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Climate smart agricultural policy in sub-Saharan Africa: a case study of Ngaka Modiri Molema District Municipality of North West Province, South Africa

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ABSTRACT

This paper analyses climate-smart agricultural (CSA) policies and strategies in sub-Saharan Africa, using a case study of Ngaka Modiri Molema District Municipality in South Africa. It is argued that the development and implementation of coherent policies is one of the approaches to offering effective responses to adaptation and to mitigating the influences of climate change. The results of the study, which drew on qualitative data gathered through participatory research, showed that 30%, 70%, 50%, and 60% of the community members, farmers, NGOs, and government participants were unaware of or did not understand climate-smart agriculture practices. Additionally, this study highlighted the absence of awareness and knowledge of CSA policies across all participants, indicating a significant gap in information dissemination and education on sustainable agricultural practices. These findings underscore the urgent need for targeted education and awareness initiatives to promote climate-smart agriculture in the region. Without a proper understanding and implementation of CSA practices, communities in Ngaka Modiri Molema District Municipality struggle to adapt to the changing climate and its impacts on agriculture. The results emphasise the necessity of raising awareness among different stakeholders in order to enhance the efficacy of agricultural practices' adaptations to climate change. In order to ensure sustainable agricultural practices in Ngaka Modiri Molema District Municipality, it is imperative that practices like collaboration, CSA technology, integration, financing, increased private sector involvement in CSA promotion, and sector-specific policies foster an environment that is favourable to CSA practices.

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Introduction

Changing climate impacts both developing and developed countries, with adverse effects on industries and communities, and according to Van der Bank and Karsten (2020), these effects are felt most strongly in developing countries, affecting the pace of development. Ziervogel et al. (2014) stated that annual average temperatures have increased by at least 1.5°cover the last five decades and severe weather events have become more frequent. Climate change has, therefore, reduced the potential production of food crops in many developing countries' agricultural sectors, including South Africa,

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such that food production as well as pasture quality continue to decline, thereby worsening prices and yield volatility as atmospheric CO_2 concentrations increase, due to the negative influences of climate change (Steenwerth et al. 2014). This further undermines food security in developing countries (Mthethwa and Wale 2022), in addition to disrupting the wellbeing of individuals in rural areas, lowering their living standards, and in the process perpetuating the poverty cycle (Makate 2019).

Climate-Smart Agriculture (CSA) involves practices that solve environmental problems and is being adopted by many nations around the world as a way to combat the negative influences of changing climate on agricultural production (Chitakira and Ngcobo 2021). Sullivan et al. (2012) referred to CSA as farming practices that reasonably increase profitability and enhance ecological framework versatility while decreasing the outflows of ozone-harming substances. CSA guarantees that environmental change variation and moderation are straightforwardly fused into agricultural advancement planning and investment policies (FAO 2013).

For the vast majority of the world's poor, agriculture is their primary means of financial support, and research has revealed that expanding agriculture is often the most effective option for decreasing poverty, building resilience as well as enhancing food security, but the changing climate makes it challenging to achieve these goals (Recha 2020). In this context, CSA can serve as a holistic and effective way to address these interconnected concerns by guiding agricultural systems reform and realignment initiatives to effectively and continuously promote growth and food abundance as climate change exists (Recha 2020). CSA includes systems and practices that farmers can use to respond to changing climate while also increasing productivity and lowering Greenhouse Gas (GHG) emissions. CSA could also aid various governments achieve food security in their countries in addition to poverty reduction (Barnard et al. 2015). CSA is suitable because it incorporates both adaptation and mitigation strategies. Water and soil management, agricultural development, rangeland management, urban agriculture, and agro-processing are all CSA practices that can be utilised to tackle climate change (Matteoli, Schnetzer, and Jacobs 2020). CSA is particularly beneficial for farmers in rural South Africa, as they are more susceptible to adverse climate and weather effects (Barasa et al. 2021). Strengthening the adaptability of smallholder farmers is becoming a policy priority in sub-Saharan Africa (Zseleczky and Yosef 2014), and several nations such as Nigeria and Ghana are already integrating climate mitigation and adaptation techniques (e.g. CSA) into their national policy frameworks (Zseleczky and Yosef 2014).

According to Makate (2019), lack of availability of seeds, pesticides, and herbicides, which ensure that crops are less impacted by climate change, and lack of analytical capacity and skills to scale-down global patterns of agriculture-related adaptation practices for climate change, at national as well as provincial levels, hinder effective implementation of CSA policies in the South African agricultural sector (Zhou et al. 2022). Due to the little knowledge concerning changing climate in South Africa, and the lack of guidelines for CSA policies, the intended outcome is not usually achieved (Thornton et al. 2018). To assist in formulating policy related to changing climate, as well as decision-making, the CSA practice proposes integrating climate change into the planning as well as the implementation of sustainable agricultural techniques, thereby highlighting trade-offs as well as synergies amongst the three key pillars of CSA (Nagothu and Kolberg 2016). The adoption of CSA principles and practices in Zimbabwe, Nigeria, Ethiopia, South Africa, Ghana, and Mozambique, have resulted in a considerable rise in yields of drought-tolerant maize varieties (Barasa et al. 2021; Nagothu and Kolberg 2016); an overall increase in the farmers' household income; increased agricultural productivity, and reduced farm losses in these countries (Adoghe et al. 2017).

