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Exploring the need and suitability of "The green revolution" in South Africa

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South Africa has for years, been a self-sufficient country in terms of its food resources. However, its food security has been noted to be only at national and not household level. In fact, poverty has remained the major characteristic of most rural communities of South Africa. Rural development and poverty alleviation have therefore been the main focus of the nation's democratic government since it first came into power in 1994. At the same time, other challenges such as the ever-growing population have resulted in the national government having a hard time balancing its efforts and resources to meet the needs of the citizens such as human settlements, jobs, infrastructure, etc. The technologies adopted successfully during the Green Revolution era in Asian countries have emerged as a potential vehicle to drive rural development and address the food insecurity challenges experienced, particularly at household levels. As much as these technologies brought great success and economic growth in Asian countries, concerns have been raised about their suitability in South Africa. This paper attempts to highlight and discuss both the merits and demerits of these technologies with specific reference to the country of South Africa. The idea is to debate their suitability in South Africa so that an informed decision on whether the Green Revolution could be the answer to the nation's rural development and household food insecurity challenges can be made.

Key words: Green revolution, food security, poverty, rural development, population growth.

INTRODUCTION

Hazell (2009) defined the Green Revolution as the introduction of a package consisting of modern inputs such as improved seed cultivars, fertilizers, and pesticides aimed at enhancing crop production to curb escalating hunger and poverty in Asia. The same challenges of hunger and poverty are still well pronounced in Sub-Saharan Africa to date, with millions of rural people undernourished and a growing urban population suffering from high food prices. In fact, literature from Gaus (2012) suggests that Sub-Saharan African countries exhibit the world's highest level of food insecurity and also rank lowest globally in terms of agricultural productivity. At the same time, human population has continued to grow and Haub and Kaneda (2013)

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predicted that between now and 2050, the 51 countries of sub-Saharan Africa will add more population (1.3 billion) than any world region. The region's natural resources are already struggling to sustain the current population as difficult decisions have to be made on how to strike a balance between using these limited resources like land for agricultural and human settlement purposes. Furthermore, the condition of productive land has deteriorated immensely both in terms of quantity and quality due to erosion, overpopulation, overgrazing and global warning thereby promoting food insecurity even more. South Africa is no exception because its food security is only at national level whereas its rural citizens continue to suffer from poverty, malnutrition and food insecurity, with the black community being the most disadvantaged (Hart et al., 2009; Mathole, 2005). In Koch's (2011) view, the country's rural food insecurity crisis is mainly linked to a lack of food purchasing power caused by poverty, unemployment and more recently, steep increases in food and fuel prices, energy tariffs and interest rates.

This is a common phenomenon in most, if not all, developing countries. The big question therefore is how to strike a balance between the available natural resources and the growing population pressure to ensure food security especially at household level. This paper tries to evaluate if the same technologies adopted during the Green Revolution era could be adopted here in South Africa to enable the nation's agricultural sector to provide enough food to sustain the ever-rising population. The Bias is towards crop production since the Green Revolution technologies were limited to crop production.

Problem statement

More than 14 million South Africans (35%) are estimated to be vulnerable to food insecurity, with the majority being the elderly, women and children (Rose and Charlton, 2002). However, rural households are the ones most affected by food insecurity, with 85% of them regarded as unable to afford even the 'below average dietary energy costs' (Jacobs, 2009). In addition, the nation has a 2% annual population growth rate which poses a big threat to food security as the population is expected to rise to at least 82 million by the year 2035 from 49 million in 2009 (Chisasa and Makina, 2012). This could result in a possible shift in government priorities and resources away from agriculture to address the human settlement needs of the citizens thereby putting a further strain on food security. To cope with such an expanding population, either the quantity of food imports will have to drastically increase and/or better farming technologies have to be introduced to increase food production. Furthermore, not only should these technologies result in more output but they should also be suitable for smallholder farmers as these occupy the biggest combined agricultural land in the country and the majority are also located in rural areas where poverty and food insecurity are well-pronounced. Is the Green Revolution approach therefore the solution to South Africa's food production challenges?

