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AGRICULTURAL EXTENSION SERVICES: ARE THESE BARRIERS OR OPPORTUNITIES FOR SMALL-SCALE SUBSISTENCE CROP PRODUCTION IN THE ERA OF CLIMATE CHANGE?

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ABSTRACT
The livelihoods of smallholder farmers in semi-arid regions are being threatened by climate change and variability. The combination of rising temperatures and less rainfall poses a significant challenge to crop productivity and food security for these farmers. Consequently, the implementation of agricultural extension services is regarded as a more effective approach to bolstering small-scale agricultural productivity. This review describes the contributions made by agricultural extension officers in assisting small-scale farmers, as well as an examination of the obstacles and potential avenues for enhancing subsistence crop production in the context of climate change in Limpopo Province, South Africa. A comprehensive selection of literature was examined, and a deductive coding methodology was employed to analyse the literature. The results of the study reveal that agricultural extension support given to small-scale farmers, specifically climate information and training on alternate ways of crop production, is an opportunity crucial for adapting to and managing the challenges posed by fluctuating temperatures and rainfall patterns. These services offer the potential for enhanced food production. The farmers use both extension services and their indigenous adaptation practices simultaneously. This review proposes a novel strategy for mitigating the adverse effects of climate change on subsistence crop production; the integration of conventional and contemporary production technology and expertise offered by agricultural extension officers to formulate a pertinent and well-received policy for climate change adaptation, with the aim of ensuring food availability and accessibility.

KEY WORDS
Agricultural extension service, small-scale farmer, climate change, climate resilience, climate adaptation.

Extension services have a crucial role in supporting small-scale farmers in their pursuit of food security objectives (Bontsa et al., 2021). According to Loki et al. (2021), farmers can acquire valuable knowledge on farming techniques, enhance their understanding of evolving climate patterns, and acquire proficiency in management strategies that enable them to adapt to climate change and maintain sustainable agricultural productivity through their access to extension services. According to Somanje et al. (2021), there exists a level of awareness among small-scale farmers regarding the various services and support mechanisms provided by agricultural extension officers. The implementation of agricultural extension services seems to be a more effective approach in bolstering agricultural production (Agholor et al., 2013). This strategy assumes a significant function in augmenting agricultural productivity and ensuring food security (International Food Policy Research Institute [IFRI], 2015). Acevedo et al. (2020) appreciates the use of agricultural extension methodologies to enhance agricultural extension service delivery and foster agricultural development among small-scale farmers who experience adverse effects of reduced rainfall and increasing temperatures on their productivity. These resources aim to enhance subsistence production in the context of climate change.

The provision of extension services to smallholder farmers is mostly contingent upon the capabilities of extension workers in disseminating sophisticated agricultural technologies and knowledge (Mgbenka et al., 2016). According to a study conducted by Abdu-Raheem (2014), it is crucial for extension workers to view farmers as collaborators in the process of

developing novel approaches and creating innovations. This perspective emphasises the importance of recognising farmers as active participants rather than mere users of agricultural extension services, which may not always align with their specific lives and farming practices. Similar to other poor nations, South Africa faces challenges in accessing up-to-date and advanced solutions to combat the adverse impacts of climate change. Farmers inherently encounter challenges related to low agricultural output and food shortages (Tomlinson & Rhiney, 2018). Climate change plays a significant role in the diminished agricultural output observed in South Africa. According to Ubisi (2016), the agricultural practices in Limpopo province mostly rely on rainfall and are susceptible to the impacts of climate change, particularly alterations in temperature patterns and precipitation cycles, along with occurrences of severe weather events. According to Maponya (2021), it has been suggested that the Department of Agriculture, Land Reform, and Rural Development has the potential to assume a significant role in providing training to extension personnel about climate change strategies and adaptation measures specifically tailored for smallholder farmers.

