Land Reform and Climate Change in South Africa: Adaptation and Mitigation Through Indigenous Knowledge Systems

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Abstract

Land reform programmes could be affected by changing climatic conditions, which could affect smallholder farmers and rain-fed agricultural production. Beneficiaries of the land reform programme could be frustrated by erratic rains and unpredictable weather conditions. Predictions show that climate change will decrease agricultural production substantially in Africa and this could mostly affect small-scale farmers and new farmers with limited farming capital. This theoretical paper focuses on indigenous knowledge systems that could be utilised by new farmers to mitigate the effects of climate change in South Africa. Indigenous knowledge systems are posited as being capable of reducing the effects of climate change in situations such as severe storms, flooding and droughts. The new farmers could embrace indigenous knowledge systems in crop planting, crop cultivation, harvesting, food processing, crop storage, and weather prediction strategies. Beneficiaries of the land reform programme could use natural fertilisers and traditional methods of moisture retention to complement modern methods of farming. The new farmers in South Africa are expected to actively engage in activities that seek solutions to mitigate and adapt to unpredictable weather and disastrous climatic conditions. Policies and programmes that incorporate new farming ideas in South Africa such as the Global Change Grand Challenge would be utilised to help beneficiaries of the land reform programme to understand the causes and effects of climate change and how indigenous knowledge could be employed to supplement modern methods of farming during times of scarcity. The study stimulates future studies to research the effects of climate change on land reform programmes in South Africa and Africa at large.

Keywords: Land reform programme, climate change, adaptation, mitigation, indigenous knowledge systems.

Introduction

The Intergovernmental Panel on Climate Change (IPCC) predicted that climate change will decrease agricultural production in African countries by as much as 50% by the year 2020, resulting in loss of income mostly

for small-scale farmers, and an increase of Africa's food insecurity levels (Abudu-Raheem & Worth, 2011:91). The decrease will be a result of extreme weather conditions such as severe storms, floods and droughts (Muller *et al*., 2011:4313). Globally, countries are putting mechanisms in place to prepare for climate change and African countries participate in global warming forums. South Africa, in particular, as one of Africa's largest economies, is actively engaging in activities that seek solutions to mitigate and adapt to climate change. The country is preparing itself for disastrous climatic and weather conditions that emanate from global warming. South Africa's approach to the climate change challenge began by adopting the view that climate change is more of an environmental rather than a developmental challenge. However, South Africa's focus gradually shifted to the current perspective that regards the phenomenon as diverse, cross-cutting and affecting all sectors of the economy. The paradigm shift resulted in a plethora of policies and programmes aiming at both understanding and addressing the causes and effects of climate change.

One of the comprehensive responses is that of the Department of Science and Technology's 10-Year Global Research Plan for South Africa that identifies contemporary research challenges in global warming. The Global Change Grand Challenge (GCGC) identifies four major themes for research, namely, understanding a changing planet, reducing the human footprint, adapting the way we live, and innovation for sustainability (Swilling, 2014:1). Adapting the way we live focuses on security issues, sustainable development, and future preparations. Indigenous knowledge (IK) and indigenous knowledge systems (IKS) fall under the third theme and their role in climate change adaptation practices is the focus of this paper. This is explored through examining the indigenous knowledge practices of small-scale farmers engaging in subsistence farming in the rural areas of South Africa.

Vital Concepts in Global Change

Global climate change is understood as an ongoing and complex pattern of changes in the composition of the earth's atmosphere which affects the ecosystem (Azevedo, Perera & Pinto, 2014:1). It is hypothesised by most natural scientists that the changes are a result of human activity such as industrialisation, which contributes to the release of greenhouse gases, whereas some believe the change is a natural process (Saryal, 2018:1; Lloyd & Winsberg, 2018:1). The debate on the causes of climate change and consequences is complicated and controversial between developed and developing countries. Natural resources that are found in abundance in some countries such as asbestos, coal or oil could be threatened by technological advancement against pollution and campaigns to reduce occupational diseases caused by fossil fuels. Urban greening and the use of electric vehicles are promoted as they are regarded as environmentally friendly. Vehicles that use diesel and petrol damage the ozone layer by emitting carbon dioxide (Barbarossa, Pelsmacker & Moons, 2017:190). The associated diseases could be contracted in the agricultural or mining sectors. Concepts such as "zero emission" and "urban greening" challenge the world community to prevent global warming. Manufacturers are compelled to adhere to

