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Farmers' perceptions on the capacity of extension practitioners on climate change in the Eastern Cape Province of South Africa

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Farmers expect agricultural extension practitioners to provide and effectively communicate knowledge on climate-resilient agricultural practices and their impacts. In the face of increasing climate variability, extension services are crucial in equipping farmers with strategies for adaptation and mitigation. However, the effectiveness of these services in improving farm level adaptation remains limited. This study utilized a cross-sectional survey with 175 randomly selected farmers, employing interviews and structured questionnaires for data collection. Farmers' perceptions of extension practitioners' competencies were analyzed through content analysis, while a binomial logistic regression model identified factors influencing these perceptions. The findings revealed that most farmers accessed extension services and relied on them for climate adaptation information. Approximately 72.6% of respondents viewed practitioners as knowledgeable, positively influencing their adaptation efforts. However, significant differences in perception emerged: male and female farmers evaluated practitioners differently, and experienced farmers were more critical of practitioners' climate competencies. Membership in farmer organizations correlated with more favorable perceptions, while limited access to extension services was associated with less positive views, highlighting access barriers. Observed climate changes include floods (53%), prolonged droughts (63.4%), very hot seasons (25%), and very wet seasons (22%), while 3.7% of respondents reported no observed changes. Farmers emphasized the importance of technical climate knowledge among practitioners and the need for continuous training to enhance their effectiveness. The study recommends fostering regular farmer-practitioner engagement, prioritizing ongoing technical training for extension officers, and incorporating indigenous knowledge systems into extension frameworks to address local adaptation needs effectively.

KEYWORDS

climate change, extension practitioners, capacity needs, perception, farmers, Eastern Cape, smallholder farmers

1 Introduction

Agricultural extension is the primary delivery system for information to farmers in South Africa (Stevens and Van Heerden, 2016). It has been shown to improve farmers' agricultural knowledge and skills, disseminate new technology, and change farmers' perceptions and attitudes (Khan et al., 2012). A study by Danso-Abbeam et al. (2018) in Ghana showed that farmers participating in agricultural extension programs had increased income and enhanced welfare. This indicates that agricultural extension enhances productivity while also serving as a key driver of broader development goals, including reducing poverty and ensuring food security.

Agricultural extension services are essential for providing farmers with the knowledge and resources needed to tackle challenges such as climate variability. These services act as a key channel for delivering timely and relevant information, empowering farmers to implement adaptive strategies and build resilience against adverse conditions. For example, well-executed agricultural extension can foster better understanding of climate change and encourage smallholder farmers to adopt conservation agriculture practices, thereby strengthening their ability to adapt (Karbo and Crentsil, 2021; Landaverde et al., 2022).

Despite the bureaucratic changes aimed at transforming the agricultural extension sector into a vibrant provider of services to all farmers, the literature suggests that the industry still needs to improve in providing quality service. According to the National Policy for Extension and Advisory Services (EAS) [South Africa Department of Agriculture, Forestry and Fisheries (DAFF), 2014], these services EAS face several challenges in relevance, efficiency, accountability, and sustainability despite the country facing significant socio-economic challenges, including poverty, malnutrition, and food insecurity. In addition, Ajala et al. (2013) and Suleiman et al. (2021) highlighted the challenge of working with a high stated rate of illiteracy among farmers, making it difficult for them to understand all the concepts and put the new knowledge into practice. Also, many farmers are not open to changing longstanding agricultural traditions and practices.

According to Makara (2010), in Zanyokwe, Abdel-Hussein and Fayyadh (2023) extension practitioners need more technical knowledge and tend to deliver information that aligns with their agenda rather than addressing farmers' specific needs and circumstances. Liebenberg (2015) argues that extension services are ineffective not just due to a shortage of field practitioners but also because of their inadequate education and lack of job-specific training.

Additionally, factors such as lack of motivation, limited mobility, inadequate management and supervision, insufficient support, ineffective operational policies and strategies, and the poor self-image of practitioners contribute to the problem (Makara, 2010; Van Niekerk et al., 2011). Worth (2012) further emphasizes that the absence of subject matter specialists affects the quality of the training provided, the suitability of the supported technological packages, and effective three-way communication between practitioners, farmers and communities.

Furthermore, the extension-officer-to-farmer ratio was reported to be very high, according to Williams et al. (2008), which is one of the continued challenges facing agricultural extension services in South Africa. Research by Liebenberg (2015) shows that the Department of Agriculture, Forestry and Fisheries (DAFF) has committed to ensuring sufficient EAS practitioners comply with the recommended extension-to-farmer ratios. The National Policy on EAS in Agriculture, Forestry, and Fisheries from the South Africa Department of Agriculture, Land Reform, and Rural Development (2021) recommends a practitioner-to-farmer ratio of 1:400 for crop farming and 1:500 for both livestock and mixed agriculture.

Technical climate change knowledge is essential for extension practitioners to enhance farmer behavior and practices, promoting independence and empowerment (Abdullah et al., 2017). Mustapha et al. (2012) identified three key roles for extension practitioners in supporting climate change adaptation: facilitating policies, providing information on new farming methods, and developing capacity. They help disseminate climate change policies and educate farmers on new methods such as drought-resistant crops and sustainable farming practices like intercropping and no-till agriculture (Davis et al., 2009; Prokopy et al., 2015). Additionally, extension services build capacity by offering technical support, training, and education, although many practitioners lack "soft" skills such as communication and networking due to their technical training background (Davis et al., 2009).

It is vital for agricultural extension practitioners to assist smallholders in managing and adapting to climate change effectively. Understanding the capacity of extension practitioners to fulfill this critical mandate is vital. The capacity of extension practitioners can be assessed by the quality of counseling they provide to farmers (Herawati and Susilo, 2019).

It is equally vital to understand farmers' perceptions of the services related to climate adaptation that they receive from extension practitioners. Perception can happen subliminally without conscious awareness (AlGhamdi et al., 2014), meaning perceptions are interpretations; for most individuals, interpretations become their truth. Therefore farmer's perceptions are powerful and essential to understanding and establishing whether extension practitioners are effective and efficient when providing support and information on climate adaptation technologies. South Africa's agricultural extension system is pivotal in providing farmers with critical information and resources, especially for adapting to climate change. However, there are notable gaps in existing research that require further exploration. One key area is the need to better understand smallholder farmers' perceptions of the effectiveness of agricultural extension services in supporting climate change adaptation. While previous studies have emphasized the role of agricultural extension in enhancing farmers' knowledge and skills (Khwidzhili and Worth, 2016; Zikhali et al., 2019), there is a lack of empirical evidence on farmers' perceptions of the competency of extension practitioners in delivering climate-related information and assistance.

