



Sustainability of agriculture development in South Africa: Towards Vision 2030

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Abstract: Sustainable Development in agriculture is taunted as a praxis to economic growth and development for several African economies. Agriculture remains one of the primary contributors to employment and food security in the sub-Saharan region, where incidences of drought and famine are prominent. However, the concept of sustainable agriculture remains ambiguous and vague in meaning-making; it is hard to implement at grassroots levels. In this systematic review article, agriculture development is advanced from social science perspective by identifying areas of concern and complementarity in the government approach to sustainability. A structured review in collaboration with desktop research was applied in this study. A sustainable framework was developed to provide an insight into sustainable development components and their outcomes. Furthermore, the study outcome highlights how actors involved in sustainable agriculture can deal with the multiplicity and complexity of this concept in a constructive manner.

Keywords: 2030 agenda, development, sustainability, environmental, strategies

1. Introduction

In 2015, the United Nations set an ambitious target of achieving a sustainable world by 2030. This was preceded by the adoption of the 2030 Agenda for sustainable development. The 2030 Agenda is composed of seventeen Sustainable Development Goals (SDGs), which aim to transform the world into a sustainable habitat. Correspondingly, South Africa produced the vision 2030 enshrined in the National Development Plan (NDP). According to Stats SA (2017), the NDP coincides with 74% of the contents of the SDGs. This paper reviews the literature regarding trends in agricultural development and driving forces in light of South Africa's vision 2030. Tremendous achievements have been made in agricultural production; however the achievements have come with various impacts on South Africa's future food security and the environment as well. Agriculture has been the mainstay of food security for the growing South African population (Knot et al., 2014).

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Additionally, the paper explores agricultural policies, their effectiveness, some unintended consequences and conflicts.

South Africa's population is growing is estimated to be growing at approximately 2% per year. The population is predicted to grow to 82 million by 2035 (World Food Programme, 2016.) For years South Africa has been grappling with the task of feeding its people. In addition, economic expansion and urbanisation have brought both opportunities and challenges for the rural and vastly agricultural society (Antonaci, Demeke, & Vezzani, 2014). Agriculture and food are important components of the Agenda 2030 for sustainable development. The ever-increasing world population exacerbates cries for food security and an intensified effort in climate change as well as land-use changes which are brought by increased agricultural production. Khwidzhili and Worth (2017) pointed out that the world population puts more strain on agricultural lands, particularly the rain-fed arable lands.

It is estimated that 80% of agricultural production would come from intensified agricultural production systems to avert large scale conversion of land to agriculture (Peru, 2011). The major challenge for the agricultural sector is to provide stable food to the growing population with the available few resources such as farmland, water and biodiversity. To achieve this, sustainability should be at the forefront of some government strategies or policies targeted at food production. This requires transformative changes towards sustainability in agriculture and strengthening sustainable use and management of existing agricultural systems to sustain food production and the ecosystems in which the production occurs (4th Industrial Revolution South Africa, 2019).

Like many other agricultural sectors across the world, South Africa's farms are heavily dependent on the ecological services of local ecosystems, including soil fertility, water resources, and pollination (Musvoto, Nortje, De Wet, Mahumani & Nahman, 2015). Because the agricultural activities have increasingly become intensive, with environmental pollution and over utilisation of resources which in turn destabilise the ecological system such as water and soil from excessive usage of bio unfriendly agrochemicals, deforestation and soil erosion from land conversion (Yu & Wu, 2018).

Over the past years, South African agriculture has witnessed significant changes due to technological advancement, institutional transformation, policy shifts, and changes in land tenure legislation (BFAP Baseline, 2018). Before the dawn of democracy in South Africa, land tenure laws in South Africa were skewed against blacks. Presently, there have been land redistribution programs which seek to give land to the formerly disadvantaged South Africans, thus widening and extending the scope of agricultural production to previously disadvantaged farmers who are primarily black.

Amongst the mentioned drivers of agricultural development, (Schulze, 2016) singled out the adoption of technology as the major driver for agricultural production growth in South Africa and beyond. A remarkable example of how technology leads to improved agricultural production is seen in the case of China. According to Yu and Wu (2018), by 2010, China could produce more than 95% of its grain, providing food security to 22% of the world's population.

Although South Africa has managed to produce a surplus for export, there have been concerns regarding the effects of the expanded agricultural production on the environment (New Partnership for African Development (NEPAD), 2013). At the local and global level, increased demand for agricultural products and the need to eradicate poverty as enshrined in the sustainable development agenda for 2030 contradicts the goal of environmental protection (Kihara et al., 2016). It has been argued that the achievement of food security has resulted in severe damage to the environment, affecting the landscape, water, nutrients, and biodiversity (United Nations Environment Programme (UNEP), 2015).

Damages to the environment are mainly caused by such factors as misuse or overuse of agrochemicals which result in pollution, poorly managed wastewater, and contamination due to wastewater irrigation (Mather, 2014). Lu et al. (2015) estimate that the economic loss due to environmental damage, such as negative impacts on the sustainability of food production and human health, ranges from 7% to 10% of the world's income from agriculture.