Many climate-smart farming methods have potential in sub-Saharan African nations (Lima 2014). Lesotho's *machobane* farming system, a type of cultivation that makes use of relay cropping, crop rotation, and intercropping techniques, together with the use of fertiliser as well as plant ash, is an example of climate-smart farming (Mekbib et al. 2011). Minimum tillage and the research and development of drought-tolerant, high-yield crop varieties are examples of CSA practices used in Botswana. These methods give poor farmers access to resources through a sustainable procedure that does not need costly external inputs, in addition to providing them with food all year long (McIntosh, Sarris, and Papadopoulos 2013).

Tanzania uses CSA techniques similar to those used in many other developing nations, such as community-based irrigation systems, traditional rainwater harvesting, mixed farming systems, rice cultivation intensification, and agroforestry, in addition to the use of livestock and drought-tolerant crop varieties (Lima 2014; McIntosh, Sarris, and Papadopoulos 2013). Other CSA practices include agroforestry systems with crops like cassava, beans, vegetables, yams, legumes, and fruit trees, as well as terrace cultivation, which uses organic material to decrease erosion and increase soil fertility (McCarthy and Brubaker 2014). Some of the policies related to CSA in most of the sub-Saharan African countries include the Livestock Management and Infrastructure Development (LIMID), the Integrated Support Programme for Arable Agriculture Development (ISPAAD), and the National Master Plan for Arable Agriculture and Dairy Development (NAMPAADD) initiatives (FANRPAN and Earth System Governance Project 2017). Furthermore, the Fourth National Development Program (NDP4) and Vision 2030 both have goals of gradually diversifying crop production and adaptation to changing climate in agriculture (Lima 2014).

Other policy problems that are negatively influencing CSA include the lack of a coherent, overarching strategy, poor coordination of actors and programmes, top-down policymaking, ignoring farmers' preferences and local knowledge, expensive input demand for the adoption of CSA practices, and gender issues (Abegunde, Sibanda, and Obi 2019 Kombat, Sarfatti, and Fatunbi 2021;; Lima 2014; Liu et al. 2011). Furthermore, CSA projects in sub-Saharan African countries are funded through foreign aid, or linked to transient projects, and programmes are scattered, with no post-project evaluation, lacking a broad, all-encompassing strategy, a CSA investment structure, as well as legislative and financial incentives (Bamanyaki 2020 Pretty and Williams 2011;). Farmers' access to training, agricultural inputs, climate information technology, markets, and credit, in addition to resource challenges, were cited as significant challenges in adopting CSA technologies in sub-Saharan African countries, specifically for female farmers (World Bank 2013).

The different approaches that propose solutions to combat environmental problems have highlighted the need for public participation, awareness, adoption of environmental protection programmes, enactment of environmental management practices, and the adoption of environmental management policies (Khalil et al. 2011). For the success of CSA, policy analysis is one of the methods that can be employed to understand how and why countries are implementing specific policies such as integrated soil fertility management, as well as their ramifications (Browne et al. 2019). As part of this research, policy analysis serves as a comprehensive assessment of the effect and implementation of existing changing climate policy, such as CSA, in addition to opportunities for implementing new climate policies (Milovanovitch 2018). According to Mnkeni et al. (2019a), the limitations to the adoption of CSA practices include lack of practical guidelines for their implementation. In 2019, the Department of Environment, Forestry and Fisheries of South Africa released compilations of "Actionable guidelines for the implementation of climate-smart agriculture in South Africa" in two volumes (Mnkeni et al. 2019). One of the conditions for the success of CSA policies is based on their integration and implementation in current policy. Example of current CSA policies employed in South Africa are those of the Food and Agriculture Organization of the United Nations, which supports the government in developing CSA approaches. However, some of the farmers in South Africa face challenges when it comes to using CSA strategies to address environmental issues caused by climate change, due to having little knowledge about the techniques.

Zokwana noted that many project participants and other stakeholders in the North West Province of South Africa involved in CSA mainstreaming lack the capacity to implement CSA, and that there is poor budgeting when it comes to implementing planned climate change adaptation response options (Zwane and Montmasson-Clair 2016). The shortage of skills is another policy problem, because relatively appropriate planning procedures for CSA-related initiatives have not always achieved the desired results. Furthermore, while South Africa might have a lot of knowledge on CSA practices, it has difficulty putting this knowledge into practice (FANRPAN et al. 2017). With the exception of the Western Cape, national initiatives on climate change such as CSA have not

been sufficiently assimilated or incorporated into specific provincial strategies and plans. The same is true at the municipal level, in the Ngaka Modiri Molema District Municipality (Zwane and Montmasson-Clair 2016). Despite a strong policy framework at the national level, integrated strategic and comprehensive CSA planning is lacking in the North West Province of South Africa (FANRPAN et al. 2017). Thus, this study conducted a policy investigation of CSA strategies in South Africa using a case study of NMMDM, which is located in the North West Province.

