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Indigenous knowledge and innovative practices to cope with impacts of climate change on small-scale farming in Limpopo Province, South Africa

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Abstract

Purpose – This paper aims to describe the indigenous and innovative practices adopted by the small-scale farmers to cope with the impacts of climate change hazards on subsistence farming.

Design/methodology/approach – The data were collected through focus group discussions with 72 small-scale farmers from a rural community in Limpopo Province, South Africa. The discussions were analysed through verbatim transcripts and content analysis.

Findings – The study results show the farmers' understanding of climate change variability and its hazards in the form of rainfall scarcity and excessively increased temperature, which are responsible for a declining production of indigenous crops. It has also been found that in the face of these hazards, the farmers experience low crop yields, which cannot provide the household food requirements. However, the small-scale farmers use a combination of local and innovative knowledge and skills to improve their crop production. They have adopted the indigenous adaptation mechanisms, which include rainfall prediction, preparation of the gardens, change of crops and the planting season to ensure better crop yields. The farmers also adopted innovative adaptation practices such as the use of fertilisers, growing of exotic crops and use of extension officers' guidance and skills to minimise the risks and maximise the chances of resilient crop production.

Research limitations/implications – This paper describes the farmers' ability to use the indigenous and innovative adaptation practices. It is only focused on the farmers' knowledge and skills other than the extension officers' skills.

Originality/value – The adaptation practices reported in the study fall within the adaptation and mitigation systems stipulated in the South African National Climate Change Strategy to assist the small-scale farmers grow and maintain the crops to improve production and minimise the risks, thus ensuring food security under observable harsh climate hazards.

Keywords Small-scale farming, Climate change, Indigenous knowledge, Innovative practices, Food security

Paper type Research paper

The local authorities for their support during the study, and the community members by consenting to participate in the study.

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1. Introduction

Climate change is characterised by increased temperatures and generally low rainfall with an erratic pattern (Intergovernmental Panel on Climate Change [IPCC], 2007, 2013, 2014). The widespread change in rainfall and temperature patterns are the most remarkable variations of the climate reported by the Intergovernmental Panel on Climate Change (2007). These changes and their threats to human livelihood are mostly remarkable in the rural areas whose livelihood patterns are still reliant on the natural resources (Rankoana, 2016). Mapaure *et al.* (2011) reported that local communities are aware of changing climatic conditions and their impacts on the community livelihood. For instance, unpredictable rainfall and increased temperature brought devastating changes in the communities' living conditions such as malnutrition, poverty, water and air contamination, increased risks of disease, floods, soil erosion and depletion of biodiversity as a result of erratic rainfall coupled with excessively increased temperatures (Mugambiwa, 2018).

The Intergovernmental Panel on Climate Change (IPCC, 2007) reported remarkable impacts of climate change on the production of subsistence crops. According to Nhamo and Chilonda (2012), rainfall scarcity is a challenge to subsistence farming in Africa. As a result, crop yields from rain-fed agriculture in Africa declined by 50% before the year 2020, which may increase the risk of hunger in vulnerable groups (Food and Agricultural Organization [FAO], 2010; Mubaya, 2017). Vermeulen *et al.* (2010) add that about 70% of people in developing countries living in the rural areas depend on subsistence crop production, which is recently characterised by low productivity and instability as a result of marginal and scarcity of rainfall. Thus, remarkable impacts of erratic rainfall have notable overwhelmed impacts on food availability and accessibility (FAO, 2016).

Mafongoya and Ajayi (2017) report that local communities use their culture-specific measures that have helped them to limit the negative impacts of climate change on crop production. The farmers use their indigenous knowledge and practices to reduce associated problems with natural disasters (Harvey *et al.*, 2014). Most subsistence farmers know and practise an array of cultural practices, which are helpful to address the factors and phenomena that appear to be threats to their production (Rankoana, 2016). Examples of these cultural practices include taking precautions of the early warning of rainfall availability or scarcity predicted by the wind direction, the shape of the crescent moon and the behaviour of certain animals (Mafongoya and Ajayi, 2017) as well as excessively high temperature (Kalanda-Joshua *et al.*, 2011). Berkes (2012) attests that these are trusted predictions of rainfall probability, from which the farmers take informed decisions to plan their agricultural activities to reduce risk and optimise productivity. Other indigenous practices include seed selection in which the best is carefully chosen for the next ploughing season as they are believed to have more chances of growing well under less rainfall (Chigavazira, 2012). For Morton (2007), these practices make up a strong body of knowledge and expertise used in climate change mitigation, disaster reduction and adaptation strategies to manage and build resilience in crop production.