Recent studies have shown that the overuse of nitrogenous fertiliser is a significant cause of economic loss in the agricultural sector. In the case of South Africa, with increased demand due to increasing population, there has been a challenge of balancing agriculture development and ensuring environmental sustainability (Khwidzhili & Worth, 2017). Available literature shows that efficient and eco-friendly cropping systems are increasingly studied to improve water-use efficiency and nutrient management (Musvoto et al., 2015). However, more efforts are needed to push forward the concept of sustainability in agriculture. These efforts include implementing such strategies as the use of genetically modified crops, technological advancements, institutional changes regarding land tenure, and policy adjustments to encourage conservation and sustainable agricultural practices (WWF-SA, 2014, Goldblatt, 2014).

In this paper, we explore the relationship between the natural environment and agricultural production from two perspectives: sustainability and food security. Central to this study are two questions which are

(1) What are the agricultural production trends for South Africa and the driving forces contributing to achieving food security for the country. South Africa has considered food secure at the national level, although there are statistics that show that there are a considerable number of households that are food insecure.

(2) The other question key to this paper is what environmental impacts are caused by agricultural intensification and expansion. Additionally, the key thrust is on understanding how the impacts/effects influence agricultural sustainability in South Africa.

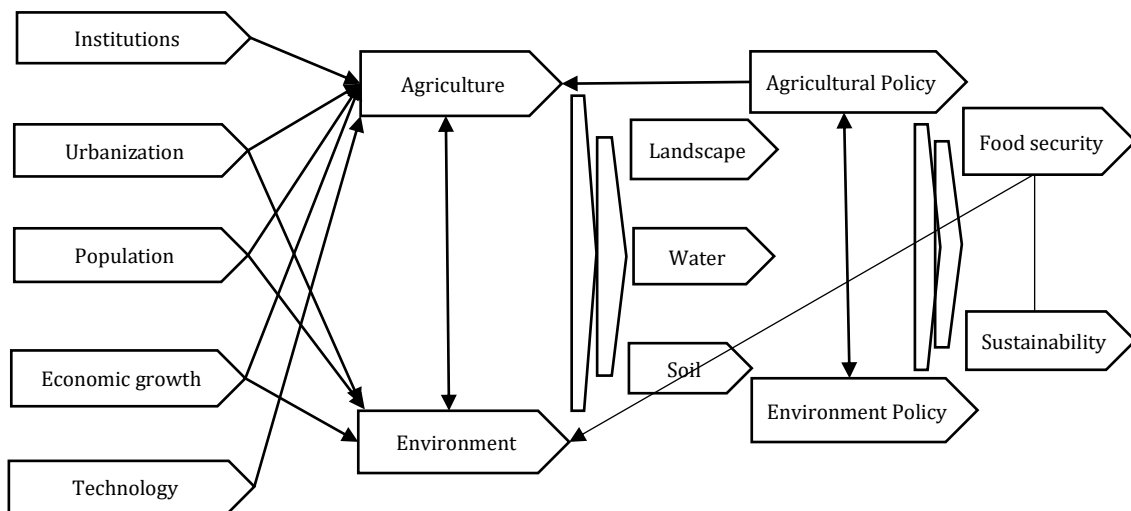
The article is arranged as follows: Section 2 provides an overview of agriculture in South Africa; section 3 provides a summary of environmental impacts on agriculture; section 4 gives an analysis of the impact of policies meant to address challenges in agriculture; lastly section 5 concludes the study.

2. Overview of agriculture in South Africa

In a look into the future of the agricultural sector in South Africa, a key debate emerges on whether farming should be labour-intensive, involving small pieces of land for high-value production or capital intensive large farms (BFAP Baseline, 2018). To address the problem of increased demand for agricultural produce, Schulze (2016) proposed technology and rationalised institutional and organisational irregularities to solve the issues of increasing demand. In addition, Walters et al. (2016) also advance the importance of complementary policies for land management, urbanisation processes, and subsidy support.

Although modern-day farming methods are credited with improving agriculture through devastating effects on the environment, there is a rising argument that traditional farming methods may hold the key to food security and agro-biodiversity conservation (APAP, 2014). Traditional farming systems include intercropping, organic manure, and pesticides. Before going into much detail, the interaction between agricultural development and the environment is provided in Figure 1.