The necessity of using climatic smart agriculture strategies in the smallholder farming sector is indisputable (Vanlauwe et al., 2015) as agriculture and food production are highly vulnerable to climate change. Extreme weather events such as droughts, heat waves and flooding have far-reaching implications for food security and poverty reduction, especially in rural communities with high populations of small-scale producers who are highly dependent on rain-fed agriculture for their livelihoods (Acevedo et al., 2020). According to the Food and Agricultural Organisation of the United Nations (FAO, 2018), unless extension officers implement climatic smart agriculture strategies to enhance smallholder farmers' resilience to climate change, farmers will remain excluded from its convenience. The aim of this review is to determine if agricultural extension officers' support to small-scale farmers are barriers or opportunities to maximise subsistence crop production in the era of climate change in Limpopo Province, South Africa. This review argues that the adoption of sustainable agricultural practices falls in the domain primarily of public sector agricultural extension (Department of Agriculture (DOA), 2014). However, these are introduced to the small-scale farmers to improve their crop productivity to alleviate food insecurity. Mostly these farmers are resident in the rural areas where cultural heritage including subsistence production practices are protected against adulteration and extinction. The results of this review may assist government and other sector players in addressing the agricultural extension barriers and maximise the opportunities for a relevant and effective agricultural extension support to the small-scale farmers to enhance food security at household level.

METHODS OF RESEARCH

This review is based on a literature to describe the role of agricultural extension and determine its opportunities and barriers to small-scale farmers to sustainable food security in Limpopo Province, South Africa. Existing literature, policies, administrative records, and government reports provided information for this study. The first section focused on the extent of climate change impacts on small-scale crop production, followed by the roles of agricultural extension support and, determining whether small-scale farmers benefit from the services or not.

The motivation for this review is the observations from the literature that subsistence rain-fed agriculture is the main source of livelihood and a local food security mechanism in Limpopo's rural communities (Maponya & Mpandeli, 2013; Rankoana, 2017; 2022; Statistics South Africa, 2021; Polokwane Local Municipality Integrated Development Plan (IDP, 2021–2022). The average annual temperature in the three districts ranges between 25 and 40 degrees, making them hot and semi-arid. From October through March, daytime highs often range from 28 to 34 degrees Celsius, making for sweltering summer days. In the summer, lows range from a warm 16 degrees Celsius to a pleasant 21 degrees Celsius. Daytime lows in the winter range from 19.6 to 25.2 degrees Celsius, making the season feel more like spring or summer. Temperatures range from 4.3° to 12.1° C throughout the winter months.

There is a heavy rainy season from November through February, with an annual average of 600 to 650 mm, according to the Polokwane Local Municipality Integrated Development Plan (IDP, 2021–2022). According to Statistics South Africa Mid-Year Population Statistics (2021), small-scale farmers are the most affected by a lack of employment opportunities and other socioeconomic issues. The aim of this review is to describe agricultural extension officers' support to small-scale farmers and determine whether they are barriers or opportunities to maximise food security through subsistence crop production in the era of climate change in Limpopo Province, South Africa.

RESULTS AND DISCUSSION

Challenges faced by small-scale farmers under climate change. The livelihoods of smallholder farmers in semi-arid regions are being jeopardised by climate change and variability. This is due to the combination of elevated CO_2 levels, rising temperatures, and reduced rainfall, which pose a significant obstacle to crop production and food security (Grace et al., 2012). The adverse impacts of climate change, including elevated temperatures, frequent droughts, and unpredictable precipitation patterns, have resulted in substantial reductions in agricultural output (Gemeda et al., 2021). This is evident through the occurrence of crop failures, water scarcity, and the emergence of disease epidemics among human populations (Mdoda, 2020). Gemeda et al. (2021) conducted a recent study which revealed that variations in rainfall, such as untimely or premature rainfall occurrences and inadequate distribution of rainfall, had a substantial influence on the productivity of crops. The Republic of South Africa has experienced notable rises in temperature and fluctuations in precipitation, and scholarly investigations indicate that the nation's climate has gradually gotten more arid over the past century, rendering it susceptible to drought conditions (Mpandeli et al., 2015).

The subsistence livelihoods of South Africa heavily rely on small-scale farming, which is vulnerable to the impacts of climate change due to the frequent occurrence of droughts in rural regions (Mogale et al., 2022). This is because smallholder farmers rely on rain-fed agriculture as their primary means of sustenance (Mpandeli et al., 2015). The farmers engage in the management of familial agricultural enterprises and employ conventional subsistence techniques, so subjecting themselves to notable climatic vulnerabilities in instances of seasonal fluctuations and droughts that are associated with climate change (Antwi-Agyei & Stringer, 2021). In addition, the issue of soil fertility, which is a defining characteristic of the smallholder farming system, poses an additional challenge that farmers must confront (Vanlauwe et al., 2015; Mogale et al., 2022). According to Tomlinson and Rhiney (2018), smallholder farmers encounter a range of difficulties, including drought, rising temperatures, degradation of pastures, heightened prevalence of parasites and diseases, and diminished productivity, all stemming from the impacts of climate change. These multifaceted and uncertain changes significantly impact farming management systems and agricultural output. Kogo et al. (2021) emphasise the adverse impact of ongoing climate change and future projections on agricultural productivity, leading to food insecurity and changes in cropping patterns.