Therefore, this study aims to investigate smallholder farmers' perceptions of the extension service practitioners' competency related to climate change. This was done by identifying farmers' views of extension practitioners' performance and determining the degree of awareness regarding climate change.

2 Methodology

2.1 Study areas and data collection

Data were collected in three districts in the Eastern Cape (Figure 1), namely Chris Hani, OR Tambo, and Amathole. Qualitative and quantitative approaches of structured questionnaires and Farmer

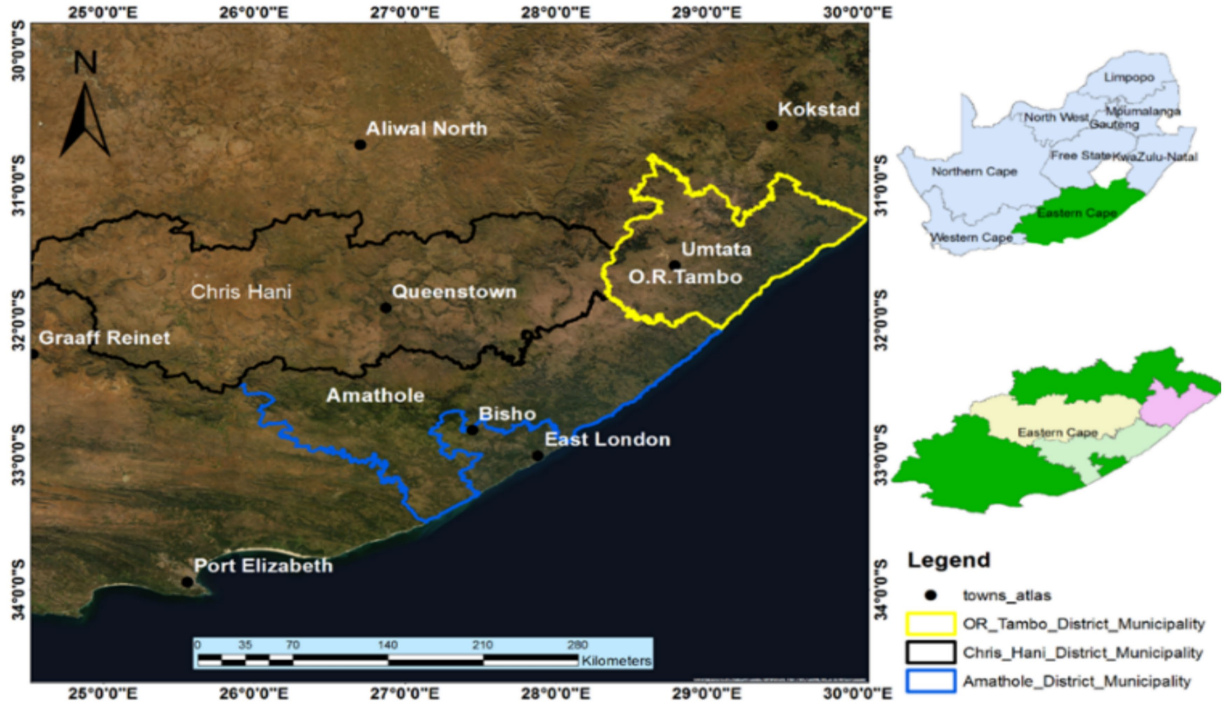

FIGURE 1
Map of the study area. Source: authors own work.

Group discussions (FGDs) were used to gather information on farmers' perceptions of the competency of agricultural extension agents related to climate change. The questionnaires consisted of two sections: demographic information and farmers' perceptions of the competencies of extension officers on climate change. The development of the questionnaire was informed by existing validated instruments from similar studies, ensuring its relevance and reliability. Key references included Zikhali et al. (2019) and Herawati and Susilo (2019) which were adapted to fit the context of this research. The questions were tailored to align with the study's objectives while maintaining consistency with previous works for comparability. The questionnaires entailed both open- and closed-ended questions. Open-ended questions were included in the survey to allow participants to share their perceptions of climate services. These questions were designed to elicit qualitative insights by allowing respondents to provide detailed explanations of their perspectives. In contrast, close-ended questions provided a predefined choice of answers for participants to select, where respondents were asked to choose from a predefined set of responses, and in other cases, a 5-point Likert scale was used to measure the extent of agreement. The Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to express varying degrees of agreement with specific statements regarding extension agents' knowledge, interventions, and communication channels. This assessment indicated the competency of agricultural extension agents and the effectiveness of climate services. The questionnaire was pre-tested on 15 farmers practicing mixed farming in KwaZulu-Natal Province, South Africa, and these results were excluded from the overall study data to ensure the validity of the data collection tool. How farmers answered during pre-testing revealed consistency in responses. FGDs were used to explore farmers' perceptions further. FGDs were used to explore farmers' perceptions further. The FGDs had 30 participants in the Chris Hani District, 54 in the Amathole District, and 25 in the OR Tambo District between 13 July 2022 and 30 August 2022.

A total of 175 farmers were selected across the three districts in the Eastern Cape Province using random sampling. Content analysis was used to code and evaluate qualitative data from the FGDs to identify the main themes that emerged from the discussions. It included transcription and highlighting recurring themes in the responses. In some cases, answers provided in the open-ended questions were also reported verbatim.

According to McNiff (2016), content analysis identifies critical ideas and topics for discussion, identifies differences and similarities across responses, and integrates themes and ideas to assist the researcher in making sense of the data gathered from respondents. Descriptive statistics was used to analyse quantitative data from the questionnaire surveys.

All the closed-ended data provided in this research paper were organized in frequency tables and graphs. A binary logistic model was also used to estimate determinants of smallholder farmers' perceptions farmers' perceptions. By integrating both qualitative insights from FGDs and quantitative analysis through Likert-scaled responses, the study ensured a more comprehensive evaluation of farmers' perspectives on extension services related to climate change.

