhanced access to new agricultural technologies and innovations as well as increasing agricultural mechanisation that maximises labour productivity without forgetting the question of agricultural marketing and infrastructure development. In short, the study by Wobst and Mhamba

(2003) emphasises government intervention with regard to policy, and structural and institutional arrangements in the agricultural sector, to alleviate the challenges of the free-market economy forces in agricultural development. The challenge however, would still be on the small size of land owned by smallholder farmers in the country which would be unsuitable for agricultural mechanisation.

Moreover, given the lower usage of fertilisers in Tanzania, which stands at nine kilogrammes per hectare of arable land, and which is lowest compared to other LDCs and sub-Saharan Africa, Tanzania cannot expect miracles in terms of improved agricultural productivity (See Figure 2).

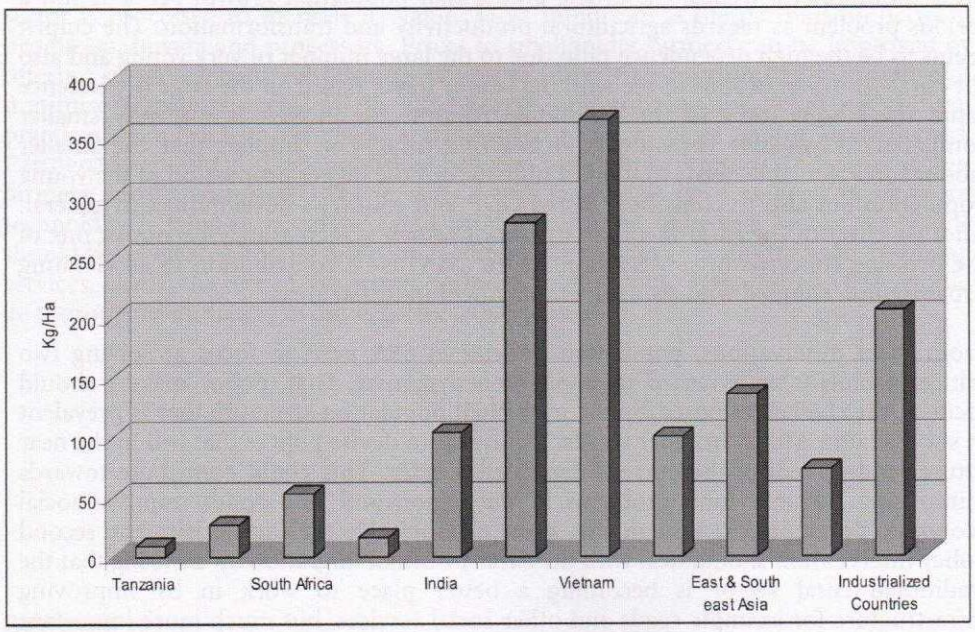

Figure 2: ***Fertiliser use per hectare of arable land in Tanzania compared to other countries***
Source: TNBC, 2009.

In addition to adoption of agricultural technologies, improved markets and other infrastructure, Tanzania's agricultural transformation would also depend on providing access to land to the rural people by specifically bestowing to individuals clearly defined property rights to land. Other relevant issues to be considered in successful agricultural transformation would be enhancing backward and forward linkages, and improving water and energy, research and training, effective institutional leadership and investment environment (DSI, 2008; TNBC, 2009). As stated earlier, a successful Tanzanian Green Revolution will also depend on integrating intensive agricultural technologies in a way that ensures agricultural sustainability by addressing pertinent environmental concerns.

4.0 Conclusion and policy implications

From the discussion, it is evident that agricultural productivity in sub-Saharan Africa is on the decline. Secondly, the dependence ratio is increasing in the region demanding increased food production to cater for the bigger dependent age group and also for supporting a broad-based growth. Further, it is noted that agriculture is not receiving considerable inputs to revamp it. As such, there is food shortage both at micro and macro levels prompting governments to import food to curtail the deficit. Negative externalities due to food shortage are multifaceted, but one that relates to the discussion in this article is the increase in rural to urban migration as agriculture can no longer hold back people especially the youth in the rural areas. However, despite these unimpressive trends, the article argues that population growth *per se* is not a serious problem as regards agricultural productivity and transformation. The culprit seems to be the high dependence ratio due to the large number of very young and also the rural-to-urban exodus of the working labour force. Based on the large dependence ratio, the labour force in the traditional rural sector in SSA is relatively smaller compared to available dependents at any one time. This implies that the smaller labour force available needs to toil not only to feed the bigger proportion of the young population but also to contribute to the GDP and country's development in general. Another effect of the rural-to-urban migration which is increasingly becoming one of the pressing concerns in sub-Saharan Africa (SSA) is its contribution to accelerating urbanisation, coupled with rising unemployment in urban areas.

From these observations, population policies in SSA need to focus at solving two critical problems with regard to population dynamics. First, policy makers should focus at the challenges posed by the pyramidal population structure that is prevalent in sub-Saharan Africa. In other words, SSA needs to devise polices that will in the near future tend to reduce the current dependence ratio. This could contribute towards minimising frequent food problems in the region and as a result improve social economic development, though this alone cannot solve the food crisis. The second policy intervention should deal with the rural-to-urban migration by ensuring that the traditional rural sector is becoming a better place to work in by improving infrastructure for example roads and other social services, but much more important initiating agricultural intensification and transformation.

Further, we are of the opinion that a Green Revolution alone will not transform agriculture in SSA unless it is government-supported in terms of policy, structural and institutional frameworks. Put differently, importing and using the experiences of the Asian Green Revolution *per se* would not transform agriculture in SSA. What is required is drawing experience from the Asian Green Revolution especially the technologies that were used; adopting or internalising the most appropriate experiences and technologies suitable for SSA; and bringing in new ideas to improve the African Green Revolution. The reason is that SSA is in a different context altogether and a lot of variations exist within and between countries in terms of policy, structural and institutional arrangements deemed fundamental for enhancing agricultural transformation. Thus, comprehensive research needs to be conducted to investigate appropriate agricultural technologies suitable for SSA between and within countries. Drought and floods are also increasingly becoming incidences of concern in

SSA, negatively affecting agricultural productivity. Transforming agriculture in the sub-continent therefore needs to consider among other things, mitigation of climate change impacts. In addition to agricultural technologies and infrastructure improvement, policy interventions should also focus on the following: access to land; clearly defined property rights and ownership of land; subsidised farmers in terms of fertilisers; improved irrigation; contract farming; and provision of agricultural credit to smallholder farmers.

It is imperative that the sector should be considered together with other sectors of the economy, such as the industrial sector. Forward and backward linkages and vibrant markets are highly needed to ensure that what is produced by the traditional rural sector is processed to increase its value. Most important is the partnership between producers, buyers and processors. Prices to smallholder farmers can be improved by offering subsidies, contract farming as well as improving transport infrastructure to minimise transport costs. All in all, research and training for better agricultural practices, coupled with extension services need to be in place and/or strengthened. Partnership should also be established between research institutions, industrial sector, farmers and extension services in such a way that what farmers need in terms of technology is what is researched and produced by the industrial sector. The same should be advocated and its diffusion facilitated by the government through extension services. Lastly, the role of the private sector in transforming agriculture in SSA should be thoroughly studied to avoid negative consequences.

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