According to Myeni et al. (2019), the impact of climate change on food security and the livelihoods of South African smallholder farmers, who heavily rely on rainfed agricultural production and possess limited adaptation capabilities, is a matter of concern. The vulnerability of Limpopo province to climate variability and change is attributed to its reliance on the quality of rainfall for agricultural production (Maponya & Mpandeli, 2012). The findings derived from the investigation conducted by Rankoana (2022) support that subsistence farmers depend on the rainy season in order to engage in the cultivation of rain-fed indigenous crops. This observation implies that a significant amount of rainfall is crucial for the cultivation of subsistence crops, rendering it a climate-dependent agricultural system with less potential for adaptability. Antwi-Agyei and Stringer (2021) add that the agricultural sector is particularly susceptible to the impacts of climate change due to its sole reliance on rain-fed systems. According to the findings of Adeagbo et al. (2021), it is anticipated that smallholder

rain-fed systems will experience a reduction of approximately 10% in the overall maize yields by the year 2055. The Limpopo Province has experienced a noticeable decline in overall precipitation, resulting in adverse consequences primarily for rural communities reliant on subsistence farming as their main source of sustenance (IDP, 2021–2022). According to Shikwambana and Malaza (2022), the current local food security strategies are susceptible to the unpredictable and quick fluctuations in rainfall patterns. The vulnerability of farmers to climatic variability and change is primarily influenced by their socio-economic status and limited capability for adaptation (Dang et al., 2018). The circumstance is further aggravated by the presence of poverty and illiteracy, all of which serve to restrict the farmers' ability to adapt and demonstrate resilience. Shikwambana and Malaza (2022) concur with these findings, asserting that subsistence farming is characterised by diminished crop yield productivity because climate change has had a significant impact, leading to a pervasive issue of food insecurity.

The challenges encountered by small-scale farmers arise from the recognition that the Limpopo province is particularly susceptible to the adverse effects of climate change. Within this province, the impacts of climate change disproportionately burden impoverished rural households, while large-scale farmers and urban residents are comparatively less affected (Maponya & Mpandeli, 2014). According to Mpandeli and Maponya (2012), a significant number of small-scale farmers are susceptible to climatic risks and shocks and have been grappling with the consequences of climate-induced shocks for a considerable duration. Hence, the dissemination of innovation among small-scale farmers is a crucial function of agricultural extension services. The necessity for the farmers to adapt to the impacts of climate change stems from the need to modify their knowledge, attitudes, resilience capacities, and skills (Maponya & Mpandeli, 2014). The potential for agricultural extension to facilitate this transformation is predicated on its primary objective of providing guidance to farmers in mitigating various challenges and enhancing their productivity and profitability.

Agricultural extension officers' support to small-scale subsistence crop production. Agricultural extension services are a formal entity that plays a crucial role in providing support to small-scale agricultural production and in the attainment of household food security (Rickards et al., 2018). The provision of extension services plays a crucial role in enhancing farmers' agricultural knowledge and skills, facilitating the dissemination of new technology, and fostering a shift in farmers' attitudes (Raidimi & Kabiti, 2019). Additionally, these services contribute to the promotion of community development by fostering the development of human and social capital, facilitating market access, and collaborating with farmers to achieve sustainable natural resource management (Rickards et al., 2018). The services also serve as primary mechanisms for attaining the agricultural development objective of ensuring food security and eradicating hunger by delivering suitable agricultural information and knowledge to empower land users and farmers in order to enhance, sustain, and promote economic development (Zwane et al., 2014).