2.2 Content analysis

To comprehend the written and spoken communication of the respondents unobtrusively, the researcher used content analysis. This

methodology allowed the researcher to generate conclusions that could be generalized to other situations (Neuendorf, 2002). The competence relative to climate change was divided into the following themes: knowledge about climate change, interventions and their impact, and the channels used to deliver extension services. The main goal was to uncover concepts and relationships that would aid in interpreting the data collected and support quantitative data. The data was then conceptualized for the objectives of the study and grouped logically into themes (Yıldırım and Şimşek, 2006). Therefore, the intended classification and construction of the common aspects through generalization quantification was achieved (Gökçe, 2006).

2.3 Empirical model

In this study, the logit model was chosen to analyse the determinants of farmers' perceptions in the Eastern Cape Province. The binary logistic model is well-suited for situations where the outcome variable is dichotomous, with 1 or 0 values representing two choices. In this case, the outcomes were "competence of extension practitioners" (1) and "incompetence of extension practitioners" (0).

The logit model was preferred over other methods like probit regression because it is more flexible when interpreting results for dichotomous outcomes. The model is used for computational simplicity and is generally favored for binary outcomes (Hosmer et al., 2013). It allows for estimating variables influencing farmers' perceptions of extension practitioners' competence about climate change.

The dependent variable, "competence of extension practitioners," was regressed against explanatory variables, including socio-economic factors. The binary logistic model can accommodate two categories in the dependent variable and address issues like heteroscedasticity and the assumption of a cumulative normal probability distribution, making it a suitable choice for this study (Joshi and Dhakal, 2021). The binary logistic model was used as it provides a robust and effective approach for analysing perceptions of extension practitioners' competence in climate change-related matters among smallholder farmers.

$X = (X_1, X_2, \ldots X_n)$ as a set of explanatory variables which can be discrete, continuous, or a combination of both discrete and continuous (Hastie et al., 2009) (Equation 1). Then, the binary logistic function π_i is given by:

$$logit\ \pi_i = \log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots\ldots + \beta_n x_{i,n;} \quad (1)$$

Where,

$$\pi_i = \frac{\exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_n X_{i,n;}\right)}{1+\exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_n X_{i,n;}\right)} = \frac{\exp\left(x'_i\beta\right)}{1+\exp\left(x'_i\beta\right)} = \wedge\left(x'_i\beta\right) \quad (2)$$

Here in Equation 2, π_i denotes the probability that a sample is in a given category of the dichotomous response variable, commonly called the success probability and, clearly, $0 \leq \pi_i \leq 1$. $\Lambda(.)$ is the logistic Cumulative Distribution Function (CDF), with $\lambda(z) = ez/(1 + e - z) = 1/(1 + e - z)$, and β s represents a vector of parameters to be estimated (Joshi and Dhakal, 2021). The expression $\left(\frac{\pi_i}{1-\pi_i}\right)$ is called the odds ratio or relative risk.

2.4 Estimation and likelihood ratio test

Maximum likelihood is the preferred method to estimate β since it has better statistical properties, although we could also use the least-squares approach (Equation 3). Consider the logistic model with the single predictor variable X given by the logistic function of:

$$\pi(X)\frac{\exp\left(x'_i\beta\right)}{1+\exp\left(x'_i\beta\right)} \quad (3)$$

We predict finding the estimates such that plugging βˆ into the model for $\pi(X)$ gives a number close to 1 for all subjects who perceive extension to be competitive relative to climate change and 0 otherwise (Equation 4). Econometrically, the likelihood function is given by:

$$L(\beta_0,\beta_1) = \prod_{i:_{y_i=1}} \pi(x_i) \prod_{i':_{y_{i'}=0}} \left(1\pi\left(x_{i'}\right)\right) \quad (4)$$

The estimates β are chosen to maximize this likelihood function. The logarithm is taken on both sides to calculate and use the log-likelihood function for estimation. We used the likelihood ratio to test if any subset of estimates β is zero (Equation 5). Suppose that p and r represent the number of β in the full model and the reduced model, respectively. The likelihood ratio test statistic is given by:

$$\wedge* = 2\left[l\left(\beta^{(0)}\right) - l(\beta)\right] \quad (5)$$

where $l(\beta)$ and $l(\beta^{(0)})$ are the log-likelihoods of the full model and the reduced model, respectively, evaluated at the maximum likelihood estimation of that reduced, and $\Lambda* \sim \chi$ 2 n − r; n and r being the number of parameters in full and the reduced model, respectively.

2.5 Description of explanatory variables

Table 1 shows the independent variables included in the logit model and their measurement and expected outcome.

Ethical clearance for the study was received from the University of the Free State, UFS-HSD2022/0482/22.

3 Results and discussion

This section presents results from the topics developed based on the predefined questions. Verbatim quotes from the participants were used where necessary. The results section is divided into: (1) demographic characteristics of respondents, (2) farmer characteristics, (3) farmers' knowledge of climate change, (4) farmers' perceptions of

TABLE 1 Relationships between dependent and explanatory variables of the Logit model.

Explanatory variable	Measure	Expected outcome
Full-time farmer	Yes = 1 No = 0	+
Farmer experience	Categorical – <5 years = 0 More than 5 years, but <10 years = 1 More than 10 years, but <20 years = 2 More than 20 years = 3	+
Gender	Male = 1 Female = 0	–
Level of education	Categorical – Never been to school = 0 Grade R to Grade 8 = 1 Grade 9 to Grade 12 = 2 National certificate/matric = 3 Tertiary qualification = 4	+
Member of farm organization	Yes = 1 No = 0	+
Land ownership	Yes = 1 No = 0	–
Access to extension	Yes = 1 No = 0	+

Dependent variable	Measure	
Competency of extension officers on climate change	1 = Extension officers are competent 0 = Extension officers are incompetent	

TABLE 2 Farmers' demographic characteristics.

Variable	Percentage (%)
Sex	
Male	43.8
Female	56.2
Racial group	
African/Black	100
Non-Black	–
Highest level of education	
Never been to school	5.8
Grade R to Grade 8	36.3
Grade 9 to Grade 12	18.1
Matriculated	20.5
Tertiary qualification	19.3
Years of experience	
Less than 5 years	25.6
Between 5 and 10 years	23.8
Between 10 and 20 years	19.8
More than 20 years	30.8

the knowledge of extension officers on climate change, (5) farmers' perceptions of the capacities of extension officers related to climate change, and (6) farmers' perceptions of the capacities needs of extension officers related to climate change.