SUPPORT FOR THE GREEN REVOLUTION APPROACH FOR SOUTH AFRICA

Proponents of the Green Revolution school of thought have based their opinions on the history of the well-documented agricultural successes that emanated from the modern plant breeding, improved agronomy and the development of inorganic fertilizers and modern pesticides. According to the International Food Policy Research Institute (IFPRI) (2002), the driving factor behind the Green Revolution was the High Yielding Varieties (HYVs) that could mature quicker and grow at any time of the year thereby allowing successful and continuous in and out of season production. Other positive qualities documented by the IFPRI (2002) include making varieties that were very responsive to plant nutrients, and stiffer straw to support the weight of heavier heads of grain. Furthermore, with limited agricultural land available, monoculture was a common practice hence the new plant varieties had to be resistant to major pests and diseases common in such intensive farming conditions whilst not losing their good consumption qualities.

These interventions resulted in huge increases in returns which in turn enhanced the farmers' incomes. Wolf (1986) argued that developing countries increased their cultivated land by only 20% between 1965 and 1980 but managed to increase their rice and wheat production by 75% and thus improving livelihoods. Despite the human population increasing by 60%, the absolute number of poor people in Asia declined between 1975 and 1995 from 1.15 billion to 825 million in 1995 (IFPRI, 2002). Not only did the new interventions enhance total output but they also led to a decline in food prices which automatically improved farmers' real incomes thereby allowing them to afford to diversify their food and attain a more balanced diet. Thus, by raising rural incomes, the Green Revolution contributed to the overall economic development through creating a market in rural areas for non-agricultural products and services which in turn led to new jobs being created and money circulating locally. South Africa's rural communities do need such forward and reverse linkages between different economic sectors, especially if they are self-sustainable. Having such linkages would stimulate rural development and create self-sustaining economies in rural areas thereby creating jobs, enhancing the development of other industries and reducing the need for rural-urban migration, among other things.

The proponents of this school of thought therefore advocated that the re-introduction of these very technologies would revive the dwindling South African agricultural sector and help meet the food requirements of the citizenry. They further pointed out that government and the private sector will have to play a leading role in financing the research and production of HYVs and other necessary inputs such as fertilizers, pesticides and irrigation systems to support the smallholder farmers who are very poor in terms of resources but outnumber their commercial counterparts.

SUITABILITY OF THE GREEN REVOLUTION IN SOUTH AFRICA

The Green Revolution was a great success in "less developed" countries like India, Pakistan, Bangladesh, Indonesia and China. Some of the interventions contributing to its success could also be adopted in South Africa to boost the agricultural sector that has gradually continued to shrink and be overtaken by other sources of income such as social grants as a major source of rural household income. Grain crops occupy more than 60% of South Africa's cultivated land. In fact, South Africa is the main maize producer in the Southern African Development Community (SADC) and exports even to overseas markets such as Japan, Taiwan, Mexico and South Korea. Its commercial farms are mainly in North West province, the Free State, the Mpumalanga Highveld and the KwaZulu-Natal Midlands producing at least eight (8) million tons of maize grain annually (du Plessis, 2003). However, du Plessis (2003) further argued that the current challenge in maize production is that the natural, unmodified maize cultivar is very sensitive to temperature, doing well in warm weather and not so well in areas where the mean daily temperature is less than 19°C or where the mean of the summer months is less than 23°C. As a result, its production in South Africa is only limited to summer when temperatures are warm. The great success stories of the maize Green Revolution in Zimbabwe and Kenya in the mid-eighties show that the same agricultural interventions could be a success in the Sub-Saharan African countries (Eicher, 1997; Karanja, 1993; Hassan and Karanja, 1997). This creates a strong case for adopting them even here in South Africa so that production is perennial.

Another great performer of the Green Revolution era was wheat, which is also the second most important field crop in South Africa. According to DAFF (2010), its production is throughout South Africa and average yield ranges from 1,5 to 3 million t/ha. This includes 2 to 2,5 t/ha under dryland and about 5 t/ha under irrigation, with the Western Cape, Northern Cape and Free State being the largest producers accounting for 84% of production. Two cultivars of wheat are grown in South Africa, the summer wheat meant for temperatures of between 22° and 34°C and winter wheat meant for cool temperatures of between 5° to 25°C (DAFF, 2010). What makes wheat very important in South Africa is that it is used to make bread, which is a staple food in the country. Despite the mass production of the crop, the nation remains a net importer due to excessive local demand, unsteady erratic rainfall due to climatic change and, as some would say, the government's decision to open up the domestic market to the global forces. Poor infrastructure and high transport costs have also led to wheat prices going up and beyond what the majority of the citizens, particularly those in rural areas can afford. It is therefore of paramount importance that local production be increased to curb price increases by stimulating economies of scale through mass-production and also to meet the demand without necessarily increasing the size of the land under cultivation because land too is a limited resource in the country. Intensively cultivating HYVs of the crop seems a reasonable intervention under the circumstances.