Other functions of agricultural extension are educational in nature, since its agents are responsible for the provision and dissemination of information to farmers and offering institutional support and assistance in addressing the requirements of farmers (Maponya & Mpandeli, 2013). Additionally, Mmbengwa (2009) asserts that farmers who have access to extension services are more likely to participate in agriculture with greater profitability compared to those who lack such access. According to Raidimi and Kabiti (2019) support that agricultural extension services have a significant impact on enhancing the productivity and incomes of farmers, thereby leading to a reduction in poverty levels and an improvement in food security. According to Maake and Antwi (2022), the primary objective of agricultural extension officers is to guarantee that farmers are provided with the necessary assistance to effectively produce sufficient and high-quality agricultural products, hence contributing to food security. To these observations, Maponya and Mpandeli (2014) say that agricultural extension offers agricultural assistance to farmers and aid them in making informed decisions to enhance

Extension officers are responsible for many services, including the provision of institutional support and the facilitation of farmers' requirements to enhance agricultural

production (Maponya & Mpandeli, 2014). Farmers are provided with a wide range of knowledge pertaining to cultivation practices, fertilisation, plant protection (including pests, weeds, and disease control), marketing strategies, livestock and crop management, and the impact of climate change through government agricultural extension and advisory services (Maake & Antwi, 2022). The implementation of agricultural extension services has been found to significantly improve the decision-making process of farmers regarding the adoption of climate change coping techniques. Consequently, this would contribute to the facilitation of smallholder farmers' adoption of such practices. According to Maponya and Mpandeli (2014), there is a contention that farmers who have access to extension services are more likely to adopt new farming technology compared to farmers who do not have access to extension contact. According to a study conducted by Afful et al. (2014), a survey of extension agents in Limpopo province revealed that many of these agents actively advocated for the implementation of techniques aimed at coping with and adapting to climatic variability among farmers (Buthelezi et al., 2020).

The availability of extension services is expected to influence the adoption of coping mechanisms among farmers in response to suboptimal crop yields. According to Ngarava (2019), this practice is indicative of farmers' pursuit of sustaining or enhancing subsistence production, as well as preserving its social and symbolic significance within rural communities. The findings of Vanlauwe et al. (2015) demonstrate the significance of extension services as a valuable information resource for farmers. These services contribute to the enhancement of farmers' managerial and technical capabilities, hence enabling them to effectively utilise the acquired knowledge. Farmers who value extension services have the capacity to impart knowledge and skills pertaining to agricultural production and the dynamics of climatic variability and change to surrounding farms. The significance of extension services in assisting smallholder farmers to addressing the numerous issues associated with agricultural output cannot be overstated. Nevertheless, there is a scarcity of research that examines the methods by which the competencies of agricultural extension agents might be enhanced to better support smallholder farmers in their management of climate-related risks and consequences (Antwi-Agyei and Stringer, 2021). According to a study conducted by Mokgomo et al. (2022), it is acknowledged that the provision of agricultural development supported by the South African government has proven to be efficacious in mitigating food insecurity and enhancing agricultural productivity, yielding advantages for small-scale farmers.

Communicating climate information to the farmers. Monthly climate advisories are regularly provided to the agricultural sector as a precautionary measure to aid farmers in effectively mitigating and adapting to potential climatic hazards. Agricultural extension agents rely on the agricultural department and various media channels as primary sources of climatic and agricultural information. The extension officers disseminate the information to the farmers. Research has demonstrated that farmers that possess early-warning systems, such as meteorological forecast systems, are more adept at managing and adjusting to the impacts of a dynamic climate. Farmers can enhance their farming practices, such as the selection of crop varieties for cultivation, through the utilisation of weather forecast data, which can be obtained from sources like community-managed weather stations. A survey conducted among extension agents in South Africa revealed that most of them actively advocated for the implementation of coping and adaptation measures to address climate variability among farmers (Afful et al., 2014). According to Stevens and Van Heerden (2016), the principal mechanism for disseminating knowledge to farmers in South Africa is the agricultural extension system. The attainment of enhanced agricultural productivity and the establishment of sustained food security in South Africa may prove challenging in the absence of pertinent and dependable agricultural information (Davis & Terblanché, 2016).

The significance of involving extension staff in comprehensive and ongoing professional development is emphasised by Wojcik et al. (2014). For him, this development is specifically targeted at enhancing the staff's expertise in climate education and equipping them with the necessary skills to effectively convey climate change information to farmers who are particularly susceptible to its impacts. However, there is limited knowledge regarding

the capacity requirements of agricultural extension agents, the obstacles they encounter, and the potential solutions that can enhance their effectiveness in helping small-scale farmers. The availability of climatic information can enhance the probability of adopting adaption strategies. According to the Intergovernmental Panel on Climate Change (IPCC, 2011; 2019), there is strong support for the notion that governments should prioritise the incorporation of adaptation to climate variability and change into several levels of policy-making, including national, provincial, local, and sectoral development agendas. The implementation of policies that are specifically designed to enhance the efficacy of extension services within communities has significant promise in bolstering subsistence crop output among farmers. It is imperative for governmental policies to provide substantial backing for the training of extension officers since this would enable them to effectively disseminate pertinent information regarding climate change adaptation to rural communities. According to the findings of Kephe et al. (2021), educational support emerged as the primary determinant of farmers' adaptive capacity.