3.1 Demographic characteristics of respondents

The survey's findings show that women make up most farmers in the study areas, with a proportion of 56.2% compared to 43.8% of their male counterparts (Table 2). These results also corroborate to those of Ndhleve et al. (2017) Mdoda (2020) conducted in the Eastern Cape. Statistics South Africa (2016) and Saloshni and Nithiseelan (2022) found that in South Africa households headed by women are more likely than households headed by men to engage in agriculture. This trend not only highlights women's resilience but also their critical role in maintaining food systems and supporting household economies in rural South Africa (Odimegwu, 2022; Mandikiana, 2024). Women in South Africa contribute more to increasing agricultural production by generating food than men because men move to cities and are employed in other sectors (Saloshni and Nithiseelan, 2022). Regarding the racial groups, blacks comprised many of the farmers at 100%. A study by Zantsi (2021) categorized smallholder farmers into population groups, age, sex, farm location, and size, noting that black farmers are typically linked with smallholder farming (Khapayi and Celliers, 2016; Zantsi, 2021). According to StatsSA's most recent Agricultural Census, almost 95% of the country's smallholder farmers are black (Statistics South Africa, 2016), primarily due to the legacy of apartheid when black South Africans were barred from land ownership and agriculture (Binswanger-Mkhize et al., 2009).

With regards to respondents' level of education, only 5.8% of the respondents were illiterate, while others had completed some form of education. About 19% attended tertiary institutions, and the results suggest that many farmers could read and write. An average (50.6%) of farmers had more than 10 years of demonstrable experience in agriculture.

It has been shown that farmers with more knowledge and education are more likely than illiterate ones to comprehend climate change and how it affects their farming activities (Mandleni and Anim, 2011; Eneji et al., 2020).

3.2 Farmer characteristics

The following sections present additional farmers' characteristics, including reason for farming, farmer organization membership, land ownership, and farming enterprise, as shown in Table 3.

Results presented in Table 3 show that most farmers (71%) were full-time farmers and relied entirely on their income to provide for their needs. On the other hand, some respondents (28.7%) took off-farm employment or engaged in other economic activities to supplement their income.

Of the survey participants, 73.5% are members/or are affiliated with farmer organizations. Research shows that farmer organizations, associations, cooperatives, self-help groups, and women's organizations are examples of farmer organizations, which are collective entities created to further the interests of their members (Bizikova et al., 2020). The

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TABLE 3 Farmer characteristics.

Variable	Percentage (%)
Full-time farmer	
Yes	71.3
No	28.7
Reason for farming	
Household consumption	19.4
Selling	20.6
Both	60
Land ownership	
Yes	65.3
No	34.7

benefit of farmers being affiliated with farmer organizations includes helping these smallholder farmers to overcome the challenges they face, including access to information, lack of bargaining power, and limited resources (Bizikova et al., 2020). Farmer organizations are now essential to rural development and agricultural productivity (Bijman and Wijers, 2019; Chimombo et al., 2022). Over two-thirds (65.3%) of the respondents indicated owning land in the study areas. A study by Akinyemi and Mushunje (2019) surveyed land access in South Africa, highlighting that most households with access to land are from the Eastern Cape, KwaZulu-Natal, and Limpopo provinces. The farmers in the area practiced crop farming (38.7%), livestock farming (23.3%), and mixed farming (38.1%). The reasons for farming were for consumption (19.4%), selling (20.6%), and a combination of the two (60%).

The respondents were questioned about their knowledge of extension services and if they had access to them in their area. Data show that many (76%) of the respondents were aware, but only 59.8% had access to extension services. It is concerning to note that a total of 40.2% of the farmers did not have access to extension services. During the FGDs, a farmer stated that:

> "Our occupancy is not officially registered with the Department of Agriculture because we farm on municipal or communal land. We believe this to be the reason why government extension agents are absent. Having ties to farmer organizations is the only way we receive extension assistance" (Female Farmer, FGD, Amathole District, August 2022).

The statement points to a significant issue for many smallholder farmers in South Africa, especially those farming on municipal or communal land. The lack of official registration with the Department of Agriculture, which is necessary for accessing certain government services, could hinder their ability to receive agricultural extension support. In this context, the absence of registration likely limits the involvement of government extension agents, as they generally focus on registered farms when providing technical guidance and resources.

The farmer also highlights that their main source of agricultural extension support comes through informal networks, like connections with farmer organizations. This emphasizes the crucial role these organizations play in connecting farmers with the state. They are key in spreading agricultural knowledge, providing assistance, and advocating for resources that would otherwise be out of reach due to bureaucratic or administrative challenges.

3.3 Farmer's knowledge of climate change

The respondents were asked about their recent observations of climate change and its effects on their community. The results presented are based on the farmer's perceptions and live experiences, which may not represent factual scientific knowledge. A total of 93.7% noted that they had observed a change in climate over the years. The observed changes by farmers are presented in Figure 2.

Figure 2 shows that most respondents (63.4%) considered drought a significant event in the area. This concurs with a study in the Eastern Cape by Amoah and Simatele (2021) on food security and coping strategies of rural household livelihoods to climate change, where drought was evident. About half the respondents (53%) noted that they have also observed flooding in the study areas, which, according to Dalu et al. (2018), has been mainly caused by poor drainage and drainage clogging in the province. Other observations were very hot and very wet seasons (25 and 22%, respectively).

Another question posed to respondents was the impact of climate change on the local community, livelihood, and agricultural production. It was noted that it mainly led to crop failure and livestock loss, at 70.9 and 48.6%, respectively. Another impact was the deterioration of infrastructure (21.7%). The responses of the majority of respondents thus suggest that climate change led to reduced income and increased socio-economic challenges.

During the FGDs, the respondents elaborated on their experience with climate change. They agreed that their crop planting date has changed due to climate change. They have seen a relative increase in several pests during extreme weather conditions. Furthermore, most study site respondents believed they received rain later than expected. One of the participants stated:

> "We farm but do not get anything from farming because of drought and recent flooding. Our food production has reduced drastically due to high temperatures. Just last year (2021), three of my goats died because of the dryness of the grass and hunger. High temperatures severely impact our livestock. They do not get greener pastures to feed on, lose weight, and sometimes die" (Female Farmer, Chris Hani District, August 2022).