international standards against pollution and environmental damage. Farmers are challenged to stop polluting the environment by adhering to practices that are environmentally friendly, such as water conservation and the production of crops that do not disturb plant ecology (D'Antonio & Flory, 2017:140). Commercial farmers and rural subsistence farmers are advised to adopt best practices in agriculture that promote the reduction of greenhouse gases. This includes disaster risk reduction and the lessening of potential adverse impacts on farming. Rural subsistence farmers avoid farming practices that damage land for farming and pastures. However, the least developed countries (LDCs) and resource-poor countries are particularly vulnerable to the projected impacts of climate change as they have limited financial resources to reduce climate risks and associated disasters (Kuruppu & Willie, 2015:72). Rural subsistence farmers in South Africa are prone to natural disasters that threaten crop and animal production.

Climate Change and its Effects in South Africa

The effects of climate change in South Africa differ from place to place according to seasons and rainfall pattern. Climate change has a negative impact on South Africa's water resources, temperatures and precipitation, rainfall pattern, and food security (Maponyar & Mpandeli, 2012:48). Farmers are affected by unpredictable weather conditions that disrupt planning and sourcing of inputs. Smallholder farmers respond to variations in rainfall frequency and humidity intensity with limited preparedness and resources (Rakotobe *et al.*, 2016:114). In South Africa, disaster preparedness among rural subsistence farmers is characterised by the provision of water and grass to livestock during the dry spells but the rural farmers usually run out of animal feed.

Fluctuations in temperatures and rainfall make it difficult for farmers to decide on what to grow and when to plant because different crops require different temperatures, rainfall and day-lengths. Small-scale farmers prioritise food crops with a shorter maturation period over those that require more rain. A shift in farming practices in response to climate change makes it difficult for the farmer to even produce the basics crops. They either grow early-maturing varieties, which may not be as high-yielding as their normal varieties, or change to other varieties that tolerate drought and are less sensitive to day-length variation (Shiferaw, Tesfaye, Kassie, Abate, Prassana & Menkir, 2014:67). In areas where more than normal rainfall is received, problems of waterlogging, nutrient leaching and plant diseases may be experienced and farmers have losses due to stunted growth and diseased plants (Reynolds, Waddington, Anderson, Chew, True & Gullen, 2015:795).

Adaptation to Climate Change

Adaptation to medium or long-term climate change is now the focus of South African scientists. Farmers work to reduce vulnerability and unpredictable disasters such as crop failure and they take advantage of early warning systems to avert such failures. Early warning systems about an impending drought are based on information obtained from risk assessment, communication about drought and decision support systems (Pulwarty & Sivakumar, 2014:14). Farmers are given information on risks

involved and the farmers' perception of risks involved would be incorporated into the farmer education campaign to enhance their preparedness for dry spells (Pulwarty & Sivakumar, 2014:14). In South Africa, there is collaborative effort between scientists and the South African Government to explore the design of a system that is capable of evaluating adaptation responses of farmers to current and future climate variability (Ziervogel *et al.*, 2014:605). Farmers in South Africa are responsive to climate change. They take a proactive approach to mitigate the effects of global warming, for example, apple orchards have been replaced by vineyards, which are more tolerant of high temperatures in the Western Cape, and some of the commercial farmers are switching from crop production to pasture farming (Mills, Birch, Stephenson & Bailey, 2012:191). In anticipation of inadequate rainfall due to climate variability, some of the farmers have increased their capacity to store water in the Southern Cape and emerging agricultural sector in Suid Bokkeveld, South Africa's arid western region (Ziervogel *et al.*, 2014:605). Climate change features such as increasing temperatures and decreasing rainfall also threaten rooibos tea farming in South Africa (Ziervogel *et al.*, 2014:605).