Climate resistant crops and use of fertilizers. Enhancing the ability of small-scale farmers in susceptible areas to effectively handle climate-related risks is becoming imperative. Over the course of the last two years, agricultural extension assistance has been extended to land and agrarian reform initiatives in the form of drought-resistant seeds and fertilizers. This provision plays a significant role in enhancing food security and mitigating poverty. Consequently, extension initiatives prioritise the provision of education to farmers on various adaptation strategies, with the aim of bolstering their resilience and response capabilities (Mustapha et al., 2012). The support systems offered by extension officers to assist farmers in Limpopo Province can be classified into three categories as outlined by Mustapha et al. (2012): policy and programme facilitation and implementation, provision of information and guidance on adopting new farming techniques, and capacity development. According to Wojcik et al. (2014), there have been attempts to facilitate the dissemination of suitable technology, primarily focused on crop and livestock production systems, from central research institutions to small-scale farmers. Enhancing the agricultural proficiency of farmers in employing climate-smart practices, such as soil conservation, is of utmost importance due to the heightened susceptibility of farming households in the era of climate change (Myeni et al., 2019).

Climate-smart agricultural technologies provide farmers the potential to enhance food production, bolster adaptive ability, and mitigate the hazards associated with climate change. Extension agents have a crucial role in disseminating knowledge and information pertaining to climate-smart technologies, as highlighted by Olorunfemi and Oladele (2021). According to Maponya and Mpandeli (2013), the exposure of farmers to extension services has a significant impact on their ability to adapt to climate change. This is attributed to the educational nature of these services, which provide farmers with knowledge and skills, such as the development and dissemination of local cultivars of drought-resistant crop varieties. The information provided through these services also includes details about the advantages and disadvantages associated with these crops. The significance of agricultural extension in facilitating adaptation should not be overlooked, as it serves as a catalyst for transforming the knowledge, attitudes, resilience capacities, and skills of individual farmers. The potential for agricultural extension to facilitate this transformation arises from its fundamental objective of providing guidance to farmers on how to mitigate various challenges and enhance their agricultural output and economic gains (Mdiya et al., 2023). In Nigeria, agricultural extension workers have implemented and advocated for a range of resilient methods, including but not limited to crop rotation, crop diversification, organic farming, sustainable land management, cover cropping, as well as facilitating access to markets and financial resources, with the aim of assisting farmers in adapting to various challenges (Chikezie et al., 2019).

Agricultural extension support: A barrier to improved subsistence crop production? Smallholder farmers have effectively adapted to climate change shocks using their indigenous knowledge, tacit knowledge, and accumulated experience in crop production. The smallholder farmers employ various adaptation strategies in response to climate change, such as altering crop varieties, practising intercropping, adjusting planting schedules,

implementing water conservation techniques, adopting shifting cultivation practices, and utilising indigenous vegetables and fruits. These strategies are significantly influenced by their cosmological perspectives and cultural values in a limited manner. Similar to other cultural practices, these practices are location-specific adaptation methods in response to climate change. The preservation and safeguarding of these values are vital in order to uphold and maintain cultural heritage, which is integral to the promotion of sustainable development. However, the recognition and examination of their coping mechanisms are rather limited. Regrettably, there is a lack of emphasis on culture-specific adaptation strategies, as the primary focus lies on agricultural extension support. This support mostly pertains to climate change adaptation methods that are applicable to the growing of exotic vegetables and fruits. These observations challenge the assertion made by Taruvinga et al. (2016) that on-farm crop-based adaptation practices are inadequate in terms of providing diverse adaption options for rural smallholder farmers.