These results highlight the vulnerability that smallholder farmer's face, struggling to maintain their livelihoods amidst increasingly unpredictable and extreme climate events. The impact of such climatic stressors extends beyond the loss of livestock, as it also threatens food security, economic stability, and the overall wellbeing of farming communities. Over time, such disruptions erode the resilience of farmers and their communities, weakening their ability to adapt and recover from future climate-induced stresses. In this context, climate change is not just a physical phenomenon but also a social and economic crisis, exacerbating inequality and pushing vulnerable farming communities further into poverty.

3.4 Farmer's perceptions of the knowledge and capacity of extension officers on climate change

Farmers were asked about their perception of extension officers' knowledge and capacity on climate change.

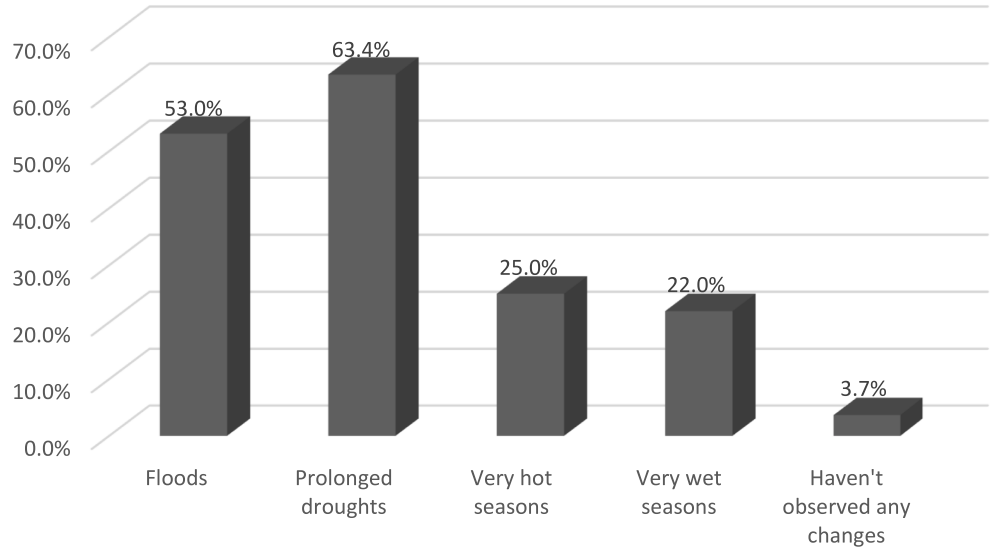

FIGURE 2
Observed changes in the climate.

To establish the capacity of the practitioners, the three aspects proposed by Mustapha et al. (2012) were used as the basis for questions. These are (i) whether they were facilitating and implementing policies and programs, (ii) providing information and guiding management of new methods of farming, and (iii) developing capacity.

The respondents were asked if the extension officers made them aware of climate adaptation policies in the study areas. Awareness refers to whether extension officers informed farmers about these policies and services, while knowledge implies a deeper understanding, including the ability to explain, apply, or assess their relevance in practice. Knowledge was measured through self-reported confidence.

Notable, (72.6%) of those with access to extension services perceived practitioners to be knowledgeable about climate change. The study results further revealed a general agreement among participants that extension officers are knowledgeable about climate change support interventions. Using a Likert scale, most participants found practitioners to be knowledgeable; specifically, 16.8% of participants strongly agreed, 58.4% agreed, 20.8% were neutral, 3.4% disagreed, and 0.7% strongly disagreed.

Those respondents (89.1%) further indicated that the information they receive makes a difference in their adaptation and production. One respondent stated:

> "We lack the education to comprehend weather patterns and effective adaptation measures. We rely only on officials for information. We mainly depend on indigenous knowledge, which we have since learned is insufficient. Due to most of our time spent in the fields, we cannot receive any warnings issued via radio or television. Additionally, due to network connectivity issues in our area, we cannot utilize cell phones" (Male Farmer, focus group discussion, OR Tambo District, July 2022).

The study further noted the farmer's lack of formal education on climate change, making it challenging for them to assess the knowledge of officers directly. To address this, the study assessed the knowledge of extensionists by determining whether farmers had been made aware of key policies, climate adaptation tools, and strategies. This approach would provide insight into the quality of services the officials offer, reiterating that if farmers remain uninformed about these critical resources, it indicates a knowledge gap among extension officers. The evidence shows that the majority (64.6%) were not made aware of policies in line with climate adaptation in the country and province. Farmers should be aware of climate change adaptation policies because they can help them boost their climate resilience, manage the effects of climate change, and advance sustainable agricultural practices. Additionally, most farmers (67.5%) indicated that they have never been made aware of weather/climate services by extension practitioners. The only familiar tool to the respondents was the South African Weather Service (SAWS).

Most respondents (68%) stated that practitioners provided interventions and programs assisting climate change adaptation. The strategic adaptations options the practitioners recommend to farmers include multi-cropping; crop diversity; crop rotation; changing planting dates; changing from crop farming to livestock farming or the other way round; expanding irrigation systems; changing the use of chemicals, fertilizers, and pesticides; increased water conservation and soil conservation; and using insurance. Concerningly, 45.7% of the respondents pointed out that the practitioners do not monitor the effectiveness of the advised farming strategies.

Results show that practitioners use various channels to increase farmers' capacity, and most respondents (60.6%) indicated that these were their preferred communication channels, including face-to-face, mass media and farmer-to-farmer. To further understand the perception of farmers on the capacity of extension practitioners, a binomial logistic regression was performed to determine which independent variable/s had a

statistically significant effect on the perception of extension capacity. The results are presented in Table 4.

Seven independent variables included in the logistic regression model were gender, education, full−/part-time farming, land ownership, experience, belonging to an organization, and access to extension.

The pseudo r-squared was 0.625%, indicating that the model used was strong to reliably predict factors affecting farmers' perception of extension competency, the explanatory variables, and the variance.