Small scale farmers are seriously affected by climate change as they do not have irrigation facilities to water crops during dry periods. Farming focuses on livelihoods; there is scarcity of water and the land is not fertile in most places. Indigenous knowledge and indigenous knowledge systems have been the strategy adopted by most rural farmers to adapt to climate change. It is also widely accepted that in rural South Africa, more than half of rural households are headed by women and together with children, they constitute the poorest of the poor (Flato, Muttarak & Pelser, 2016:41). Female-headed households including widows are affected by variations in rainfall and limited access to protective social networks (Flato *et al.*, 2016:41). Indigenous Knowledge Systems need to be considered in the South African rural subsistence farming context since it is one of the countries with high levels of poverty and food insecurity in Africa (Chakona & Shackleton, 2017:e812). There is a great need for attention to be given to the role of IKS and its incorporation in the Global Change Research Plan since it is directly linked with subsistence farming, which is one of the survival mechanisms of people located in rural areas.

Indigenous Knowledge and Indigenous Knowledge Systems

Indigenous knowledge refers to ideas that are learnt from previous generations and passed on to future generations. The knowledge is gained from social institutions and in various social contexts (Iloka, 2015:1). Indigenous knowledge is used in community agricultural developmental projects in which members of the community apply traditional knowledge to produce crops and protect their harvest. Communities use traditional knowledge to solve problems and they use indigenous knowledge in food gathering, fishing, hunting, and related activities that are needed by communities to adapt to their natural environments. Indigenous knowledge makes it unnecessary for communities to use money to buy equipment and food as traditional methods would be used to produce food. Indigenous knowledge is capitalised on by scientists and planners striving to improve

conditions in rural localities. If indigenous knowledge is incorporated into programmes for agricultural development in the rural areas it could increase farmer participation as the farmers would feel valued through the inclusion of community knowledge systems into their farming practices.

IK, IKS and Climate Change

The threat of drought and heavy rainfall poses a threat to South Africa's farming sector. Drought leads to crop moisture stress that affects food crops and reduces the crop yield; floods wash away crops, rich topsoil and even physically damage the crops (Kang, Khan & Ma, 2009:1665). Storms and floods reduce harvests, also resulting in food insecurity. In South Africa, this also implies a reduction in export agricultural produce and a drop in national revenue.

Whereas modern methods of farming and practices have been explored and employed in commercial farming, there are limited reports on IK practices playing a role in adapting to climate change in South Africa. However, the Food and Agricultural Organisation (FAO) acknowledges the contribution of indigenous knowledge systems to food production and food security in developing countries (FAO, 2009:1). The combination of both indigenous knowledge systems and conventional methods of farming could potentially boost agricultural production in South Africa despite the challenges caused by climate change.

Indigenous Knowledge Systems and Agriculture

Agriculture contributes to economic development and it provides food security to the country. It is reported that high levels of food insecurity exist in rural areas of South Africa and about 85% of rural households are unable to afford a balanced diet (Jacobs, 2009:410). Food security policies that utilise baseline indicators can better target food insecure households in South Africa so that interventions reach the affected population (Jacobs, 2009:410). In South Africa, indigenous knowledge systems based on the constellation of stars, appearance and disappearance of reptiles and migration of certain bird species are used by subsistence farmers (Zuma-Netshiukhwi, Stigter & Walker, 2013:383). The rural farmers use indigenous knowledge to assess clouds that bring rain and clouds that bring dry winds, to detect diseases in animals and use medicinal plants to treat livestock (Luseba & Tshisikhawe, 2013:593). They also grow indigenous plants to provide vegetables and traditional medicine.

IKS and Food Crop Production

Instead of looking at the manner in which rural farmers have been sustaining their agricultural activities for the past centuries, the Global Change Research Plan seeks to develop existing food production mechanisms against the backdrop of climate change (Luseba & Tshisikhawe, 2013:593). As the environment changes, the rural farmer develops means of coping with the changes. Furthermore, information about IKS also needs to be publicised and used concurrently with the western methods developed by scientists to address the challenge of climate change on food security in South Africa. Some of the indigenous subsistence farming techniques that have been previously used, such as mulching, the use of

organic manure and traditional pesticides, are still relevant in some areas and some farming communities still use them today (Garutsa & Nekhwevha, 2016:106).