Other than wheat and maize, there are a number of other important crops that South Africa is already producing, albeit not adequately. These include millet, sorghum, oats, sugar cane, sunflowers, pulses (such as cowpeas, beans and groundnuts), fruits and vegetables, just to mention but a few. Intervention is needed to enhance their production without necessarily increasing the area under cultivation since land is already scarce. However, evidence from Pingali and Heisey (1999) points at the fact that the agronomists behind the Green revolution only bred HYVs of cultivars of three cereal crops (maize, wheat and rice) and none of the crops that dominate the agricultural sector in countries in the Sub-Saharan Africa like South Africa. If HYVs of these crops have to be introduced, then the onus will be on South African breeders to develop them locally and this will require excessive sums of money.

It is worth noting though that introducing the HYVs of the Green Revolution will always come with both positive and negative effects on the farmers, the economy and the environment, just like any piece of technology. It is therefore critical to assess these drawbacks with particular reference to the South African context to determine if they are worth carrying along for the sake of achieving food security.

CRITICAL DRAWBACKS AFFECTING THE GREEN REVOLUTION'S APPLICABILITY IN SOUTH AFRICA

This new agricultural intervention did not come without some drawbacks, the same drawbacks that have become the backbone of the campaign against the adoption of the Green Revolution technologies by proponents of organic farming in South Africa. It is critical to carefully scrutinize these drawbacks from the South African perspective to

arrive at an informed conclusion of whether to continue and push for their adoption or discard them completely and pursue alternative interventions. What is also important to note is that what could be regarded as a serious challenge in a particular region, nation or group of people could actually be a minor challenge with a simple solution in another. This means that every region or nation is unique in its own way hence even the challenges of the Green Revolution should be analyzed *vis-à-vis* the ability of the nation of South Africa to handle or avoid them through its available resources or lack thereof.

In terms of these drawbacks, the first one documented by Shiva (1991) was that the High Yielding Varieties (HYVs) introduced required large quantities of pesticides and nitrogenous fertilizers for them to perform well and surpass the indigenous varieties.According to Leibbrandt et al. (2010), poverty rates in South Africa have remained very high despite increases in the real income levels of people within different races in the country. This will automatically make the affordability of pesticides and fertilizers to be a huge stumbling block, especially also considering that these are required in large quantities for the Green Revolution to succeed. In fact, Stats SA (2014) documented that at least 25.2% of the nation's population was unemployed by the end of March 2014, the worst rate of joblessness seen since 2008, and not much has been done to reduce this figure thus far. Furthermore, the contribution of wage income and remittances to household incomes has fallen and replaced by social grants whose contribution went up from 2.5 million in 1998 to nearly 16.1 million beneficiaries (or 22 per cent of households) by the end of 2012/13". Such high unemployment and poverty rates suggest that a sizeable number of citizens are not in a position to adopt and sustain these technologies using their own funds even if they wanted to. If Machete (2004) and Eicher's (1994) perception that smallholder agriculture in South Africa is the best way to promote rural development, then the high cost of implementing the Green Revolution techniques will be a great stumbling block.

Smallholder farmers in South Africa are not able to borrow capital due to lack of collateral hence will be left out should such technologies be adopted. Collateral comes in the form of land but even though some communities have agricultural land that they cultivate, they do not have title deeds for these pieces of land, hence do not qualify for financial assistance. Mbilinyi (1997) further wrote that financial constraints also manifest themselves in the form of very high interest rates on borrowed loans as financial institutions try to offset risk in the event that loans are not repaid. This, coupled with very high transaction costs has made smallholder farmers to struggle in their attempts to acquire the needed capital and use their farms as the main source of their livelihoods. Introducing more capital-demanding technologies will not help smallholder farmers at all, unless these technologies are free or at least heavily subsidized – even though subsidies affect the government's financial reserves.

Looking at the impact of excessive use of nitrogenous fertilizers from an environmental point of view, soils tend to suffer and lose vital trace elements that cannot be replenished through these fertilizers. Even though there is proof that replenishing soil nutrients through fertilizers is effective in the short run, soils do need a break and can do with being left fallow for a while. Leaving the land fallow for some time is recommended so that the lost trace elements could be replenished naturally by "Mother Nature". Unfortunately, improved cultivars can grow in and out of season thereby making the land to be cultivated throughout without a fallow break.