Reducing the impact of erratic rainfall on food production can be maximised through a combination of different knowledge systems (Berkes, 2012). New and improved technologies and financial initiatives may be considered to supplement the indigenous practices adopted by the farmers as a collective effort to address the impact of climate change on small-scale farming (Davis and Terblanché, 2016). The use of adaptation technology options in agriculture involve the application of organic fertilisers to improve the soil fertility and moisture content (Dejene *et al.*, 2011). For Ponge (2013), indigenous knowledge could be used to improve the productivity of crop production under erratic rainfall, and can only be effective when supplemented by appropriate modern scientific technology interventions such as the use of organic fertilisers and pesticides, and meteorological data.

The goal of the present study was to describe the types of indigenous knowledge and skills and innovative practices adopted and used by the small-scale farmers as adaptation measures to cope with the negative impacts of rainfall scarcity and rising temperature on subsistence crop production. This goal is supported by the observations that small-scale farmers have unique knowledge and skills to improve their crop production (Davis and Terblanché, 2016) supplemented by innovative practices to increase the production and ensure food availability and accessibility. Smit and Pilifosova (2001) corroborate that climate change adaptive capacity is characterised by the availability and access to information and skills, infrastructural and technological support systems. The indigenous and innovative practices identified in the study could be recommended to the South African National Development Plan to develop programmes and projects that foster support and empowerment of small-scale farmers as important agents to enhance food security through the application of indigenous and technological practices.

2. Method

2.1 Study area

The study is based on fieldwork conducted in Mogalakwena community in Limpopo Province, South Africa. The community falls within Rebone area, which has a total area of 20 km^2 with a population of about 10,579 (991.83 per km^2) (Statistics South Africa, 2011; Figure 1). The community falls within the summer rainfall region of Limpopo Province. The average rainfall is 600–650 mm with the highest measurements in January and December. The climate is renowned for its pleasant summer and mild sunny winter. Summer temperatures are from October to March ranging between 27°C and 30°C. Thunderstorms are recorded fairly often. The climate is renowned for its hot but pleasant summer and warmer winter. Topography of the area is characterised by irregular undulating lowlands with hills and low-lying mountains. Environmental challenges are inadequate sanitation systems, erratic rainfall, drought and inconsistent water supply. Mines and industrial activities negatively affected underground water quality. The local municipality is the largest contributor to domestic fuel burning emissions in the district, contributing to approximately 52% of emissions (Mogalakwena Local Municipality Integrated Development Plan [IDP], 2014/15). Mogalakwena community is a rural settlement. The residential area is made up of demarcated housing stands with a block of demarcated ploughing fields in a flatter and red-sandy area (IDP, 2014/15).

2.2 Study design

A qualitative study was conducted to describe the small-scale farmers' adaptation practices to the impacts of climate change hazards on subsistence crop production. Data were collected through direct interaction with the small-scale farmers.

2.3 Participants

Nine groups of eight members each were formed with a sample of 72 farmers purposely selected in Mogalakwena community. The farmers were practising subsistence farming in their home-gardens to supplement food bought from the supermarkets. The farmers' ages ranged between 29 and 76 years.