Methodology

This paper is based on information, which was gathered through two research phases. The first phase involved a comprehensive review of archival records, and peer-reviewed journal articles on CSA, both in the global, regional and local contexts. The reviewed literature was accessed through a search of archival records and other sources, such as different library databases of universities in South Africa (i.e. Witwatersrand, Pretoria, Johannesburg, Cape Town, KwaZulu-Natal and Stellenbosch). In addition to this, web-based search engines, such as Google, Yahoo and Google Scholar, were employed to search for both historical and recent journal articles on topics of a similar nature. Both library and internet searches yielded an estimated 80 journal articles and 8 textbooks focusing on climate-smart agriculture in a global and regional context. A rapid appraisal and meta-analysis of these pieces of literature resulted in the selection of a total number of 40 peer-reviewed articles focusing on climate-smart agriculture issues in the global North and 15 in the global South being selected for inclusion in informing the argument presented in this paper. Other grey literature from the print media: newspaper articles, reports of workshops and press conferences were also engaged with in order to gain a comprehensive understanding of local issues about the state of climate-smart agriculture in South Africa. The systematic review process adopted in this study commenced with the establishment of a set of inclusion and exclusion criteria (Table 1) for screening – both peer-reviewed "academic" and non-peer-reviewed "grey literature" publications to be included in the study. Table 1 presents the systematic review methodology process adopted in the study.

Further to the above, a set of possible search strings were piloted initially over a two-week period using both the ISI Web of Knowledge (WOK) database for academic literature as well as Google Scholar for grey literature. Around 280 papers were downloaded (peer-reviewed articles, reports, blogs, chapters in books, and technical reports) and then screened with criteria such as CSA, Policy, and Africa. After the first initial screening only 120 papers met the criteria (see Table 1). Further screening was done using criteria such as guidelines, South Africa, CSA techniques, and practices. A full-text screening was done, which led to 80 papers being retained. Forty documents were

Table 1. Systematic review process adopted in the study.

Peer-reviewed article	Criteria	Non-peer-reviewed
Level 1: Paper identified through initial database search using various search strings yielded: 280	Inclusion Criteria:	Level 1: Paper identified through initial database search using various search strings yielded: 120
Level 2: Initial screening of paper titles and abstract using criteria yielded:120	Documents that focus on answering the research questions	Level 2: Initial screening of paper titles and abstract using criteria yielded: 50
Level 3: Full text screening included:80	Documents that examine the legislation of CSA in the study area	Level 3: Full text screening included: 58
Level 4:Documents included for thematic analysis consist of:40	Documents that emphasise more on CSA strategies and practices, in addition to adaptation methods.	Level 4:Documents included for thematic analysis consist of: 40
	Documents on the awareness of CSA policies	
	The barriers that influence CSA implementation	
	How CSA can be implemented without influencing the policies that have already been applied	

utilised for the thematic analysis, which consisted of criteria, namely legislation, guidelines, adaptation, and awareness. Ten of the papers from the guideline criteria discuss how in South Africa, CSA practices are being explored and implemented due to the semi-arid nature of a vast area of the region, as well as the region's high susceptibility to the effects of changing climate on rainfall. However, there are many challenges to CSA implementation, such as the problem of inconsistent policies. Ten of the papers that deal with the legislation of CSA emphasise lack of incentives for farmers to implement the recommended measures.

The second phase was a survey, which was conducted in NMMDM (see Figure 1). NMMDM covers 28,114 km^2 and has a population of 961,960 people (Municipality 2020). NMMDM was chosen because there has been widespread concern about the negative consequences of climate change, particularly given poor villages' propensity to uncertain and frequent environmental changes. These produce adverse effects on the productivity of various crops such as spinach, sunflower, wheat and maize in the research area, leading to low yields, food shortage and low income (Oduniyi 2018; Oduniyi, Antwi, and Tekana 2019).

The research population includes the staff of the Department of Agriculture and the Department of Forestry, Fisheries, and Environment (DFFE), Non-Governmental Organisations (NGOs) that specialise in climate change and are in charge of agriculture, and farmers, as well as the people living in the community of the NMMDM.

A list of the population of study was compiled and divided into strata using a stratified random.

Figure 1. Map of Ngaka Modiri Molema District Municipality (Phillips 2022).

sampling approach (Oduniyi and Tekana 2020). This strategy was employed because of the homogeneous subgroup in each of the district municipalities. The sample size of 10 participants per stratum was purposively selected due to observance of practice of CSA or mandates related to CSA across the strata. This resulted in a total number of 30 participants. Data were collected using interviews with both closed- and open-ended questions to solicit responses from participants. The interviews were organised and included a logical flow of inquiries about existing institutions and legal frameworks of CSA at the national level, policy problems affecting CSA in the North West Province, and relevant strategies that can facilitate CSA policy in the study area. The data obtained was analysed with the Statistical Package for Social Sciences (SPSS) using frequency counts and percentages using the equation that is utilised in this research $\boxed{N = F \div 10 \times 100}$. *F* represents the frequencies of the different variables in this research that have been presented to the participants, **10** is the total amount of respondents in each group (farmers, community citizens, government organisations, and NGOs), and *N* will be the percentage of the variables.