The agricultural extension support lacks substantial consideration of cultural relevance and acceptability. Nevertheless, it is worth noting that small-scale farmers are provided with training and education regarding the use of modern technology and skills, without acknowledging the significance of their indigenous knowledge in crop production. This approach implies that their traditional knowledge and associated practices are deemed inconsequential in addressing the challenges posed by climate change on crop production and management. The Limpopo government places a high priority on extension services due to their ability to enhance farmers' understanding of evolving climatic conditions and their corresponding adaptation strategies in agricultural productivity. According to Maponya and Mpandeli (2013), there is evidence to suggest that farmers might benefit from embracing new adaptation practices that necessitate modifications in individuals' knowledge, attitudes, resilience capacities, and skills. The author argues that agricultural extension services have the potential to facilitate this transformative process. The adoption of new technology by farmers is influenced by their access to extension services, which expose them to novel knowledge and enhance their technical abilities. Additionally, this process involves utilising the indigenous knowledge derived from two primary sources of information, namely extension services and farmers, in order to enhance the implementation of adaptation strategies (Mmbengwa, 2009; Taruvinga et al., 2016). According to Maponya and Mpandeli (2013), extension officers are responsible for a range of services, including offering institutional assistance and facilitating the requirements of farmers to enhance agricultural production. These officers employ diverse approaches, such as organising study groups, farmer days, demonstrations, lectures, and distributing literature, to effectively engage with farmers and promote the adoption of improved farming methods. Additionally, they play a crucial role in communicating farmers' challenges to the media. According to a recent investigation carried out by Maake and Antwi (2022), there is evidence to suggest that agricultural extension officers demonstrate effectiveness in adhering to the principles of Batho Pele, which involves providing high-quality services and goods, particularly in their interactions with individuals and in planning activities. Furthermore, these officers are found to actively promote equity among various groups, including subsistence small-scale farmers, women farmers, and farmers with disabilities.

Notwithstanding these noteworthy and favourable observations, it is argued that the imposition of agricultural extension on farmers through the transfer of technological extension ways, as elucidated by Khwidzhili and Worth (2020), is not advisable. The primary obstacles to the implementation of adaptation techniques were identified as insufficient availability of climate change information and limited access to extension services, as revealed in the research conducted by Olabanji et al. (2021). The issue at hand was similarly observed in Nigeria, Ghana, and Pakistan. Studies examining the limitations faced by smallholder farmers in their efforts to cope with and adapt to climate change revealed that a significant proportion of these farmers lack adequate knowledge about climate change and were thus unable to employ appropriate coping and adaptation strategies (Onyeneke & Madukwe, 2010; Acquah & Onumah, 2011; Abid et al., 2015). According to Gandure, Walker, and Botha (2013), the limited availability of climate change early warning systems and inadequacies in

seasonal forecasts have hindered the ability to effectively cope with and adapt to climate change. The imperative of the South African Department of Agriculture to advocate for agriculture as a significant means of addressing poverty, hunger, and malnutrition does not exclude the use of conventional climate change adaption strategies. A noteworthy aspect to consider is that smallholder farmers in Capricorn encounter a significant obstacle in the form of the requirement to embrace novel methodologies for crop cultivation. These methodologies include the adoption of non-native seeds, the utilisation of fertilisers, the acquisition of knowledge regarding climate change, and the implementation of effective crop management strategies (Maponya & Mpandeli, 2013).

There has been a tendency among agricultural extensionists in sub-Saharan Africa to assume that farmers may only derive benefits from novel concepts that are not directly applicable to their existing farming systems (Ngomane, 2006; Magoro & Hlungwane, 2014). According to Davis (2008), there is support for the conventional techniques to agricultural development and extension that have proven to be ineffective in addressing the challenges faced by small-scale farming in developing countries. According to a study commissioned by the Department of Agriculture, Forestry and Fisheries (DAFF) in 2009, it was determined that there is no specific extension model that is recommended for South Africa. This recommendation was made due to the high rate of failures and limited success observed in agricultural development projects. As a result, it became necessary to review and analyse the roles and responsibilities of agricultural extensionists in addressing the perceptual problems faced by farmers within the Limpopo province. In a recent study conducted by Khwidzhili and Worth (2020), it was determined that agriculture extension services play a fundamental role in facilitating agricultural development. Nevertheless, the advancement of this sector necessitates the establishment of a proficient and productive extension system. An additional factor is the lack of alignment between the new technologies and skills provided to farmers and their traditional subsistence crop production practices, which are deeply rooted in their cosmological perspective, cultural values, and belief systems. Despite the adverse effects of increasing temperatures and unpredictable rainfall patterns, farmers are confronted with the challenge of low agricultural productivity. To mitigate this issue, they employ indigenous adaptation strategies, including weather forecasting, adjusting planting schedules, implementing mulching techniques, selecting appropriate seeds, and practising effective crop management. The implementation of adaptation strategies is enhanced by the utilisation of indigenous information pertaining to rainfall patterns and seasonal projections. This knowledge proves valuable in effectively scheduling the planting season (Maponya & Mpandeli, 2012; 2013; Rankoana, 2017; 2020; 2022). According to Myeni et al. (2019), the farmers are more inclined to adopt traditional sustainable agricultural practices such as intercropping, mulching, and crop rotation. In contrast, they suggest that new agricultural practices such as cover cropping, minimum tillage, tied ridging, and planting pits, which require more knowledge, capital, and labour, are likely to be adopted by a smaller number of farmers.