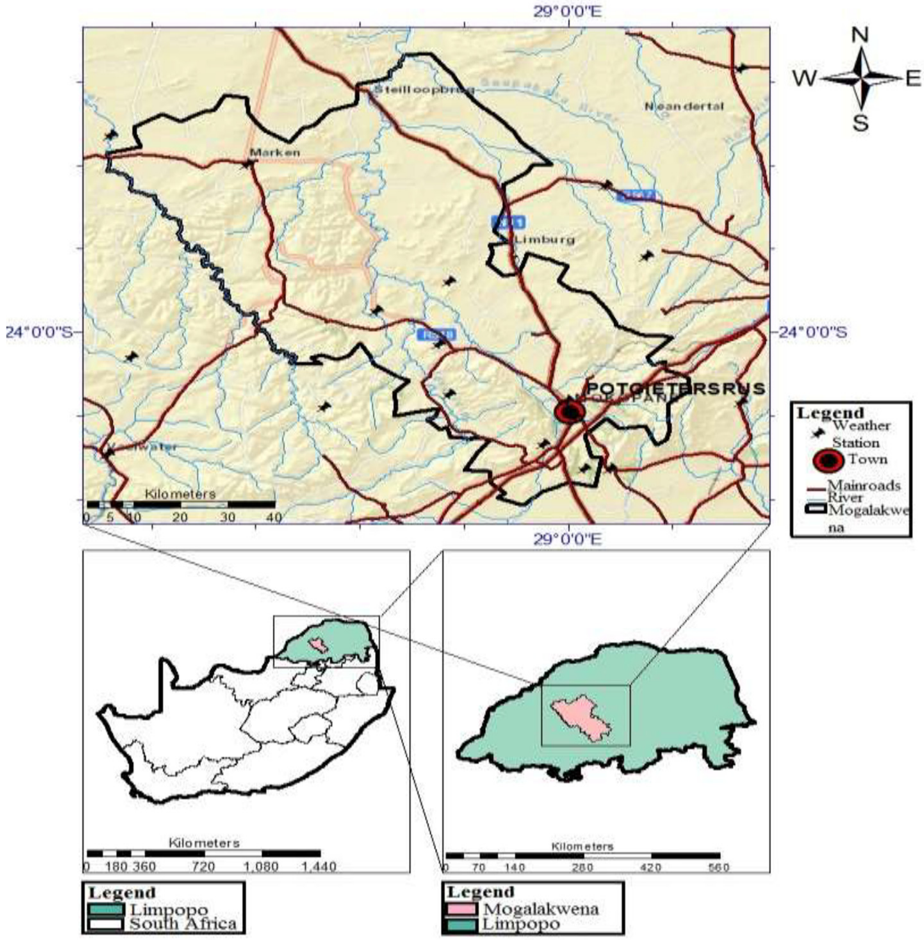

Figure 1.
Study location

2.4 Ethical considerations

The participants were assured that the information they provided during the discussions was confidential and would not be traced back to them. Anonymity and confidentiality were observed using pseudonyms to protect the participants' identity. All participants consented to participate in the study by signing the consent form.

2.5 Data collection

The purpose and goal of the study were explained to the participants per group. A list of questions was developed to guide the data collection process. Validity of the data collection tool was ensured by developing the questions that captured information about the farmers' understanding of climate change, how rainfall scarcity and increased temperature impact on their production, and the types of practices the farmers have adopted to improve crop production. The purpose of this was to ensure the use of a reliable data collection tool that yields consistent results from the participants. The focus group discussions lasted for one-and-half hours per group. Data were collected by making the notes of the responses from the groups.

2.7 Data analysis

Thematic content analysis was used to analyse the data. The method was used to identify, analyse and report patterns within data. Analysis of data started with familiarisation with the responses and implications from the participants' point of view. This process enabled coding, where the data were scored by counting the number of times a particular theme was expressed. Coding was followed by the development of themes and sub-themes. Lastly, the researcher contextualised and interpreted the data to determine how far the research problem was addressed. The last step was report writing and follow-up meeting with the groups to share and verify the study findings to ensure that the findings represent the participants' views.

3. Results and discussion

3.1 Farmers' perceptions of climate change and its impacts on small-scale farming

The farmers reported that small-scale farming in the study was solely rain-fed. The farmers grew a variety of indigenous crops in the home-gardens. The farmers ensured self-sufficiency by growing the crops in the home-gardens. The farmers were aware that their production was declining because of change in climatic conditions. For example, they noticed that they were already experiencing rising temperatures and erratic rainfall, which were negatively affecting the growth and quality of the crops. They noticed a decline in the intensity and amount of rainfall, that rain has become scarce and comes after the usual rainy season, which was between September and November months, the usual growing season. The farmers reported that there was not enough rainfall required to grow and maintain the crops. Rising temperature events, associated with climate change, were reported as another factor that impacted negatively on subsistence farming. Excessively hot temperature was responsible for sudden reduction in crop quality and yields, in which the crops wither and die off because of excessive heat without rainfall. Whenever the crops survive drought, the heat stress reduces their quality and yields. The farmers reported that reduced rainfall coupled with increased temperature are responsible for reduced food availability, accessibility and utilisation, which are important elements of food security. These negative impacts of climate change on small-scale farming are supported by the observations that indigenous food security mechanisms are threatened by climate change hazards, mostly drought, rainfall scarcity and temperature variation (Maponya and Mpandeli, 2012). The above agricultural conditions are not unique to the studied community. They are the same conditions observed by Mönnig (1967) where rainfall was regarded as the greatest factor that determined food scarcity and sufficiency. Hanjra and Qureshi (2010) corroborate these findings that the impacts of unreliable rainfall and increased temperatures have reduced food production capacity, resulting in food insecurity and economic shutdown. According to Maponya and Mpandeli (2012), small-scale farmers are prone to the climatic risks and shocks and have been with the climate-induced shocks for some time. The three dimensions of food security, namely, food utilisation, availability and accessibility at household level are being negatively hampered by climate change (FAO, 2010). For Angula and Kaundjua (2016), poverty is linked to food insecurity intensified by the effects of climate change where most small-holder farmers in the rural communities are faced with low agricultural output, which impacts negatively on food production and security efforts.