Figure 1: Conceptual Framework of the study



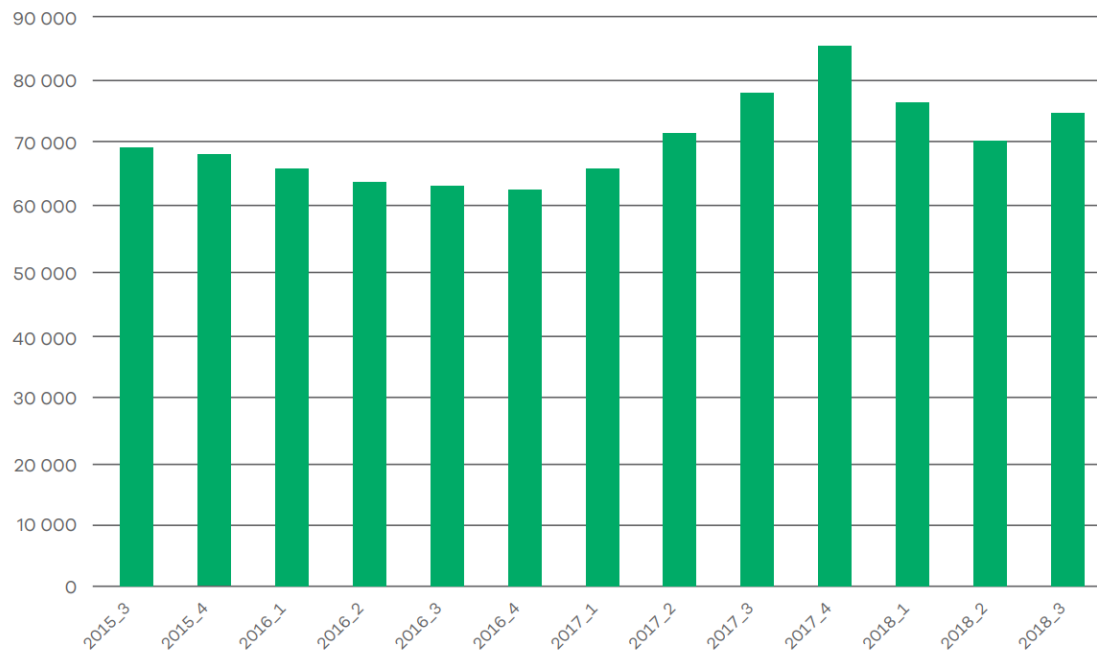
Source: Author

Figure 1 serves as the framework of the study where the logic of the article is explained and linkages between various components are illustrated.

As mentioned earlier on, this paper seeks to answer two questions; the first one is on the driving forces influencing the agricultural production and development trends in South Africa. Moreover, the other is on the impacts of those developments and their effects on sustainable agriculture in South Africa. In attempting to answer these questions, the paper focuses on how agriculture affects the environment through water, landscape, and soil and how the environment feeds back into agriculture. In addition, the paper also reviews how agricultural policies in South Africa affect the relationship between the environment and agriculture, as well as determining what the future looks like in relation to food security and sustainability.

3. Trends of agricultural production and its driving forces

Figure 2: South Africa's GDP from agriculture (ZAR million/quarter)



Source: GreenCape (2019)

3.1 Trends of agricultural production in South Africa

The available literature shows that production has been on the rise in South Africa since 1971. As shown in Figure 2, agriculture production to the gross domestic product has been steadily above ZAR60 000 million/quarter from 2016 to 2018. The increase in agricultural production has enabled South Africa to be food secure at the national level. According to DAFF (2014), South Africa is currently one of the most food-secure countries in Africa. According to the Global Food Security Index (2014), the country was ranked 2nd in the continent and 44th globally. However, while the country is food secure nationally, at the household level food security remains a fundamental problem, especially for that residing in the rural areas. DAFF (2014) estimated that 12 million South Africans go to bed hungry. This figure has current worsened due to the COVID-19 pandemic and prevalent droughts that affect South Africa in 2020, and currently floods in 2022. To show the positive effects of an increase in agricultural production, the number of people who are food insecure is decreasing in South Africa (Oxford Business Group, 2014). According to the 2013 General Household Survey report, the percentage of households that experienced hunger decreased from 29,3% to 13,4% between 2002 and 2013 and while households with inadequate to severely inadequate access to food decreased from 23,9% in 2010 to 23,1% in 2013. Based on this, it can be asserted that the need to ensure increased availability and affordability of food for all South Africans remains critical. Hence the government adoption of the Vision 2030 in which ending poverty is one of the goals to be achieved through agricultural development.

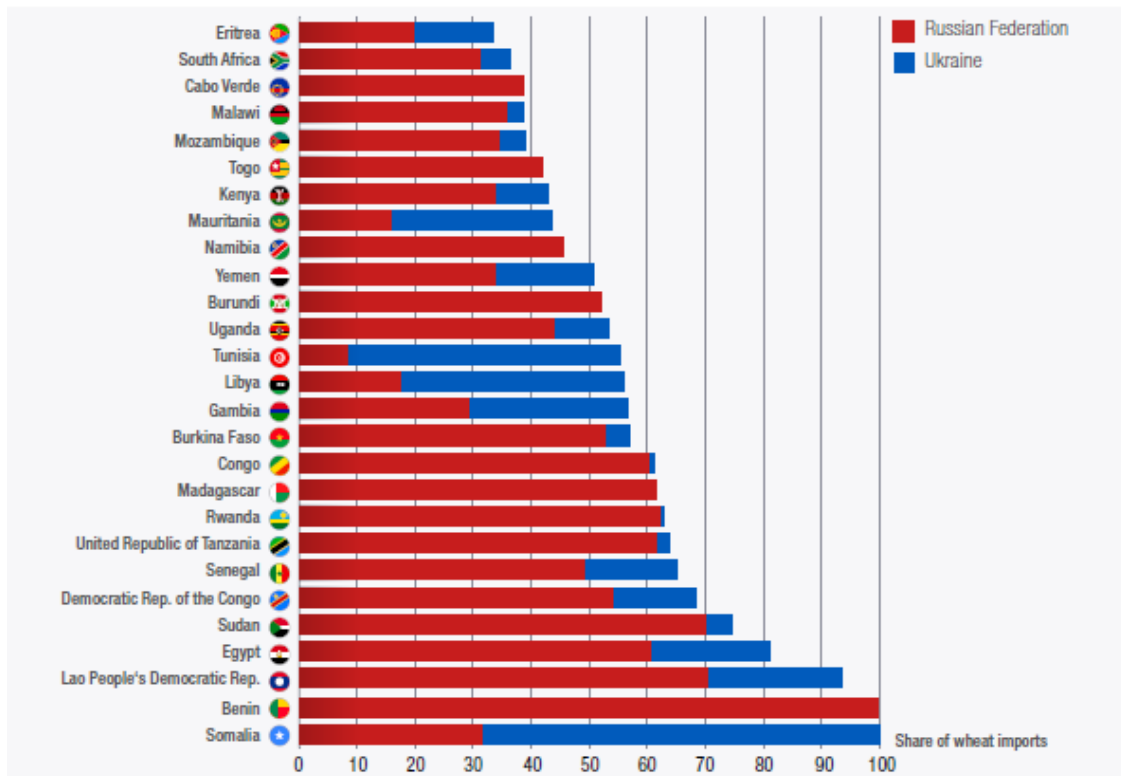
Evidence shows that the country is on a path to eradicating poverty. However, the covid19 pandemic and natural disasters coupled with the Ukraine-Russia war have set the country back in terms of achieving that goal. This can be seen in the fact that during the period 1971 to 2010, total grain production expanded at an average annual rate of 0.4%, while the total consumption grew at an average annual rate of 1.33% (WWF-SA, 2014). For instance, available statistics indicate that the domestic production of maize was able to meet the domestic demand for both human and animal feed consumption from 1971 to 2010. During this period, production grew at an average yearly rate of 0.73%. Despite the steady increase, empirical evidence shows the area planted shrunk from close to 4.8 million hectares in 1971 to an average of around 3 million hectares between 2006 and 2010. Concerning meat production, South Africa has been a net importer. However, based on available statistics, meat production grew at an average annual rate of 2.07% between 1971 and 2010 (Schulze, 2016).