Table 4 shows that gender was statistically significant at a 5% level in relation to farmers' perception of the competence of extension offices. This means that being a male or female farmer directly influences the farmer's opinion on the competence of the extension officer. The coefficient marginal effects are positive, meaning the expected difference in probability of y = 1, associated with farmers' perception of the competence of practitioners, increases by 25% (0.253). This is a result of the likelihood of the interaction between extension practitioners, which suggests that male farmers have a lower perception of extension officers. This may be due to male farmers having more access to agricultural extension delivery than their female counterparts (Quaye et al., 2019), as such, having higher expectations or prior experience (Ragasa et al., 2013). Furthermore, according to Lahai et al. (1999) gender dynamics play a critical role in how farmers perceive extension services. The study highlights that female farmers supervised by female practitioners had higher levels of satisfaction; this finding is relevant to the current study, given the higher proportion of female farmers in the sample. Idowu (2005) notes that gender is significant in the perception of extension services, and it may be due to the socio-cultural setting that delineates the male–female relationship.

The marginal effects for farming experience were significant at 5% related to extension competence. However, the coefficient is negative (−0.062). This means a one-unit increase in farming experience decreases farmers' perception of extension officer competency regarding climate change. This proves that more experienced farmers may perceive extension practitioners with less urgency or reliance because they already have a certain level of farming experience and have acquired knowledge and skills over time; this concurs with Sebeho (2016). Meaning, that more experienced farmers perceive officers as less competent, due to the preference for indigenous knowledge, which could stem from the ways and knowledge that communities have acquired over the years to address climate-related issues, which may not be known or understood by extension services.

TABLE 4 Factors affecting farmer's perceptions of extension competency.

Explanatory variables	Coefficient estimates		Marginal effect	
	Coff.	Std. err	Coff.	Std. err
Gender	−1.234	0.050**	0.253	0.108
Highest level of education	0.222	0.531	0.310	0.147
Full/ part-time farmer	0.845	0.544	0.351	0.162
Farming Experience	−0.422	0.496	−0.062	0.036**
Land ownership	0.176	0.532	0.150	0.071*
Member of an organization	1.392	0.545	−0.082	0.056*
Access to extension	−0.170	0.022**	0.081	0.036**
Number of observations = 175 Pseudo R – Squared 0.625 −2 loglikelihood 103.868 Prob > chi2 = **				

***, **, *means significant at 1, 5 and 10% levels of significance, respectively. ns, not statistically significant.

The coefficient estimate for land ownership is not statistically significant. This implies that land ownership does not significantly impact farmers' perception of extension competency, as seen in Table 4. The positive marginal effect (0.150) shows a potential positive relationship, suggesting that owning land positively increases the probability of perceiving extension competency by 0.150 units.

The marginal for being a member of an organization was statistically significant at the 5% level. However, the coefficient estimate was negative, indicating a decrease. This could be due to being a member of more than one group. According to the coefficient estimate (1.392), being a member of an organization is linked to a higher sense of extended competency, and it enhances perceptions of extension competency; this emphasizes how crucial social networks and group participation are for improving the efficacy of extension services.

Access to extension services had a negative coefficient of −0.170. This implies that farmers' perceptions of extension competency correlate with their limited access to extension services. It suggests that farmers tend to have a less favorable impression of the competency of extension services when they encounter barriers to accessing them. According to the coefficient estimate of −0.170, there is an association between a one-unit increase in limited access to extension services and a 0.170 reduction in the likelihood that extension expertise will be positively perceived. Meaning farmers with limited access to extension have a negative perception to the competency of extension services. This offers a quantitative assessment of how access restrictions impact farmers' perspectives.

3.5 Farmer's perceptions of the capacity needs of extension officers on climate change

To obtain data on the capacity needs of extension practitioners, from the farmers' perspective, participants were asked whether extension officers needed climate change training. A total of 71.4% agreed that that such training is needed. The respondents were provided with structured options on the different climate change capacity areas, where they could indicate whether they received those services from practitioners, and based on how important they considered them. The farmer's responses were based on their lived experience with practitioners, and Figure 3 shows the capacities practitioners need to improve to support farmers in adapting to climate change, according to the farmers.

The respondents (21.7%) highlighted that communication skills are needed for extension practitioners, which extend to using

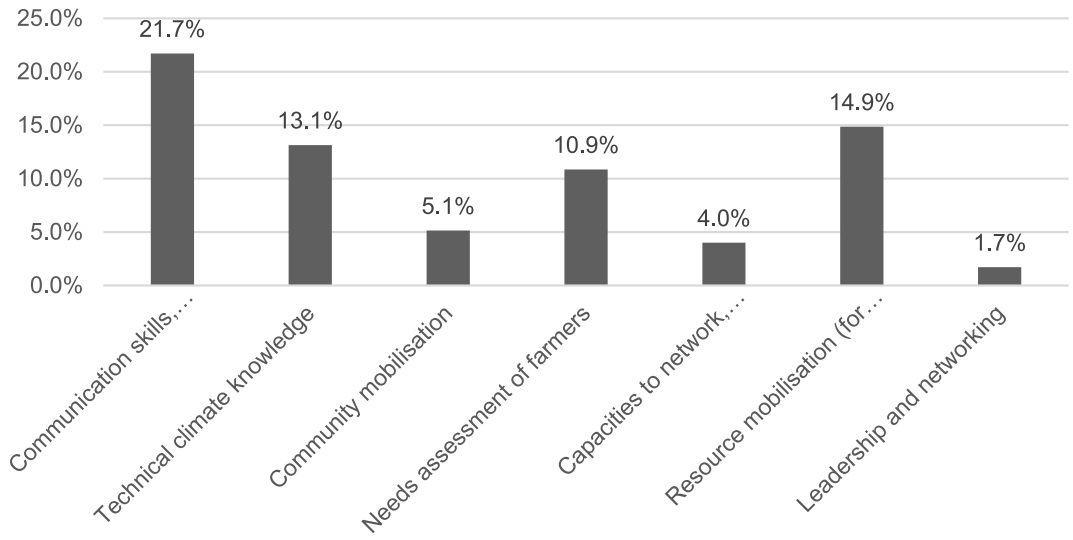

FIGURE 3
Capacity needs of extension practitioners according to farmers.