3.2 Farmers' indigenous knowledge of coping with climate change

Long periods of erratic rainfall were noted by all the farmers. For them, erratic rainfall has brought eminent shift in the household agricultural production, which traditionally did not require any shift in the production systems because rain was received in the correct seasons with minor environmental challenges. The farmers reported a variety of local adaptation practices used to improve the production of subsistence crops and promote resilience to unpredictable rainfall. The practices included rainfall prediction, soil fertilisation, crop management and change of the planting season and crop diversification.

3.2.1 Rainfall prediction. The farmers observed a change in the onset and quantity of rainfall that is impacting negatively on their agricultural activities and quality of their agricultural production. They, therefore, adapted to this change by relying on their knowledge of predicting rainfall to plan their farming activities. For example, the most important predictions reported were high temperatures at the beginning of summer and the appearance of Sekgopetšana (a morning star/planet venus), which were associated with a high probability of rainfall. The predictions of higher rainfall probability encouraged the farmers to prepare for the planting season well in advance to ensure that planting would ensue with the first good rain. Also the farmers' plan of agricultural activities was determined by the prediction of reduced rainfall probability by notable increase in strong winds, which are believed to drive away rain clouds. Another prediction was the wind blowing in all directions, which suggested a good rainfall season, while winds blowing from the south-east were indicators of drought. Lastly, farmers mentioned that the beginning of summer and rainfall season, which was mentioned as the planting season, was marked by the flowering of Acacia plants. By observing these flowers, the farmers could tell whether the rainy season would be good or bad. Good quality of the flowers determined a good rainy season. Kalanda-Joshua *et al.* (2011) support that the farmers use climate predictions, which are trusted forecasts of rainfall probability that allowed communities to take informed decisions to plan their agricultural activities. For Smit and Pilifosova (2001), these are developed as the art of predicting rainfall availability where local communities use their experience, observation and accumulated knowledge developed and relied upon throughout generations. The local climate predictions are largely based on keen observation of changing floral, planetary and other physical changes in the surroundings that precede or accompany meteorological phenomenon of larger interest (Camberlin, 1997).

3.2.2 Soil fertilisation. The most common practice adopted by the farmers before growing of the crops was preparation of the soil to enhance crop sustenance. This entailed soil fertilisation through the use of the previous harvest remainders such as maize stalks, dried bean and nut plants into the soil, and the use of kraal manure. Other products reported to be used were the ash and char remains from cooking. These practices were meant to improve the soil productivity and structure, the retention of moisture content and prevention of soil erosion. This type of garden preparation before planting is similar to the techniques practised in Burkina Faso, Kenya, Senegal and Niger in which the farmers bury the crop residues to replenish soil fertility, burning crop residues to enhance quick release of nutrients and allowing livestock to graze on farmlands after harvesting crops to improve soil organic matter (Lema and Majule, 2009). Similar adaptation practices used by the small-scale farmers in Limpopo Province, South Africa, embrace soil mulching, soil ripping or direct seeding (Afful and Ayisi, 2020) to hold the soil particles together and reverse desertification.

3.2.3 Change of the planting season. Another common adaptation practice reported in the study was adoption of the late planting season as a result of late onset of rainfall. The farmers observed that rainfall was starting late and was negatively affecting commencement of the planting season. The farmers reported that in the past 20–30 years, the rainfall season started the beginning of September to early December. During this period, the farmers would start preparing the fields for planting. But, the current observations were that the first rain is unpredictable as sometimes it comes earlier towards the end of winter or later in the year. Another important factor was the less quantity of rainfall experienced, which would not allow any planting to ensue. The farmers would not start planting until enough rain has fallen to drench the soil sufficiently to enable growing of the crops. The farmers agreed that planting is recently done late in the year to the beginning of the following year because of late rainfall. These observations are corroborated by Afful and Ayisi (2020) that South Africa is a region that is prone to significant intra-seasonal variability during the rainy season (September–December) when the farmers in the summer rainfall areas have to begin farming. Makuvaro *et al.* (2018) attest that poor production of subsistence crops is because of seasonal changes in temperature and rainfall amount and timing.