Results

The findings on the knowledge related to CSA show that 40% of the participants from government organisations knew what CSA was, and the remaining 60% did not know (Figure 2). The knowledge of CSA among participants from government organisations is low. One of the interviewees stated that:

> *The staff only knew the basics regarding agriculture, and when it comes to advanced topics like CSA, only a handful of the staff members had proper knowledge on the topic.*

Responses from farmers who participated in this study indicated that only 30% of them were aware of CSA. The reason may be that agricultural officers and extension officers who train farmers also have low knowledge of CSA. This finding supports the arguments of Setshedi and Modirwa (2020) that there is a lack of knowledge about climate-smart agriculture in the local municipality of Mahikeng. NGO participants, as shown in Figure 2, had an equal proportion of 50% each of those who knew about CSA and those who did not. The reason for this result, according to one of the

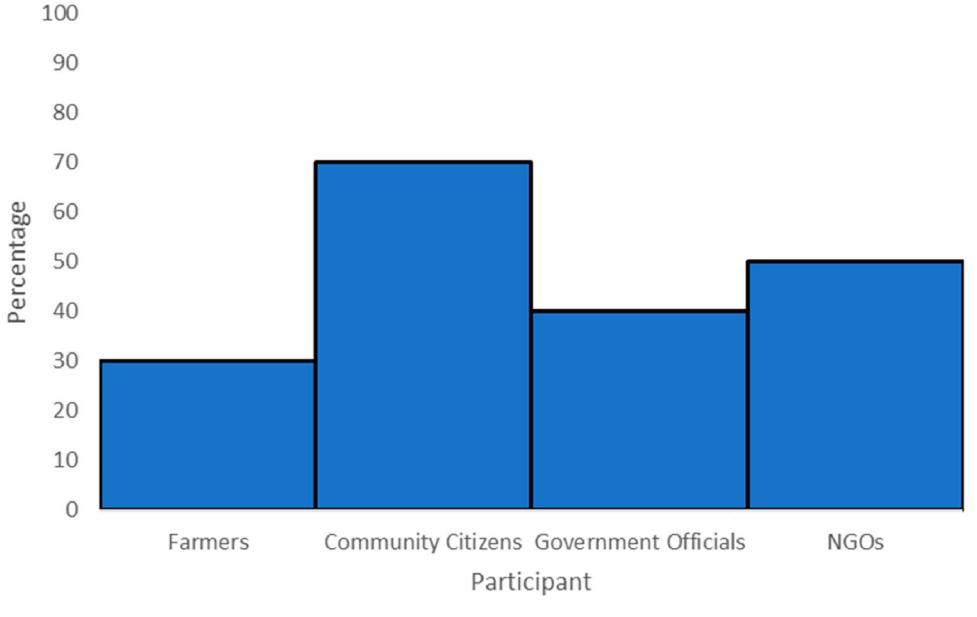

Figure 2. Knowledge on CSA.

participants, can be linked to the fact that "agriculture is at the epicentre of the changing climatic concerns, which means in the sense that agricultural production is the target of the harmful effects of the climate change". Thus, these NGOs wish to acquire knowledge to curb these harmful effects. Similarly, the need for NGO staff to ensure the adoption of CSA practices by the beneficiaries of their services has improved CSA learning. Community citizens are the only participants with a high knowledge of CSA, with 70% of community member participants knowing about CSA (Figure 2). The reason for the high knowledge of CSA can be attributed to the fact that 70% of these attendees are professionals in the agricultural sector and have an in-depth knowledge of CSA.

According to the findings of this study, when it comes to CSA training, the group of participants with the highest CSA training are government organisations (40%), followed by NGOs (20%), farmers (10%), and community citizens (10%). One of the interviewees from the governmental organisations stated:

> *There is not enough of CSA training in Ngaka Modiri Molema, and that in a year there could be only four CSA trainings which is not enough to build CSA knowledge and skills amongst farmers as well as the staff members of the governmental organisations and NGOs.*

The lack of formal training and education on climate change among extension officers was not considered a pressing issue, nor was it included in the curriculum, or competencies expected of extension officers. This oversight has resulted in a gap in knowledge and skills needed to effectively address climate change issues within agricultural communities. As a result, extension officers struggle to provide accurate information and guidance on sustainable practices in the face of changing environmental conditions. In order to improve their awareness of and sensitivity to the changing climate, training was given to the extension officers taking part in the study. Furthermore, because of conflicting priorities and a lack of perceived relevance, attendance is low during times when training is offered.