While the agricultural sector has been contributing less than 3% of South African Gross Domestic Product (GDP), the sector plays a huge role in food securing and supply and employment

creation. According to the National Planning Commission (2014), the agricultural sector contributed value-added goods above 7.7% per cent between 1994 and 2014. However, this contribution is expected to be exceptionally low due to the ongoing Russia-Ukraine conflict.

One of the key concerns about the Russia-Ukraine conflict is the impact it has on food prices, especially in South Africa, given the fact that both countries are global players in the agri-food markets. According to UNCTAD (2022), both countries account for 53 per cent of the share of global trade in sunflower oil and seeds and 27 % of global trade in wheat. In the global energy supply, Russia is the second oil exporter in the world, selling over 5 million barrels per day. Both countries are major suppliers of wheat in Africa, with Russia providing 32% of total wheat imports and Ukraine providing 12 %. A breakdown of African countries that supplied wheat by the two countries is provided in Figure 3.

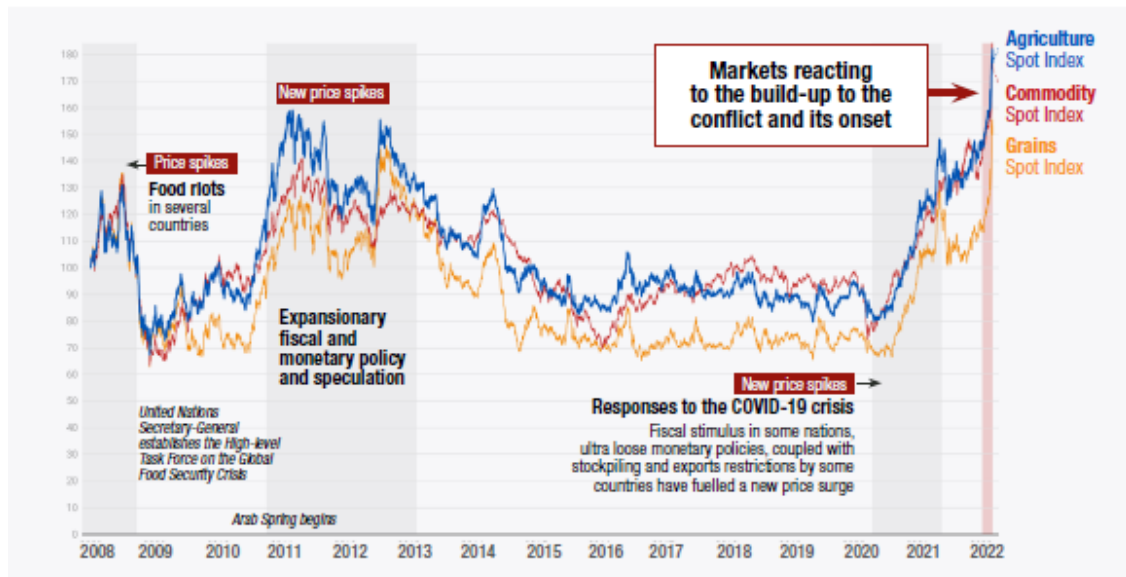
Figure 3: Share of wheat exports from Russia and Ukraine



Source: UNCTAD (2022)

The share of wheat imports for South Africa from Russia is 33 % and approximately 5 % from Ukraine. UNCTAD (2022) pointed out there is a limited scope to replace the wheat imports from the two countries through intra-African trade because the regional supply is comparatively smaller and lacks efficient transport and storage. Therefore, this is expected to feed into the prices of commodities that rely on wheat, such as bread, flour, sunflower oil, cereals, and many other food items. A sustained conflict is expected to have an impact on food security and political instability, as shown in figure 4. Unstable prices coincide with major political events, as shown in 2009 when the Arab Spring began. Again in 2020, the agriculture spot index, commodity spot index and grains spot index increased from 90-point to current levels of over 160 points. This is not looking good for many African economies that rely heavily on these two countries for food security in the stated commodities. There is an expectation that by June 2022, prices would have reached alarming levels, and the government would be forced to react with expansionary fiscal and monetary policy. In this regard, they are an expectation that the SARB and Treasury would only intervene when the prices of basic commodities reach unprecedented levels.