Information and Computer Technology (ICTs). In the survey, 30.9% of farmers noted that extensionists' knowledge of using ICTs was average to poor. According to Ali et al. (2017), agricultural extension practitioners' communication abilities are crucial for boosting farmers' capacity for adaptation. Therefore, the ability of agricultural extension practitioners to communicate effectively is essential for increasing farmers' adaptability.

A total of 13.1% of respondents said that improving technical knowledge was necessary to deliver extension effectively. This indicates that agricultural extension agents should be well-versed in the science related to climate change. This agrees with Dinesh (2016), who explains that extension practitioners need training in climate change to build more resilient farmers and ensure that they can cope with the impacts of climate change. Other capacity needs highlighted by farmers include community mobilization (5.1%), need assessment of farmers (10.9%), leadership and networking (1.7%), capacities to network and partner (4%), and resource mobilization (14.9%).

4 Conclusion

This study highlights the critical role of extension practitioners in supporting farmers' climate change adaptation efforts in the Eastern Cape. Findings indicate that gender, farming experience, and membership in farmer organizations significantly shape farmers' perceptions of extension officers' competencies. Notably, more experienced farmers viewed extension officers as less competent, while those in farmer organizations had more positive perceptions. Limited awareness of climate adaptation policies suggests a gap in knowledge dissemination.

To strengthen extension services in climate change adaptation, the following recommendations are proposed:

1 *Regular farmer engagement:* the Eastern Cape Department of Rural Development and Agrarian Reform (DRDAR) should facilitate ongoing interactions between extension officers and farmers to ensure the timely exchange of climate-related observations.
2 *Capacity building*: practitioners require continuous training, focusing on communication skills, ICT use, technical climate knowledge, community mobilization, farmer needs assessment, networking, leadership, and resource mobilization.
3 *Indigenous knowledge integration*: efforts should be made to incorporate Indigenous Knowledge Systems (IKS) into extension services, recognizing and enhancing the adaptive techniques that farmers already employ.

Enhancing practitioners' competencies through targeted training, policy awareness, and farmer engagement will improve the effectiveness of climate change extension services and foster more positive farmer perceptions.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the University of the Free State, General/Human Research Ethics Committee (GHREC). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

AM: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. OL: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Writing – review & editing. JS: Conceptualization, Formal analysis, Investigation, Project administration, Supervision, Writing – review & editing. JV: Writing – review & editing, Conceptualization, Project administration, Investigation, Funding acquisition, Resources. MZ: Formal analysis, Project administration, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. The authors utilized ChatPDF to summarize key information from the literature reviewed. In addition, research trends from peer-reviewed sources were identified and analyzed using Consensus. Lastly, minor language editing and formatting was done using Grammarly.

Publisher's note

References

Abdel-Hussein, M. A., and Fayyadh, S. O. (2023). Requirements for developing the technical capabilities of agricultural extension service providers to face the effects of climate change in Baghdad province. *IOP Conf. Series Earth Environ. Sci.* 1259:012131. doi: 10.1088/1755-1315/1259/1/012131

Abdullah, A., Jamila, M., Amidah, A., Aslina, A., and Nurlaelah, A. (2017). Analysis of the determining factors on the performance of extension practitioners for transferring livestock feed technology am. *J. Sustain. Agric.* 11, 72–76.

Ajala, A. O., Ogunjimi, S. I., and Farinde, A. J. (2013). Assessment of extension service delivery on improved cassava technologies among cassava farmers in Osun state, Nigeria. *Int. J. Appl. Agric. Apic. Res.* 9, 71–80.

Akinyemi, B. E., and Mushunje, A. (2019). Land ownership and usage for agriculture: empirical evidence from south African living conditions survey. *Cogent Soc. Sci.* 5:1663691. doi: 10.1080/23311886.2019.1663691

AlGhamdi, K. M., Moussa, N. A., AlEssa, D. S., AlOthimeen, N., and AlSaud, A. S. (2014). Perceptions, attitudes and practices toward research among senior medical students. *Saudi Pharm J.* 22, 113–117. doi: 10.1016/j.jsps.2013.02.006

Ali, S., Liu, Y., Ishaq, M., Shah, T., Abdullah, A. I., and Din, I. U. (2017). Climate change and its impact on the yield of major food crops: evidence from Pakistan. *Foods* 6:39.

Amoah, L. N. A., and Simatele, M. D. (2021). Food security and coping strategies of rural household livelihoods to climate change in the eastern cape of South Africa. *Front. Sust. Food Syst.* 5:692185. doi: 10.3389/fsufs.2021.692185

Bijman, J., and Wijers, G. (2019). Exploring the inclusiveness of producer cooperatives. *Curr. Opin. Environ. Sustain.* 41, 74–79. doi: 10.1016/j.cosust.2019.11.005

Binswanger-Mkhize, H. P., Bourguignon, C., and van den Brink, R. (2009). Agricultural land redistribution: Towards greater consensus on the how. Washington, DC: The World Bank.

Bizikova, L., Nkonya, E., Minah, M., Hanisch, M., Turaga, R. M. R., Speranza, C. I., et al. (2020). A scoping review of the contributions of farmers' organizations to smallholder agriculture. *Nat. Food* 1, 620–630. doi: 10.1038/s43016-020-00164-x

Chimombo, M., Matita, M., Mgalamadzi, L., Chinsinga, B., Chirwa, E., and Kaiyatsa, S. (2022). *Interrogating the effectiveness of farmer producer organisations in enhancing smallholder commercialisation - frontline experiences from Central Malawi*. Institute of Development Studies. Available at: https://opendocs.ids.ac.uk/articles/report/Interrogating_the_Effectiveness_of_Farmer_Producer_Organisations_in_Enhancing_Smallholder_Commercialisation_Frontline_Experiences_From_Central_Malawi/26434093?file=48183760 (Accessed March 12, 2025).

Dalu, M. T., Shackleton, C. M., and Dalu, T. (2018). Influence of land cover, proximity to streams and household topographical location on flooding impact in informal settlements in the Eastern Cape, South Africa. *Int. J. Disaster Risk Reduc.* 28, 481–490. doi: 10.1016/j.ijdrr.2017.12.009

Danso-Abbeam, G., Ehiakpor, D. S., and Aidoo, R. (2018). Agricultural extension and its effects on farm productivity and income: insight from northern Ghana. *Agric. Food Sec.* 7:225. doi: 10.1186/s40066-018-0225-x

Davis, K., Faure, G., Nahdy, M. S., and Chipeta, S. (2009). Institutional changes and challenges for agricultural advisory services in Africa. Available at: https://agritrop.cirad.fr/551498/1/document_551498.pdf (Accessed March 12, 2025).