Thirty per cent of the farmers; 40% of the community citizens; 20% of the participants of the government organisations; and 30% of the NGOs participants stated that CSA policies have been implemented in Ngaka Modiri Molema District Municipality (Figure 3). The responses, which show a low proportion on the recognition of CSA policies, can be connected to the fact that most of

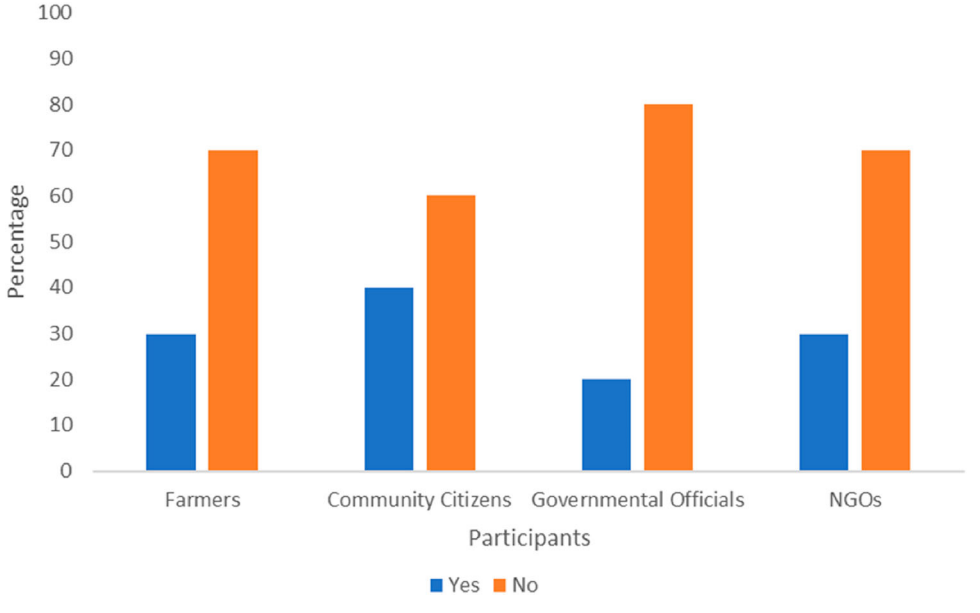

Figure 3. CSA policies implemented in NMMDM.

the participants lack proper knowledge of CSA and have very little interaction with the process of formulating, planning, and implementing the policies.

The results on prominent CSA policies that have been implemented in Ngaka Modiri Molema district municipality among the study participants show agricultural insurance (30% each of community citizens, government organisations, and NGOs participants); guidelines on organic soil fertility (30% of NGOs participants); guidelines on CSA water management (30% of farmers); guidelines for holistic range livestock management (30% of NGOs participants); guidelines for using improved cultivars (23% of community citizens) and guidelines for selected in-field rainwater harvesting practices (20% each of government organisation, and NGOs participants).

The results on the level of awareness among study participants on the policy problems affecting CSA show that 30% of the farmers, 60% of the community citizens, 20% of the government organisation, and 40% of the NGOs were aware of the policy problems affecting CSA. This is supported by the participants' knowledge capacity on CSA. These participants identified policy problems such as the lack of guidelines in policies. The issue of land rights and the lack of compensation for positive externalities like improved ecosystems for wildlife, soil carbon, as well as increased food security are among the problems affecting climate-smart agriculture. One of the participants supports the response to policy issues affecting CSA by stating that "the lack of interconnection between all actors in the agricultural sector is the main political issue affecting the implementation of CSA". Furthermore, other participants stated that "only once all actors have focused on CSA can decisions and actions be taken to improve CSA knowledge".

The finding regarding institutional problems being a policy problem can be attributed to the absence of practical guidelines, which fosters a lack of a coherent, overarching strategy and poor coordination of actors and programmes for the enactment of CSA, even though there is considerable knowledge of CSA in South Africa. This lack of clear implementation strategies may be hindering the effective integration of climate-smart agriculture practices at the institutional level, ultimately impeding progress towards sustainable agricultural development in the region. Addressing this gap through the development and dissemination of specific guidelines could help bridge the disconnect between knowledge and action in promoting CSA practices in South Africa.

The participants indicated that CSA policies can be improved in NMMDM, through the use of technical capital to provide knowledge and support systems for producers, and agricultural extension agents, as well as other organisations involved in agriculture management. The other participants stated that since the study area's economy is primarily based on agriculture, governmental investment in CSA should be given top priority in order to encourage farmers to embrace CSA techniques. The investment plans should include easily adaptable plans for designing and implementing policies, as well as clear prospects for CSA investments. The commercial sector and other stakeholders should be connected in order to make informed investment choices on the identified CSA technologies and practices. Collaboration between the government, private sector, and NGOs is crucial to ensuring the successful implementation of climate-smart agriculture initiatives in South Africa.

This multi-stakeholder approach will also help to leverage resources and expertise for scaling up sustainable agricultural practices in the region. Farmers will be motivated to adopt CSA practices if there are incentives in place, such as ecological compensation or access to financing for climate-related projects. By providing these incentives, farmers will be more likely to invest in climate-smart agriculture, leading to increased resilience to climate change and improved food security in the region. Additionally, capacity-building programmes and knowledge-sharing initiatives can further support the adoption of CSA practices among farmers in South Africa. The establishment of CSA will also be supported by increased access to scientific and practical evidence about CSA technology among governmental organisations, researchers, and farmers, which can help inform policy decisions and encourage widespread adoption. Overall, these efforts can contribute to a more sustainable and climate-resilient agricultural sector in NMMDM.