Figure 4: Price levels due to the conflict



Source: UNCTAD (2022)

3.2. Driving forces

This section reviews the driving forces that have been instrumental in developing the South African agricultural sector.

3.2.1. Institutional and policy shifts

Major institutional and policy shifts have been done in South Africa after abolishing apartheid in 1994. The first significant policy shift that spearheaded agriculture growth in South Africa was when the government reduced its involvement in agricultural markets (OECD, 2006). In addition, the democratisation of government in 1994 and the repelling of the Marketing Act of 1937 opened up the market to be freer and liberal. In 1996, reforms were initiated and implemented, leading to more open trade (DAFF, 2014; OECD, 2006).

Although the deregulation of markets created some uncertainty, it should be credited for opening opportunities for entrepreneurial farmers and creating a more efficient allocation of resources in agriculture. The major contribution of these changes is that the South African agricultural sector is less dependent on the state for support and is more competitive internationally (Relx Group, 2016).

The post-independence era also saw the introduction of a land reform program aimed at extending and expanding farming to the previously disadvantaged communities (mostly blacks). As a result, the government devoted efforts to the land reform programme. In 2005 new programmes were established to support the market-oriented family farms emerging from the programme, mainly through microcredit, investments grants and retail financial service in rural areas (Khwidzili & Worth, 2017). These can be credited for the improvement and development of agriculture in South Africa.

3.2.2. Technologies

The other factor that has enhanced and accelerated agricultural development in South Africa is technological advancements. In numerous studies (e.g. NEPAD, 2010; King, 2017), technological advancements have been identified to be a significant driver of agricultural growth. Notable technological advancements and innovations that have been instrumental in the growth of agriculture include irrigation, genetically modified crops, chemical inputs and mechanised machinery (4th Industrial Revolution South Africa, 2019). Irrigation systems have enabled farmers to be productive throughout the year and have reduced the effects of weather conditions such as droughts (United Nations Environment Programme (UNEP), 2015). In South Africa, approximately 3% of the 12% that is suitable for arable production is truly fertile. Although irrigation has played a pivotal role in the development of agriculture, the area of arable land that is currently under irrigation in South Africa is very low. According to WWF-SA (2014), only 1.5% of South African land

that is arable is supplied with water by irrigation systems. More promisingly, the 1.5% produces around 30% of South Africa's crops.

Although irrigation is largely beneficial in agricultural production, it has its problem and can pose challenges to the environment. As a result, farmers are encouraged to deal with the negative consequences of using irrigation systems which include water shortages in water bodies, reduced water usage efficiency and water pollution, among others (Stats SA, 2017).

3.2.3. Chemical uses

Technological innovation has also resulted in the development of chemicals that have helped in growing the agriculture sector not only in South Africa but across the world (WWF, 2018). These chemicals include pesticides, fertilisers, and herbicides. The use of chemicals such as synthetic fertilisers has contributed to the increase of productivity in the agricultural sector through the replenishment of nutrients in the soil (Staurt, 2017).

Herbicides and pesticide use have also increased as agriculture becomes intensive. Despite the benefits, misuse and overuse of chemicals can contribute to the acute problem of nonpoint source pollution of surface water, groundwater, and soil (Khwidzhili & Worth, 2017). This, therefore, threatens the well-being of the environmental well-being and its ecosystems.

3.2.4. Genetically modified crops

Genetically modified crops have also contributed to the development of agriculture both in South Africa and beyond. According to Yu and Wu (2018), genetically modified crops are widely cultivated worldwide, reaching 181.5 million hectares globally. South Africa has adopted genetically modified crops though there has been opposition to the growing of the crops from some quarters of the South African farming community. They argue that genetically modified crops might have adverse health effects on human beings. OECD (2016), report empirical evidence on the benefits to farmers' health due to reduced use of pesticides on food crops.

3.2.5. Machinery use

The mechanisation of agriculture in South Africa is a key factor in the development of the sector. In the whole of Africa, South Africa has been at the forefront of technological adaptations and adoptions to improve productivity on farms (Department of Agriculture, n.d). The mechanisation of farms is beneficial to the agricultural sector because it reduces labour costs and improves production efficiency (OECD, 2016). According to Yu and Wu (2018), land transfer enhances productivity by transferring land from less productive households to the ones with higher productivity, and machinery use reduces production costs by replacing labour. The increased machinery use is accompanied by higher agricultural income and migration rate, and land transfer and machinery use complementarily increase crop income (Jayne, Kwame & Henry, 2017).