According to Gandure et al., (2013), the limited availability of climate change early warning systems and inadequacies in seasonal forecasts hindered the ability to effectively cope with and adapt to climate change. According to the study conducted by Juana et al. (2013), the implementation of climate-friendly practices includes the utilisation of indigenous seeds that possess the ability to withstand severe weather conditions such as drought and flood. Additionally, diversifying production systems and adjusting the date of planting are also among the selected strategies. Additional strategies that can be implemented include the adoption of water, soil, and nutrient conservation techniques, the enhancement of irrigation practices, the cultivation of varied cultivars within the same crop type, the establishment of tree crops, the cultivation of short-duration crops, the diversification of livestock, and the utilisation of veterinary officers as support systems.

While certain research has demonstrated that extension services efficiently fulfil their duty in disseminating information (Maponya & Mpandeli, 2013), other studies have argued that they are insufficient, particularly in terms of providing farmers with resilient and adaptive information (Ugwoke et al., 2012). Moreover, the insufficient degree of consciousness and

dearth of climate change-related proficiencies among extension workers had an adverse impact on their ability to assist farmers in adapting to the challenges posed by climate change (Kassem et al., 2019). In a study conducted by Defang et al. (2017), it was found that smallholder farmers perceive a lack of adequate information regarding climate change and a limited understanding of suitable coping and adaptation strategies as primary barriers to effective adaptation. According to Popoola et al. (2020), the impact of agriculture extension services on smallholder farmers' understanding of climate change is quite limited. The farmers reported relying on knowledge shared among their peers, as they felt that extension services were not adequately supporting them in their adaptation efforts. According to Mapiye et al. (2021), smallholder farmers have numerous complex obstacles, and among these, the primary barrier to their sustainability is the restricted availability of extension services. The issue of insufficient knowledge and understanding of climate change, as well as the lack of appropriate coping and adaptation strategies, was observed in Nigeria, Ghana, and Pakistan. Studies conducted in these countries, namely by Onyeneke and Madukwe (2010), Acquah and Onumah (2011), and Abid et al. (2015), highlighted the constraints faced by smallholder farmers in these regions. These constraints included a lack of information about climate change and a knowledge gap regarding suitable coping and adaptation measures.

CONCLUSION

Agricultural extension services provided to small-scale farmers encompass the provision of knowledge, skills, and experience aimed at facilitating the acquisition of pertinent and valuable agricultural knowledge and skills. The ultimate objective is to enhance farm productivity, competitiveness, and sustainability. Smallholder farmers employ strategies to mitigate and respond to the impacts of climate change on agricultural productivity by utilising improved seeds and fertilisers distributed by agricultural extension agents. Agricultural extension services are implemented with the intention of providing support to small-scale farmers who had already been employing locally derived adaptation practices in order to enhance crop productivity. The introduction of agricultural extension services are implemented without due consideration of the indigenous adaptation practices already applied by the small-scale farmers. However, agricultural extension services are opportunities for the farmers to improve their crop production in era of climate change. The indigenous adaptation practices are not abandoned but are used in conjunction with the new crop production technology to ensure food security. This review proposes a novel strategy for mitigating the adverse effects of climate change on subsistence crop cultivation. The integration of conventional and contemporary production technology and expertise offered by agricultural extension officers is employed to formulate a climate change adaptation policy that is appropriate and widely accepted, with the aim of ensuring the availability and accessibility of food resources. This recommendation is based on the observation that traditional adaptation methods and abilities have demonstrated success in crop production, thus suggesting that they should not be disregarded in favour of newer alternatives.

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