The findings on the factors enhancing integration of CSA policies into current policies are organised into four categories of respondents in this study.

Farmers:

Fifty per cent stated that proper management of natural resources will enable the integration of CSA policies into current policies. Forty per cent specified for the integration of policies which will encourage initiatives that will limit the emission of gases with a greenhouse effect, in addition to assisting producers and communities adopt mitigation and adaptation strategies for climate change into existing policies. Fifty per cent indicated that significant bodies of sectoral policies are essential towards creating a favourable environment that will foster CSA, while 40% stated that financing CSA was essential for the integration of CSA into the current policies, and 40% stated that increasing the participation of the private sector in CSA promotion for the adoption of practices in the field would also be essential.

Community members:

Fifty per cent indicated that the proper management of natural resources would support the integration of CSA policies into current policies. Forty per cent advocated for the integration of policies which will encourage initiatives that will limit the emission of gases with a greenhouse effect, in addition to assisting producers and communities adopt mitigation and adaptation strategies for climate change into existing policies. Fifty per cent believed that significant bodies of sectoral policies are essential towards creating a favourable environment that will foster CSA. Thirty per cent stated that financing CSA was essential towards the integration of CSA into the current policies, and 40% stated that increasing the participation of the private sector in CSA promotion for the adoption of practices in the field would also be essential.

Government Officials:

The findings show that 80% stated that the proper management of natural resources would enable this. Fifty per cent advocated for the integration of policies which will encourage initiatives that will limit the emission of gases with a greenhouse effect, in addition to assisting producers and communities adopt mitigation and adaptation strategies for climate change into existing policies. Fifty per cent believed that significant bodies of sectoral policies are essential towards creating a favourable environment that will foster CSA. Sixty per cent stated that financing CSA was essential towards the integration of CSA into the current policies. Sixty per cent stated that increasing the participation of the private sector in CSA promotion for the adoption of practices in the field would also be essential (see Figure 4).

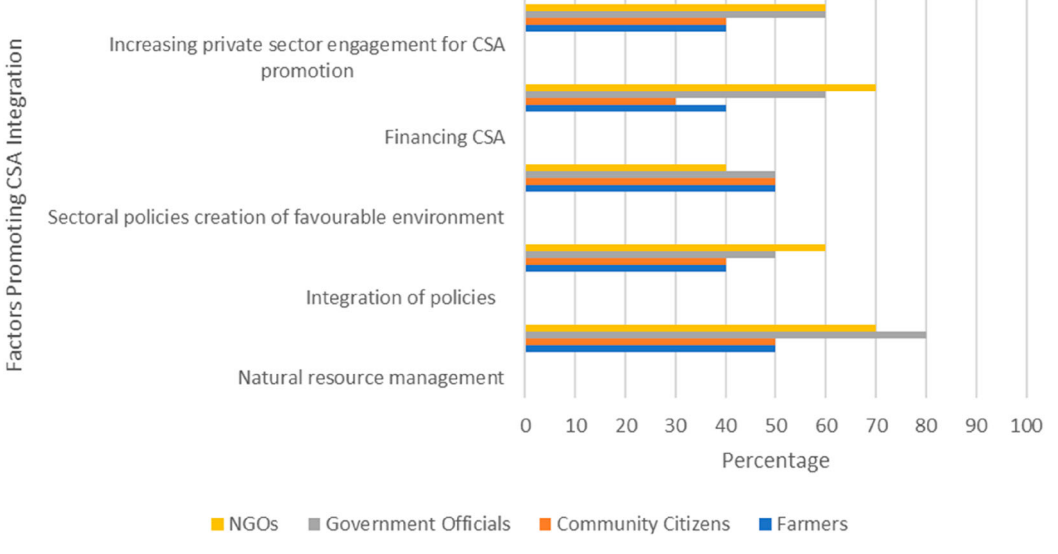

Figure 4. Factors enhancing integration of CSA policies into current policies.

NGOs:

The findings indicated (Figure 4) that 70% believed that the proper management of natural resources would enable this. Sixty per cent advocated for the integration of policies which will encourage initiatives that will limit the emission of gases with a greenhouse effect, in addition to assisting producers and communities adopt mitigation and adaptation strategies for climate change into existing policies. Forty per cent believed that significant bodies of sectoral policies are essential towards creating a favourable environment that will foster CSA. Seventy per cent stated that financing CSA was essential towards the integration of CSA into the current policies, and 60% stated that increasing the participation of the private sector in CSA promotion for the adoption of practices in the field would also be essential.

Based on the above observations, most of the participants believe that if the benefits of CSA are advertised, more people will be willing to adopt CSA techniques. Participants stated that if

> there is proper natural resource management which will in turn lead to the reduction of the wastage of resources such as fertilizers and water, and in the process, money can be saved, this would support the integration of CSA policies into current policies

and "the reduction of the effects of changing climate on crops and livestock and boosting the capacity to cultivate food on the land as well as strengthening the health of the soil is an enticing benefit of CSA". These benefits highlight the potential for CSA to not only improve agricultural sustainability but also contribute to cost savings and climate resilience. By promoting these advantages, policymakers and farmers may be more inclined to embrace CSA practices in their operations.