3.2.6. Urbanisation

Another factor that impacts agricultural production and development in South Africa is urbanisation. According to Wilson et al. (2016), rapid urbanisation and economic development have a huge impact effect on agriculture. Jaybe, Kwane and Henry (2017) noted that urbanisation leads to land conversion and labour migration, which in turn begets landless peasants and abandonment of arable land in villages. South Africa has experienced an increase in urbanisation and increased rural-urban migration. According to available statistics, 64.3 % of the South African population lives in urban areas, whereas the other percentage remains in the rural areas (Statistics South Africa, (2013). Wilson et al. (2016) pointed out that arable land is converted to non-agricultural production such as transportation, residential and commercial uses. Consequently, rural-urban migration has been identified as a major contributor to the urban population. With urbanisation and economic development, there were more off-farm job opportunities with higher wages, further aggravating labour loss problems in the agricultural sector (Gyasi, Kranjac-Berisavjevic, Fosu, Mensah, Yiran & Fusen, 2014). The impacts on labour supply for agricultural production increase the opportunity cost of labour-intensive farming and change production behaviour and patterns (de Vries, Timmer & de Vries, 2015).

3.2.7. Market changes

Changes in the market structure have also impacted the development of agriculture in South Africa. A major change in the market came with the independence of South Africa, which resulted in the state reducing its interference in the market (Louw, Jordaan, Ndanga & Kirsten, 2008). This made the market to be more efficient and motivated farmers to expand their activities. The other change that occurred in the South African market resulted from the increase in urbanisation (Crush & Battersby, 2016). An increase in urbanisation causes people's food preferences to shift. Numerous studies (Parnell & Walawege, 2011; Wilson et al., 2016) show that people residing in urban areas have a distinctly dietary preference than those in rural areas. According to Parnell and Walawege (2011), urban populations tend to consume superior grains, more animal fat, more processed food and more sugar. Thus, a change in demand-side tends to lead to dietary changes, which include a shift in consumption of grain food such as barley, maize and sorghum. Leading to the consumption of wheat and rice (Seto & Ramankutty, 2016). Consequently, South Africa's per capita consumption of meat, milk and eggs has been increasing over the years. In response to the change on the demand side, more inputs are directed to the production of livestock, vegetables, and fruits to keep up with the more diversified food demand, contributing to severe soil and water pollution from agricultural runoff and animal wastes (Greencape, 2019).

4. Environmental impacts

The expansion and further development of agriculture have resulted in several impacts on the environment. Changes in agricultural production and socioeconomic, environment severely impact the environment. While these impacts do not incur direct costs, they affect sustainability in agricultural production.

4.1. Land use

Impacts of land use have led to several changes in the agricultural sector, and these include the conversion of pastures, forests and pastures to crop production land (Lipper et al., 2014). Again, previous studies have shown that a significant amount of arable land is being lost due to urban expansion (Parnell & Walawege, 2011; Wilson et al., 2016). Additionally, urban expansion is also blamed for the reduction in agricultural land-use intensity (Corsi, Friedrich, Kassam, Pisante & Sa, 2012). Empirical evidence shows that land use for agricultural purposes changes in intensity and scale due to urbanisation, and pressures on natural resources will typically increase in the future (Clay, 2013). The result is usually a threat to the environment.

Existing studies indicate that there is increased disturbance to the ecosystem and loss of habitats together with environmental changes that are associated with urbanisation and agricultural development (Gowing & Palmer, 2008; Kassam & Brammer, 2013). For instance, the Millennium Assessment scenarios predict that at the global level, an additional 10–20% of grassland and forestland will be converted primarily to agriculture by 2050 (Whiteside, 2014). In South Africa, pressure on land in the former homeland has increased, and overgrazing and land degradation have resulted (Hoffmann, Todd, Ntshona & Turner, 2014).

4.2. Water

Water is a key factor in the development of agriculture and its sustainability. According to the state of the environment in South Africa (2008), water is a key and most limiting input for crop growth in most drylands. As a result, it is pointed out that uneven distribution of water resources is a challenge for agricultural production in South Africa. Over the past decade, South Africa has been experiencing successive droughts, thus negatively impacting the water supply. As the increase of production intensifies, over-exploitation of underground water poses an existential challenge to the sustainability of food security (Moss, 2007; Pfister, Bayer, Koehler & Hellweg, 2017). Owing to this, there have been suggestions that soil nutrients and enhanced irrigation should become focal points in discussions relating to agricultural development and must be incorporated in future strategies to improve water-use efficiency (Gomiero, Pimentel & Paoletti, 2011)

Besides leading to water scarcity, agriculture development and expansion also leads to water pollution (Dabrowski, Murray, Ashton & Leaner, 2009). Water pollution is another severe problem affecting agricultural production (Nkwonta & Ochieng, 2009). Contamination and pollution resulting from agricultural activities are usually a result of the overuse of agrochemicals by commercial and smallholder farmers (Mahvi, Nouri, Babaei & Nabizadeh, 2005)

Although land use (agriculture) has contributed to the scarcity of water in South Africa, it should be noted as well that climate change has also played a role that may worsen water scarcity and pollution as well (Abbaspour, 2011). Many studies have been conducted to better understand water security and agriculture production in the context of climate change (Hanjra & Qureshi, 2010; Turrall, Burke & Fuares, 2011; Rasul & Sharma, 2016). For instance, Qiu, Jin & Geng (2010) examine the combined impact of climate and land use on water security in northern China and found that the water availability for agriculture in northern China was simultaneously stressed by extensive changes in land use and rapid climate change. In South Africa, climate change has negatively impacted maize production, and this has forced the South African government to import maize to supplement its grain reserves (Walker & Schulze, 2018).