Mulching

Mulching is an age-old method that has been practised by farmers in Africa to avoid moisture stress in plants, thus increasing crop production (Nyong, Adesina & Elasha, 2007:787). Mulching involves the use of spear grass, leaves, shrubs, branches and elephant grass to preserve soil moisture. Considering the hot weather conditions experienced in most of South Africa's rural areas, mulching has been proven to be one of the best methods to prevent water evaporation, particularly in arid regions (Zhao *et al*., 2014:16). With the threat of continuous increase in temperatures, mulching is most likely to play an essential role in water retention and reduction of the amount of water used in farming, especially in rural areas where water is a scarce resource.

Pesticides and Organic Fertilisers

Although pesticides are promoted in agriculture, especially with the advent of the Green Revolution, they have been shown to have a negative impact on the environment, living organisms, plants, and the soil. Some of the chemicals are effective in eliminating pests but there is also an environmental threat to the extinction of pests that are required to balance the ecosystem. Some of the chemicals degrade or damage the environment (Van der Laan *et al*., 2017:236). Farmers use more agrochemicals to increase food production as demand for food increases with population increase. Traditional farming methods do not use dangerous chemicals. They use less harmful indigenous pesticides from organic materials. Some of the traditional pesticides made by subsistence farmers include a mixture of red pepper, human and animal urine, neem tree leaves and tephrosia vogelli leaves. Organic fertilisers made from animal manure and vegetable matter are friendly to the environment and the fertilisers improve soil fertility (Moyin-Jesu, 2015:291).

IKS, Food Processing and Storage

Cereal crops need threshing to detach the grain from the panicles (Kumar & Kalita, 2017:e8). In Africa, threshing of grain could be a collective effort in which rural farmers collectively assist each other to harvest and process crops for storage. The threshing process involves rubbing, stripping, impact action, beating by an individual or group, trampling by animals and the use of mechanical threshers (Kumar & Kalita, 2017:e8). These authors state that manual threshing is the most common practice in developing countries. Post-harvest crop loss could result from delays in threshing after harvesting of the crop, grain spillage, incomplete separation of the grain from the chaff and grain breakage due to excessive striking (Kumar & Kalita, 2017:e8). In Africa, poor post-harvest handling practices could result in grain loss and economic hardship for households (Neme, Tola, Mohammed & Tadesse, 2020:23). There is a significant quantity and quality of loss during grain processing. Crop damage might be caused by atmospheric humidity and moisture accumulation in crops lying in the field. Rodents, birds, and insects reduce crop quantity and quality (Kumar & Kalita, 2017:e8). After threshing, the farmer cleans the crop and the process involves separating whole

grains from broken grains and other foreign materials such as straw, stones, sand, chaff, and weed seed (Kumar & Kalita, 2017:e8). Chaff is separated from grain through winnowing, an ancient practice that is commonly used for cleaning grain in Africa and other developing countries of the world (Kumar & Kalita, 2017:e8; Neme, Tola, Mohammed & Tadesse, 2020:23). The other cleaning process involves screening or sifting grain, which is mainly practised in developing countries and Africa in particular (Kumar & Kalita, 2017:e8). It is pointed out that grain not adequately cleaned could result in insect infestation and mould growth during storage and the quality of the crop would be affected (Kumar & Kalita, 2017:e8; Neme, Tola, Mohammed & Tadesse, 2020:23).

In respect of IKS, food processing methods include sun-drying of food crops such as maize, groundnuts, vegetables and beans. Sun-dried crops can be stored for about six months or longer, depending on the crop or vegetable (Kumar & Kalita, 2017:e8). Other practices include the pounding of crops using locally made mortars, winnowing, grinding and drying over fire. Some of the storage methods still relevant, depending on context and the availability of natural resources, include the use of sacks, wood ash from any tree and banana juice. However, these methods need not only be limited to how they were initially developed and practised; there is a need for them to be complemented with modern innovative methods.

Challenges with IKS

Gender Access

Women are the driving force behind rural development. Projects on innovations in subsistence farming target smallholder farmers in rural areas. Most of the rural subsistence farmers who participate in new projects in farming are women (Lukhele-Olorunju, & Gwandure, 2018:1). Rural women who are involved in subsistence farming need infrastructural capital and financial resources to boost their farming activities and to insure their crops against loss due to unforeseen factors associated with climate change (Fletschner & Kenney, 2011:1). Even though women have maintained their position within subsistence farming, they also need to grow and expand their operations to gain financial income from subsistence farming. Women need to be assisted to grow a variety of crops to improve nutritional deficiency in rural communities.