These remarks hint that, in order to properly and carefully integrate CSA into current policies, context-specific and climate-smart methods and solutions should be encouraged. It is essential to consider the unique challenges and opportunities present in the NMMDM region when implementing CSA practices. By tailoring solutions to local conditions, the agricultural sector can effectively mitigate climate change impacts and improve long-term sustainability. This will necessitate investing in innovative technologies, ecosystem-based strategies, and a supportive environment to improve and accelerate the adoption of CSA. Furthermore, improving policy coordination and strengthening regional, local, and national organisations to aid the enactment of CSA is needed, and creative funding programmes to increase farmer's access to both agriculture and climate finance will need to be developed.

Discussion

The aim of this study was to analysis CSA policies in NMMDM in the North West Province of South Africa. The objectives were to examine the existing institutions and legal frameworks for CSA nationally, provincially, and locally, assessing the policy problems affecting CSA in the agricultural sector of the North West Province, and proposing relevant strategies and references that can facilitate CSA policy in the agricultural sector in the study area. Although the study discovered that most of the participants were knowledgeable, the findings on their knowledge of climate change indicated otherwise; the knowledge of CSA amongst governmental organisations staff and farmers was very low. This finding supports the arguments of Setshedi and Modirwa (2020) in that there is a lack of knowledge about climate-smart agriculture in the local municipality of Mahikeng. The amount of CSA training that took place in NMMDM is not sufficient according to one of the participants, who stated that CSA training tends to take place four times a year, which is very little. According to Maka et al. (2021), very few extension officers received formal training and education for the changing climate; this was not seen as an immediate dilemma or even in the curriculum or skills required of extension officers. Moreover, when training is offered, attendance is usually low (Zikhali et al. 2020). Additionally, those who participated in CSA training praised the training, indicating that it promoted their farming activities.

The policy frameworks governing CSA were also not well known by most of the participants, not even those that have been implemented in NMMDM. Very few participants knew of the CSA policies implemented in NMMDM, such as agricultural insurance, the guidelines on organic soil fertility, the guidelines on CSA water management, the guidelines for holistic range livestock management, the guidelines for using improved cultivars, and the guidelines for selected in-field rainwater harvesting practices. The results demonstrated that the majority of participants had little to no knowledge of the CSA policies being applied in NMMDM. Additionally, based on the data obtained, even though the aforementioned policies have been put into place, very few participants were aware of this. Apart from the community citizens, the other groups of participants were not aware of the policy problems affecting CSA. Furthermore, the only policy that was widely recognised amongst the participants was agricultural insurance, followed by the guidelines for holistic range livestock management and the guidelines for using improved cultivars.

The findings of this study in relation to assessing the policy problems influencing CSA negatively indicated that many of the participants noticed various policy problems that are influencing CSA, especially amongst the NGO participants and the community citizens. Some of the policy problems highlighted include institutional problems such as the lack of guidelines in policies and the issue of land rights, such as women not having access to land compared to men, the lack of compensation for positive externalities, which include improved ecosystems for wildlife, soil carbon, and enhanced food security, in addition to the absence of incentives to adopt CSA methods. This aligns with Mnkeni et al. (2019b) study, which highlighted the absence of practical guidelines for the enactment of CSA policies in NMMDM, leading to a lack of awareness and understanding among various stakeholders. Land tenure is another example of a policy issue impacting CSA, according to Williams et al. (2015), where a large number of poor farmers have unstable and insecure access to land, hindering their ability to invest in long-term sustainable practices. When the participants were asked to propose strategies that would facilitate CSA policy in the agricultural sector of NMMDM, most of them proposed different approaches. As a means of encouraging equitable and sustainable use while advancing conservation, some of these approaches included funding ecosystem-based initiatives like the preservation and restoration of wetlands, peatlands, and forests; safeguarding the oceans; improving grassland management; and employing ecologically friendly agricultural practices (Chong 2014).

Others suggested the utilisation of better technologies to enable environmental adaptation to climate change and augment the uptake of CSA practices, such as precision agriculture and drip irrigation systems. Branca and Perelli (2020) corroborate this conclusion, arguing that increased adoption of CSA technology would result from its widespread use in the agricultural sector, leading to greater resilience to climate change impacts. In order to expedite the shift to sustainable agricultural practices, participants stressed how vital it is for farmers, the government, and private sector entrepreneurs to have improved access to capital in order to develop and implement CSA. Additionally, partnerships between stakeholders in the agricultural sector can help facilitate knowledge sharing and technology transfer to further enhance the adoption of CSA practices. Innovative funding plans will unlock both agriculture and climate finance. By leveraging financial resources from various sources, such as impact investors and development banks, the agricultural sector can scale up climate-smart practices and build resilience, in addition to contributing to overall food security and sustainable development goals. The coordination of policies as well as the enhancement of local, national, and regional institutions will promote the enactment of CSA; in addition, the awareness building and profile raising by highlighting CSA opportunities and success stories to smallholder farmers will be essential. Furthermore, the participants believed that when it comes to strengthening the coordination of CSA, it is essential to involve various institutions and actors. The participants believed that actors such as the farmers' associations, input dealers, processors, the marketers, retail outlets, extension officers, commodity associations, and NGOs, are essential institutions that can contribute to the implementation of CSA in NMMDM.