4.3. Soil

Soil is the key component that should be considered in deliberations concerning sustainable agricultural development. For instance, Corsi et al. (2012) assert that soil is an important part of the ecosystem. This is because food provision relies heavily on soil as the basic resource required for organic growth. With the intensification of agricultural production and continued overuse and misuse of agrochemicals in the ecosystem, the soil is degraded in the process (Beddington, 2012). Soil pollution and degradation have turned out to be major issues surrounding the soil's well-being and have had adverse effects on food security and agricultural productivity (Behnassi, Shahid & D'silva, 2014).

It has been established that leaching, soil erosion, loss of organic matter, as well as soil compaction are the main causes of soil degradation (Dlodlo & Kalezhi, 2015). Adoption of sustainable agricultural practices (SAPs) such as terracing, crop rotation, and strip cultivation should be considered to maintain soil quality and control soil erosion (Bureau for Food and Agricultural Policy (BFAP), 2013). In addition, there are other sources of pollution of agricultural soil such as mining, waste disposal, smelting, urban effluent, vehicle exhaust, sewage irrigation, pesticides, fertilisers application and pesticides (Canter, 2018). Soil pollution needs to be managed because it does not only cause agricultural production loss and deteriorating product quality, but soil pollution also raises concerns about health risks associated with consuming food crops grown on contaminated soil (Clark & Tilman, 2017).

4.4. Other impacts

How the environment is impacted by activities related to activities associated with agricultural production is not confined to soil, landscape and water only but also biodiversity depletion and greenhouse emissions (Clay, 2013). Although there are efforts to pursue green economic development in South Africa which promotes biodiversity, there is evidence that biodiversity still faces enormous threats due to the combined effects of habitat destruction, fragmentation, environmental contamination, over-exploitation of natural resources, and introduction of exotic species (Barendse, Roux, Currie, Wilson & Fabricius, 2016).

Various elements of traditional agriculture are biodiversity-friendly elements which are lacking in the present-day South African agricultural systems (Walter & Schulze, 2018). For instance, the use of traditional methods such as manure and traditional pesticides promotes biodiversity as compared to the use of chemical fertilisers and poisonous pesticides (Lal et al., 2015). As proven by many studies in the developed world, the loss of biodiversity in the agricultural landscape is related to agricultural production intensification. As agricultural production intensifies, expansion of agricultural and habitat fragmentation becomes common (Garibaldi, Gemmill-herren, D'Annolfo, Graeub, Cunningham & Breeze, 2017).

The lack of clearly outlined biodiversity conservation strategies turns out to be the major future impediment to implementing sustainable agriculture. Hoffmann, Todd, Ntshona and Turner (2017) argue that there is a need for more policies for biodiversity-friendly agricultural practices such as crop rotations, use of organic manure and intercropping

4.4.1. Greenhouse gas emissions

Although not as high as is in the developing world, agricultural activities in South Africa are also generating greenhouse emissions. Globally, agricultural activities are considered to be among the major sources of greenhouse gas emissions (Corsi et al., 2012). A number of practices and strategies have been suggested to curb the amount of greenhouse gas that is released into the atmosphere. These include proper application and use of agrochemicals, improving ruminant

nutrients and intermittent irrigation of fields. In addition, reduction and substitutes for nitrogenous fertilisers should be introduced to reduce greenhouse gas emissions (Davis, et al., 2012). This is because nitrogenous fertiliser overuse not only contributes to the soil, water pollution and air pollution but also is a source of greenhouse gas emissions. For every ton of nitrogen fertiliser manufactured and consumed, 13.5 tons of carbon dioxide-equivalent is emitted into the atmosphere (Tubiello et al., 2013).

5. Policy interventions, unintended effects and conflicts

There is no doubt that there is a relationship between the environment and agriculture. The relationship is two way. A healthy environment condition provides natural and fundamental conditions required for agriculture whilst, on the other hand, agricultural development has turned out to be a significant cause of environmental harm (Miczareki-Andrzejewska, Zawalinska & Czarnecki, 2018). The increased intensification of agriculture in South Africa has caused harm to the environment through the degradation of ecosystems. The damaging and adverse effects of agricultural development can be seen through air pollution, water pollution and contamination and soil erosion and pollution, to mention just a few (Kassie, Teklewold, Jaleta, Marennya & Erenstein, 2015).

In recent years calls for the protection of the environment from harmful human activities have been gaining momentum across the world. As a result, the South African government has been formulating some policies which promote sustainable development. In addition, South Africa is a signatory of the 2015 Paris Agreement on environmental protection. This section thus reviews policies that have been formulated by the South African government to reduce the adverse effects of agricultural development and production, as well as explores the contradictions between agricultural policies and environmental conservation.

Global developments are likely to affect the country through prices. The maize and wheat value chain are expected to be disturbed by this development. Unfortunate efforts to stabilise this threat would need a multilateral approach in which both parties end hostilities. However, given the destruction to the Ukrainian infrastructure, the supply chain will take a long time to be fully operational.