3.2.4 Crop diversification. The farmers reported that late rainfall has motivated diversification of crops to minimise crop failure, improve yields and expand food sources. The farmers grew varieties of indigenous crops some of which are drought resistant, and others would do well under enough rainfall. Drought-resistant crops included millet, sorghum, beans, melons and nuts. Maize would grow well under good rainfall. Mixed cropping was practised by growing different crops at the same time although they differed in the maturity season. Crop diversification is an important adaptation practice that ensures reduction of the risk of failure under unpredictable weather conditions (Lasco *et al.*, 2014; Ncube and Lagardien, 2015). This observation is supported by Makuvaro *et al.* (2017) that growing drought-tolerant crops such as sorghum and pearl millet is technically sound and, therefore, needs to be strengthened through more advocacy and ensuring availability of appropriate crop seeds. The findings from the study conducted by Gukurume (2014) in Bikita District, Masvingo Province of Zimbabwe, also established that small-holder farmers have resorted to growing crops like sorghum, finger millet and rapoko because they are more resistant to drought.

3.2.5 Crop management. The main management practice reported by the farmers was removal of weeds in-between the crops consistently until the crops mature. The observation was that many weeds could negatively impact on the crop growth and quality, or might attract insects and pests that disturb the pollination process for some plants. Dejene *et al.* (2011) support that weeding is essential during the early development stage of crops as they can compete with the crops for moisture, light and nutrients.

3.3 Innovative adaptation practices

The farmers reported three innovative practices, namely, the use of chemical fertilisers, growing of exotic crops to improve their agricultural production and ensure food security. Additionally, fewer farmers relied on meteorological data to plan their agricultural activities.

3.3.1 Use of chemical fertilisers. All the farmers reported that they often use chemical fertilisers and pesticides bought from the retailers to fertilise the soil, and dispel the pests from the crops. The farmers used these chemicals to improve the soil fertility and crop yields. To these observations, Angula *et al.* (2012) support that vulnerability of small-holder farmers to climate change is lessened by adequate access to relevant technologies. The use of chemicals in small-scale farming brought a newer class of essential production inputs to agriculture, which implies that the farmers would acquire technical skills to enrich soil fertility and crop yield (Davis and Terblanché, 2016; Popoola *et al.*, 2018).

3.3.2 Production of exotic crops. In the study, fewer farmers (35%) grew exotic crops such as spinach, tomatoes, chilies and onion in their gardens to maximise food availability in the households. Matlakala *et al.* (2020) support that small-holder farmers have resorted to planting exotic and indigenous crops simultaneously to maximise the crop yields. Climate change has dovetailed uncertainties and risks, which compelled subsistence farmers to engineer viable adaptation methods through diversification of crops and livelihoods (Khatam *et al.*, 2013; Kakumanu *et al.*, 2016).

3.3.3 Use of meteorological data. Fewer farmers (49%) acknowledged that they use meteorological data from the local extension officers to predict rainfall availability. The farmers reported that they also get scientific weather forecast from radio, television and extension officers, which they used to complement their knowledge of weather forecast. Despite availability of the modern technological tools to predict weather conditions for the next day or over the season in a specific location, traditional weather lore still remains an important source of local forecasting in many areas (Rautela and Karki, 2015).

4. Conclusion

The significance of the study was to demonstrate combined efforts to improve the production of subsistence crops under the threats of climate change hazards. Interactions with 72 farmers showed continued practice of subsistence farming in the home-gardens despite observable negative impacts of rainfall scarcity and rising temperatures on the production. The farmers' awareness of changing weather patterns did not stop them from producing subsistence crops. This was made possible by the adoption of the indigenous and innovative practices. The farmers use this blend of practices with the purpose of maximising the chances for improved crop yields such as the ability to predict rainfall, soil fertilisation, crop diversification, change of planting season and crop management. These are the knowledge and skills used by the farmers to mitigate and cope with the effects of less rainfall and excessively hot temperature on crop production. These indigenous knowledge and skills are supplemented by innovative practices such as the use of chemical fertilisers, planting of exotic crops and the use of meteorological data to minimise the risks in crop production. The resulting situation is the farmers' holistic approach towards food security at household level, which could be widely adopted to minimise the risks endured in rain-fed crop production in the era of climate change. The practices may be referred to as the adaptation practices as they fall within the adaptation and mitigation systems stipulated in the South African National Climate Change Strategy to assist the small-scale farmers grow and maintain the crops to improve production and minimise the risks, thus ensuring food security under observable harsh climate hazards.

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