The crops' severe demand for water could lead to salinization of the soil which in turn could raise the water table levels in areas where drainage is poor thereby depriving crops of oxygen. Evidence from du Preez et al. (2011) indicates that South African soils already have low organic matter levels; with at least 58% containing less than 0.5% or-ganic carbon and only 4% contain more than 2% organic carbon. Barnard (2000) studied the carbon content of South Africa's topsoils and arrived at a conclusion that the nation is characterized by topsoils with very low organic matter levels. If this is already the case, then intensive monoculture could worsen the situation. It is such findings that led Sanginga (2012) to conclude that Africa cannot achieve the fruits of a Green Revolution without first having a 'Brown Revolution' which refers to the improvement of soil conditions by applying both organic and inorganic fertilizers.

The existing body of knowledge from DAFF (2012) shows that at least 80% of South Africa's agricultural land is mainly suitable for extensive livestock farming, with only 3% of the 12% arable land considered truly fertile land. The Eastern Cape Province is already known as the livestock province of the country due to its high numbers of livestock such as cattle, sheep and goats (Makara, 2010). The vast Karoo areas of the Northern and Western Cape and the Southern Free State also concentrate more on livestock than crop production due to the type of natural vegetation which favours the former. Yet the Green Revolution was solely on crop and not livestock production.

The question that comes to mind therefore is whether these interventions are applicable in a country like South Africa where livestock rearing dominates crop cultivation in terms of land suitability. A census of agricultural households done by Stats SA in 2011 could partially answer this question as its findings show that KwaZulu-Natal (24.9%), Eastern Cape (20.7%) and Limpopo (16.3%) had the highest numbers of households involved in agriculture, with Northern Cape and Western Cape having 1.9 and 2.9%, respectively. Therefore, if expensive interventions as those of the Green

Revolution should be implemented then focus should be mainly on the three provinces with the highest participation in agriculture as these most likely have the skills, experience, dedication and favourable climatic conditions for successful farming.

In addition, the high dependency of these crops on water is a big challenge as the water resource is very scarce in South Africa. According to Scholes (2001), from early 2001 all of the nation's ground water resources have been quite limited, all surface waters had already been committed for use and surplus water was imported from neighbouring countries such as Lesotho to meet the demand. DWAF (2004) further indicated that based on the current and predicted demographic trends, South Africa is likely to have a water deficit of approximately 1.7% by year 2025. Blignaut et al. (2009) concurred with DWAF (2004) and blamed global climatic change and loss of natural habitat for the 6% decline in mean annual rainfall over the last 40 years in the country. Going forward, water scarcity is likely to persist due to demographic changes, urbanisation and a growing middle class society, with higher water, food and electricity demands. At present, the mean annual 464 mm of rainfall in the country is unevenly distributed, way below the world average of 860mm, with only 10% of this water available as surface water, one of the lowest conversion ratios in the world (WESA, 2013). As such, introducing water-draining technologies when the nation's water reserves are already strained will only result in a serious water shortage. At the same time, striking a balance between food production and water preservation is not that easy as both are equally important.

Literature from Hazell (2009) suggests that in order to sustain the high water requirement by the new HYVs, Asian countries invested heavily in infrastructure before the start of the Green Revolution. For example, by 1970, at least 25% of the agricultural land was already irrigated in Asia and India already had 10.4 million hectares under canal irrigation and another 4.6 million hectares of tank irrigated land by 1961 (Evenson et al., 1999). Investment in similar infrastructure continued between 1970 and 1995 thereby making it possible for he irrigated area to grow from 25 to 33%. Such investments are needed in South Africa if the Green Revolution is to succeed because of the high water demand by the new cultivars. Currently, the available infrastructure in the country, particularly in irrigation schemes has dilapidated so much that most of it is not even usable anymore. In keeping with van Averbeke et al. (2011), South African agriculture has gone through the Irrigation Management Transfer (IMT) and revitalization era which commenced in 1990. This was aimed at eradicating poverty and improving the quality of life among black people in rural areas and informal urban settlements by focusing on food security at community or group level through the establishment of small schemes. However, key constraints such as poor management (50% of the cases), water inadequacies (13%), conflict (12%) and theft (7%) have limited the impact of this initiative. Bembridge (2000), Kamara et al. (2001) and Shah et al. (2002) further came to the same conclusion that human (capacity) and social (institutional) resource problems have further stifled the efforts of revitalizing smallholder irrigation schemes in South Africa. Such poor attempts to revitalize the irrigation schemes already mean that successfully adopting the HYVs of the Green Revolution will not yield positive results as these cultivars require large and regular quantities of water.