South Africa is already experienced increasing food prices for most staple foods such as wheat, flour and animal proteins. The current Ukraine conflict will exacerbate the problem in the form of disturbed production and distribution of food. This would then feedback to consumers in the form of higher prices as suppliers try to salvage profits to offset their losses. Products that are directly affected include all wheat products such as bread, flour, cereals, vegetable oils and animal products that rely on grain. Furthermore, farmers would be affected by disruption in fertiliser distribution. Farmers rely on fertilisers to produce food. Altogether, fertilisers and fuel shortages will be translated to consumers in the form of high food prices

5.1. Agricultural production policy interventions

To ensure that threats to the environment resulting from agricultural activities are minimised, the national government of South Africa enacted several legislations. These legislations include the Agricultural Pests Act of 1983 (Act No. 36 of 1983), which was formulated to prevent the establishment and introduction of pests. The Act guides against the importation of controlled goods in a way that pests and diseases are not imported into South Africa or spread beyond borders (Republic of South Africa, 1996). In addition, the country also enacted the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), which aims to minimise the utilisation of the country's agricultural natural resources to promote the conservation of the soil, water sources and vegetation, and the combating of weeds and invader plants. This legislation has an environmental impact by promoting the sustainable use of natural resources to ensure the long-term productivity of the plant production sector.

The government also introduced the Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997) (Republic of South Africa, 1996). This act was introduced mainly to control and monitor the development, application and usage of genetically modified organs (GMOs). This legislation ensures the safe usage of GMO products. The government of South Africa has also implemented the carbon tax and greenhouse gas emissions taxation to curb emissions. Natural plantations and natural forests under 10 hectares are exempted from direct GHG emission taxations during Phase 1 (2020-2022) but will be indirectly taxed for energy and fuel usage. Post-2022, agriculture, forestry and other land-use sectors exceeding emissions of 100 000 tonnes of carbon dioxide equivalent (CO₂) per year can expect to be taxed after Phase 1 (Draft Carbon Tax Bill, RSA, 2017).

Furthermore, the White Paper on Agriculture generated in 1995 emphasised the fragility of South Africa's soil and its proneness to soil erosion (Republic of South Africa, 1995). This is worsened by the fact that there are farmers who use incorrect or improper irrigation and other farming techniques. For instance, excessive and improper use of chemical pesticides and synthetic fertilisers leads to the pollution of groundwater as well as rivers and dams. The paper also notes that new cultivars that are produced by hybrid plant breeding and biotechnology may threaten indigenous species that are cultivated over generations by traditional farmers. In response to this, the government, through various policies, aims to prevent further harm of the natural environment (Republic of South Africa, 1995).

5.2. Policies conflicts and integration

In the environmental-agriculture relationship, there exist policies that sometimes contradict each other, and this might have unintended effects of even changing the behavioural incentives of the stakeholders (Stringer et al., 2009). As such, there is a need for careful policy designs, and more efforts should also be devoted to integrating related and interacting policies so that they become coherent. In terms of policy goals, it has been established that there are trade-offs between conservation policy goals and agricultural policy goals to improve productivity (Yu & Wu, 2018).

In the context of South Africa, the National Development Plan (NDP) outlines that agriculture is a key sector that will play a key role in the eradication of poverty and unemployment in South Africa. It pins all hope on the expansion of agriculture through the introduction of more and new irrigation systems (Department Of Agriculture, Forestry and Fisheries (DAFF), 2015). According to the NDP, the agriculture sector alone should create 1 million jobs by 2030. The NDP also puts export-led, labour-intensive irrigation farming at the core (National Development Plan0, 2011). The encouragement for expanded irrigation systems contradicts the conservation policies that are aimed at reducing fresh and underground water sources, as a result, there is a need to find common ground and balance between increasing production and protecting the environment.

6. Conclusions

Going forward, it is predicted that sustainable agricultural development and food security will continue to be the two critical goals of agriculture in South Africa (Drimie & Pereira, 2016). A key question to be answered is how South Africa is going to meet the food needs of its citizens with improved and more varieties in a sustainable manner. Traditionally, food security simply meant that the agriculture sector should cater for a country's food needs. In the present-day world, things have changed, and it is no longer about achieving food security but also how that food security is attained. Environmental activists, pro-environmental non-governmental organisations and government departments are pushing for sustainable agricultural development. This is because such agricultural development can cater for the needs of the present generation as well as those of the future (Drimie & Pereira, 2016).

With technological innovations, South Africa has proven that it can achieve food security through the efforts toward food security that are negatively impacted by successive droughts that the country has been experiencing over the years (Walker & Schulze, 2008). Innovations are a key driver in agriculture in terms of machinery uses, information and technology.

With much of the South African population moving into cities, the demand for food is no longer about quantity but the quality of the food. For example, food safety is a great challenge now and will continue to be so in the future, especially given the threat to soil and water resources (Altman, Hard & Jacob, 2015). Pernicious substances could potentially be found in the food supply, which might be originally from water and soil, exposing consumers to a range of health risks.

Furthermore, as income increases, higher food quality and more diversified dietary expectations will place greater pressures and requirements on the country's agricultural sector (Drimie & Pereira, 2016). South Africa is classified as a middle-income country therefore, its food preferences might also be shifting accordingly. Resultantly agricultural practices which lead to the production of quality foods should be encouraged. The practices should not only lead to the production of quality food but be beneficial to the environment and agrobiodiversity (Drimie & Ruysenaar, 2010).

Although South Africa has managed to meet the food demands of its people, the achievement is a great challenge for the present, and the future comes with a cost (Drimie & Pereira, 2016). Maintaining a balance between agricultural development and environmental protection remains a challenge for the authorities. In all this, technological innovations are tipped to continue being the major drivers of growth in the agricultural sector. However, this author suggests that policies that

ensure environmental sustainability and growth for the agriculture sector should be introduced to avoid contradictions in terms of long-term goals and objectives.

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Conflicts of interest

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