Rural subsistence farming contributes to national food reserves. Donors provide food to rural communities in Africa but countries with productive rural subsistence agriculture might not entirely depend on food donations as it was shown that subsistence farming reduces vulnerability to food insecurity in rural and urban communities and it improves livelihoods (Baiphethi & Jacobs, 2009:459). Women are actively involved in rural subsistence farming activities such as the collection of food for cattle, milking of cows, and the use of dung for energy. The World Bank and other international development organisations uphold that women in rural areas engage in small-scale agricultural activities that could be enhanced at grassroots level to generate household incomes. The South African government is challenged to support rural women in agriculture.

In order to fully incorporate indigenous knowledge systems into national policies on

rural development, a number of challenges still need to be considered in addressing agricultural reforms in South Africa. One of the most common challenges with the use of IKS is that this knowledge is in most cases communicated orally and not enshrined in national policies or laws on agriculture. In the absence of legal instruments to support ownership of claims, anyone can claim ownership of indigenous subsistence farming techniques. Rural women are contributing knowledge to subsistence farming but receive little acknowledgement if any by researchers. Their ideas are useful in the production of solutions to mitigate the challenge of climate change. In some cases, people who have indigenous knowledge may be located very far from urban areas, which makes it hard for researchers to gain access to that knowledge (Nhemachena, Chakwizira, Dube, Maponya, Rashopola & Mayindi, 2011:1). Another common issue with the holders of indigenous knowledge is that some of them are reluctant to share their knowledge with the community. In addition, other challenges include the lack of integration between indigenous and western methods of farming, especially in rural development policies. It is posited that integrating indigenous knowledge with modern farming methods could be achieved through improving accessibility and mobility of communities in rural development (Nhemachena *et al.*, 2011:1). The communities need a critical mass of infrastructure and services that could be used to link up communities to one another, thus transforming rural spaces, rural communities, and cultures (Nhemachena *et al.*, 2011:1).

In this context, climate change mitigation has been in discussion for some time and academics and government policy makers have worked closely together. In view of climate change, policies that have been developed include the Renewable Energy Independent Power Producer Procurement Programme to promote alternative sources of electricity such as wind and solar photovoltaic energy (Eberhard & Naude, 2016:1). Several government departments, national, provincial and local authorities are now developing climate change strategies. South Africa has a number of universities and research organisations with an interest in indigenous knowledge systems that could be utilised to ease food shortages in South Africa. Studies have focused mainly on changes caused by climate change such as the way oceans affect rainfall trends. Scientists in South Africa research the ecosystem and how it helps rural farmers to adjust to varying climatic conditions. The South African Weather Service could be used by women in rural areas to prepare for adverse weather conditions. The scientists on climatology could carry out research into climate change and rainfall variability for use by women subsistence farmers. The impact of climate change on subsistence farming could affect staple crops such as maize and wheat (Valizadeh, Ziaei & Mazloumzadeh, 2014:107). There is a projected increase in the need for irrigation since global warming causes dry spells but women in rural areas cannot afford irrigation equipment without donor support. Global warming brings about different types of pests and pathogens which reduce crop production and harvest (Ziervogel *et al.*, 2014:605).