Other challenges that could threaten the adoption of the Green Revolution technologies include their heavy reliance on mechanization at the expense of labour. South Africa's current high levels of unemployment present a strong case against such technologies that will result in workers, farm workers in this case, losing their jobs and the salaries of those remaining employed pushed down. At present, the agricultural sector is one of the most employment-intensive sectors of the economy, representing about 7% of formal employment in the country (DAFF, 2013). Smallholder agriculture's low "cost-per-job" characteristic puts the sector at an advantage to fight high unemployment rates in the country and drive rural development but then again, the Green Revolution technologies will stifle farm job opportunities as they are more capital than labour intensive.

Conclusion

The discussion above suggest that in terms of the demand for maize and wheat, the country's two most produced and consumed crops, supply is currently almost at par with demand. Deficits only exist when rainfalls are low but this has not been the case since 2001. In fact, the country even has surplus at national level which it exports to SADC and European nations. As such, not much intervention is needed to enhance production at national level. However, this is a completely different case when one focuses on rural citizens without the resources to produce their own crops. Such citizens are still in deep poverty as the majority are unemployed hence cannot afford to purchase the same maize and wheat crops which are abundant at national level. Thus, interventions to improve farm productivity particularly at household level without necessarily cultivating bigger pieces of land are needed in the country. However, evidence suggests that despite the great merits of the Green Revolution technologies, the extent of their negative effects mostly likely renders them not suitable for the nation, especially its smallholder farming sector. Almost all natural resources in the country such as land, water and even fertile soils have been fully allocated. As such,

implementing technologies whose positive impacts are biased towards a single national priority (food security) at the expense of non-renewable resources like water does not seem logical at all.

Furthermore, part of the success behind the Green Revolution in Asian countries was the infrastructure, especially irrigation infrastructure, which was already well-established before the revolution. This infrastructure enabled adequate delivery of water to the crops in the fields thereby boosting yields. Twenty years post democracy, South Africa's irrigation infrastructure is still very poor, especially in the rural areas of Limpopo and Eastern Cape Provinces, the country's poorest provinces despite government's attempts in the Irrigation Management Transfer (IMT) era to revitalize existing schemes in the 1990s. The targeted schemes are in the same rural areas characterized by alarming levels of poverty, unemployment and food insecurity, hence in need of urgent assistance. Development economists have proposed smallholder agriculture focusing on such rural citizens be revitalized to stimulate rural development and curb the growing "social grants dependency syndrome" but the expensive HYVs do not seem like the best solution. However, the Green Revolution approach favours the rich commercial farmers at the expense of the poor in South Africa.

As stated earlier, their heavy reliance on chemical fertilisers, pesticides and herbicides has a negative long term effect on soil fertility, soil cover, pollutes and poisons water supplies and fragile ecosystems. Even the farmers themselves and farm workers face a realistic danger of being harmed by these toxins which they will be exposed to on a daily basis. These risks seem too enormous to be transferred to South Africa's rural population that is characterized by high poverty and illiteracy rates. Be that as it may, perhaps not every trait of the new crop cultivars should be rejected in South Africa. For example, the HYVs that is able to withstand pests and diseases much better than landraces. South African Breeders should therefore focus on creating such traits in their traditional cultivars to enhance production. The Green Revolution has provided important lessons that countries like South Africa could learn to improve their own crop production and these lessons should be embraced.

In conclusion, it goes without saying that the ever-rising human population calls for the staple food production sector in the country to be developed by improved productivity and not by expansion of farmland. However, adopting the Green Revolution technologies will not address part of the reason behind food insecurity - high birth rates fueling population growth. Therefore, if any approach is to have the maximum desired effect, it should then be structured in such a way that it addresses all the causes of poverty and food insecurity whilst also paying attention to its affordability to the targeted poor citizens. Unlike those of the Green Revolution, the technologies should also be labour-intensive so that they create salaried jobs and also be user- and environmentally friendly. Based on these points, South Africa should not push for the introduction of the Green Revolution approach in the country as its demerits outweigh its merits, unless proper research is done and cultivars suitable for the resources the country currently has are developed. All stakeholders therefore have to sit down again and craft the best strategy to fight food insecurity and poverty in rural areas whilst also promoting rural development and the self-sufficient citizenry.

Conflict of Interest

The authors have not declared any conflict of interest.

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