A number of policies already exist to combat climate change. The participants were of the opinion that proper management of natural resources was one of the benefits that would ensue, and then raising awareness of this benefit would make it easier for the policies to be integrated. Other benefits that the participants stated would be to improve the chances of integrating CSA policies into current policies, which will encourage measures that will limit the emission of gases with greenhouse effects. It will also assist producers and communities in adopting mitigation as well as adaptation strategies for climate change into existing policies. Others stated that financing CSA was essential towards the integration of CSA into the current policies, and in the process, increasing the participation of the private sector in CSA promotion for the in-field uptake of practices would also be essential. Adhikari's (2018) findings reinforce the findings of this study by emphasising the need to promote context-specific and climate-smart strategies and solutions in order to effectively and cautiously integrate CSA into present policies. To improve and hasten the adoption of CSA, it will be necessary to invest in cutting-edge technologies, ecosystem-based initiatives, and a conducive environment. To support the passage of CSA, it is also necessary to enhance policy coordination, fortify local, regional, and national organisations, and develop innovative funding schemes that would facilitate smallholders' access to climate finance and agriculture.

Overall, the diverse range of proposed approaches highlights the complexity of balancing agricultural productivity with environmental conservation in the NMMDM sector. This complexity underscores the importance of collaboration between stakeholders at all levels to ensure sustainable and effective implementation of CSA practices. By fostering partnerships and sharing knowledge, the agricultural sector can work towards achieving food security and climate resilience in a changing world.

Conclusion and recommendations

This study explored the policy analysis of climate-smart agriculture strategies in NMMDM. In order to understand the context, coherence, and governance of this policy, the study looked at the current CSA policies and strategies, cross-sectoral synergy evidence, and adoption incentives. Through the use of qualitative data gathered through participatory research methods, findings highlighted that the knowledge of CSA in the study area is lacking, hindering the effective implementation of climate-smart agriculture practices. Furthermore, the study revealed that there is a need for capacity building and awareness campaigns to enhance the adoption of climate-smart agriculture practices in NMMDM. There are various methods that might be used to increase resilience and guarantee huge yields under the present circumstances. In order to increase resilience and guarantee a more sustainable agriculture sector, appropriate CSA practices must be developed and put into effect. Based on the responses provided by the participants, some of these practices include taking into consideration the importance of stakeholder collaboration and the integration of climate-smart agriculture into existing agricultural extension services to ensure sustainability and long-term impact.

Additionally, funding must be set aside for sustainable development initiatives, and national policy must be institutionalised at the provincial and local levels more successfully. By doing this, the agricultural sector in the NMMDM can develop into a lucrative industry that helps ensure the viability of this area. The implications that this study has for policymakers and agricultural stakeholders are significant, as it highlights the need for strategic planning and investment in sustainable agriculture practices. By prioritising collaboration, integration, funding, and policy institutionalisation, the NMMDM can pave the way for a more resilient and prosperous agricultural sector. Additionally, fostering partnerships between government agencies, NGOs, and local farmers can lead to innovative solutions and knowledge sharing. Ultimately, this approach can create a more sustainable and competitive agricultural sector in the NMMDM region. Furthermore, engaging with local communities and incorporating their traditional knowledge can enhance the effectiveness of sustainable agriculture initiatives.

By incorporating diverse perspectives and expertise, the NMMDM can ensure that its strategies are inclusive and culturally appropriate, leading to more successful outcomes in the long term. The limitations of this study include considering the diverse needs and perspectives of different stakeholders, which will be essential for ensuring inclusive and sustainable agricultural development in NMMDM. It is necessary to perform a more thorough examination of the factors endangering the viability of crop production in the communal agricultural regions of NMMDM. There is still room for more research on CSA in this area, particularly with regard to the challenges facing knowledge-transfer-focused extension services. This study suggests that further research be done on an efficient educational programme for CSA knowledge transfer to farmers.

The recommendations emanating with respect to this study include implementing hands-on training sessions, developing culturally relevant educational materials, and fostering partnerships with local agricultural organisations to ensure the sustainability of CSA practices in communal agricultural regions. Additionally, exploring innovative technology solutions for knowledge dissemination (such as exploring the effectiveness of different communication strategies in promoting CSA practices among farmers in NMMDM) and providing ongoing support to farmers as they transition to CSA practices are also crucial steps for the success of agricultural development in NMMDM. Furthermore, addressing knowledge gaps and providing necessary support can lead to increased resilience to climate change in the region. Additionally, investigating the impact of policy interventions on the adoption of sustainable agricultural practices in communal farming areas could provide valuable insights for improving agricultural development in the region. This holistic approach will not only benefit the farmers and their communities but also contribute to the overall economic and environmental sustainability of the region. By prioritising education, partnerships, technology, and support, agricultural development in NMMDM can thrive and adapt to future challenges.

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