Global Warming Challenges to Subsistence Farmers

Food shortages because of erratic rainfall cause malnutrition and hunger in many

households in South Africa. Health risks such as HIV and AIDS and sexually transmitted infections are associated with risky sexual behaviours due to food shortages and poverty (Ivers *et al.*, 2009:1096). Transactional sexual relations involve the exchange of sex for food and the practice could be rampant in famine-stricken households (UNAIDS, 2018). Global warming causes natural disasters, air pollution, loss of livestock and the heat affects the well-being of rural subsistence farmers who spend most of their time in the fields during the farming season. When rivers and wells dry up, domestic animals die due to water shortages. Within the business sector, Santam, an insurance company, has come up with an innovative response to climate change. The company noticed increasing insurance claims, particularly in the Eden District Municipality of the Western Cape Province, as a result of extreme weather events. There were fires, made worse by periods of drought and fanned by strong winds, and flooding and storm surges. Santam decided not to increase insurance premiums but to initiate a pilot project in collaboration with the CSIR and the Worldwide Fund for Nature (WWF) to assess landscape-wide measures to reduce risks associated with climate change (Santam, 2020:1). The Working for Water (WfW) programme seeks to reduce water scarcity and fire risks in rural communities. However, most of the rural subsistence farmers in South Africa do not take insurance cover for livestock or crops but rely on prevailing weather conditions (Ubisi, Mafongoya, Kolanisi & Jiri, 2017).

The Way Forward

Although South Africa is making significant progress in understanding the impact of climate change and is starting to implement and evaluate adaptation responses, more work is needed. The research gap is shown in the sphere of indigenous knowledge and how it could be incorporated into mainstream research on global warming. Scientists are challenged to work with rural subsistence farmers in establishing feasible farming methods and assessing the socio-economic cost of climate change in South Africa. There are three critical research areas that would strengthen adaptation research and practice. These include the development and testing of approaches that support integrated and flexible adaptation strategies, an improved understanding of the social, political, governance and financial barriers or enablers of adaptation in South Africa, and addressing questions about how adaptation processes in rural subsistence farming could reduce poverty and inequality in South Africa.

Implications and Conclusions

The challenges posed by global climate change seem to have attracted great attention and influenced the drafting and passing of a number of polices in South Africa. However, within the 10-year Global Change Research Plan for South Africa, which seeks to draw attention to various areas in which human interaction with the environment takes place, there are gaps about the inclusion of indigenous knowledge systems in rural subsistence farming that need to be filled. As much as development needs to take place in addressing the challenges posed by climate change in South Africa, there is also a need for solutions that cater for rural subsistence farmers in rural development and agricultural production. IKS and IK,

which women have been using within the rural subsistence farming sector, can be better incorporated into the global change research plan by following the Afrocentric perspectives. The indigenous ideas to be implemented should focus on Africa as capable of leading in agricultural production by using indigenous knowledge systems and modern methods of farming. Africa should not merely be a recipient of agricultural knowledge but act as an agent of change in agriculture through the utilisation of indigenous knowledge systems. IKS assists subsistence farmers in weather and crop protection. Furthermore, IKS can be used in natural disaster management to protect crops and domestic animals, since weather conditions are becoming increasingly unpredictable in South Africa. It is pertinent that the use of indigenous knowledge systems by rural farmers becomes essential. Indigenous knowledge systems are used by rural farmers with little or low levels of literacy, and they prove to be relevant and effective among rural farmers who do not have access to communication technology that provides agricultural information.

Looking at the context of South Africa and other African nations that are dependent on rain-fed agriculture, and the challenge of accessing water resources, climate change is most likely to bring disastrous outcomes in the rural subsistence agricultural sector. Currently, subsistence farmers are faced with challenges such as poor access to extension services and technologies to assist them in growing crops. In addition, there are also land availability and access issues rooted in South Africa's land laws that restrict rural farmers in land ownership and acquisition. Despite the restrictions in land access, rural subsistence farmers have been developing pieces of land allocated to them and producing food needed for the survival of their households.

Women have for centuries managed to develop alternative methods of farming without using modern equipment to till the land. Subsistence farmers in South Africa have managed to utilise indigenous farming techniques such as mulching, food processing and storage techniques to increase crop production. Indigenous knowledge is used to make pesticides and organic fertilisers needed by rural subsistence farmers. The Global Change Research Plan in South Africa could utilise indigenous knowledge systems to increase crop production in rural areas.

It has been argued in this paper that rural subsistence farming projects run by women have been successful largely as a result of indigenous knowledge systems that they apply without scientific recognition. It is anticipated that if structures of authority or the societal hierarchy that places women at the periphery of society, relax and open up for women to participate fully in agriculture and share their knowledge in relation to the role that IKS can play in addressing the potential impact of climate change within the small-scale subsistence farming sector, agricultural production in rural areas could be enhanced. Further research is needed to explore the utilisation of indigenous knowledge in commercial farming in South Africa.

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