Dinesh, D. (2016). Adaptation measures in agricultural systems: Messages to SBSTA 44 agriculture workshops. CCAFS working paper no. 145. Wageningen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Eneji, C. O., Onnoghen, N. U., Odama, J., and Diwa, J. B. (2020). Climate change awareness, environmental education and gender role burdens among rural farmers of northern cross river state, Nigeria. *Int. J. Clim. Change Strat. Manage.* 13, 397–415. doi: 10.1108/ijccsm-06-2020-0070

Gökçe, O. (2006). İçerik analizi: kuramsal ve pratik bilgiler. Ankara: Siyasal Publications.

Hastie, T., Tibshirani, R., Friedman, J. H., and Friedman, J. H. (2009). The elements of statistical learning: Data mining, inference, and prediction. New York, NY: Springer, 1–758.

Herawati, I. E., and Susilo, A. (2019). The competency of agriculture extension supervisor based on farmer's perspectives. *Int. J. Sci. Technol. Res.* 8, 117–113.

Hosmer, D. W., Jr, Lemeshow, S., and Sturdivant, R. X. (2013). Applied logistic regression. John Wiley & Sons.

Idowu, O. O. (2005). Farmers' perception of agricultural extension agents' characteristics as factors for enhancing adult learning in Mezam division of Northwest Province of Cameroon. *Australian J. Adult Learn.* 45, 223–237.

Joshi, R. D., and Dhakal, C. K. (2021). Predicting type 2 diabetes using logistic regression and machine learning approaches. *Int. J. Environ. Res. Public Health* 18:7346. doi: 10.3390/ijerph18147346

Karbo, R. T., and Crentsil, A. O. (2021). Climate-smart agriculture (csa) adaptation strategies of farmers against climate change in lawra municipality, upper west region, Ghana. *J. Sci. Res. Rep.* 11, 10–19. doi: 10.9734/jsrr/2021/v27i230355

Khan, M., Nawab, K., Ullah, J., Khatam, A., Qasim, M., Ayub, G., et al. (2012). Communication gap and training needs of Pakistan's agricultural extension practitioners in horticulture. *Sarhad J. Agric.* 28, 129–135.

Khapayi, M., and Celliers, P. R. (2016). Factors limiting and preventing emerging farmers to progress to commercial agricultural farming in the King William's Town area of the eastern Cape Province, South Africa. *South Afr. J. Agric. Ext.* 44, 25–41. doi: 10.17159/2413-3221/2016/v44n1a374

Khwidzhili, R., and Worth, S. (2016). The sustainable agriculture imperative: implications for south African agricultural extension. *SAJAE* 44, 19–29. doi: 10.17159/2413-3221/2016/v44n2a367

Lahai, B. A., Goldey, P., and Jones, G. E. (1999). The gender of the extension agent and farmers' access to and participation in agricultural extension in Nigeria. *J. Agric. Educ. Ext.* 6, 223–233.

Landaverde, R., Rodríguez, M., Niewoehner-Green, J., Kitchel, T., and Chuquillanqui, J. (2022). Climate change perceptions and adaptation strategies: a mixed methods study with subsistence farmers in rural Peru. *Sustain. For.* 14:16015. doi: 10.3390/su142316015

Liebenberg, F. (2015). Agricultural advisory services in South Africa. University of Pretoria, Department of Agricultural Economics, Extension and Rural Development, Working Paper 241722. doi: 10.22004/ag.econ.241722

Makara, N. M. (2010). An investigation of the role and impact of the extension services in the massive food programme introduced at Zanyokwe irrigation scheme of the Amahlathi local municipality in the eastern cape. Dikeni: University of Fort Hare.

Mandikiana, B. W. (2024). Evaluating rural households' welfare gains from participation in smallholder agriculture: A difference in differences approach. Research Square. [Online]. Available at: https://www.researchsquare.com/article/rs-5437189/v1 (Accessed March 12, 2025).

Mandleni, B., and Anim, F. D. K. (2011). Climate change awareness and decision on adaptation measures by livestock farmers (no. 353-2016-18073). doi: 10.22004/ag.econ.108794

McNiff, J. (2016). You and your action research project. London: Routledge.

Mdoda, L. (2020). Factors influencing farmers' awareness and choice of adaptation strategies to climate change by smallholder crop farmers. *J. Agribus. Rural Dev.* 58, 401–413. doi: 10.17306/J.JARD.2020.01280

Mustapha, S. B., Sanda, A. H., and Shehu, H. (2012). Farmers' perception of climate change in central agricultural zone of Borno state, Nigeria. *J. Environ. Earth Sci.* 2, 21–28.

Ndhleve, S., Nakin, M. D. V., and Longo-Mbenza, B. (2017). Impacts of supplemental irrigation as a climate change adaptation strategy for maize production: a case of the Eastern Cape Province of South Africa. *Water SA* 43, 222–228. doi: 10.4314/wsa.v43i2.06

Neuendorf, K. (2002). The content analysis guidebook. Thousand Oaks, CA: Sage Publications Inc.

Odimegwu, F. (2022). Climate change and agriculture: analysis and implication on South Africa. *Afr. Soc. Sci. Hum. J.* 3, 1–19. doi: 10.57040/asshj.v3i2.141

Prokopy, L. S., Carlton, J. S., Arbuckle, J. G., Haigh, T., Lemos, M. C., Mase, A. S., et al. (2015). Extension′ s role in disseminating information about climate change to agricultural stakeholders in the United States. *Clim. Chang.* 130, 261–272. doi: 10.1007/s10584-015-1339-9

Quaye, W., Fuseini, M., Boadu, P., and Asafu-Adjaye, N. Y. (2019). Bridging the gender gap in agricultural development through gender responsive extension and rural advisory services delivery in Ghana. *J. Gend. Stud.* 28, 185–203. doi: 10.1080/09589236.2017.1419941

Ragasa, C., Berhane, G., Tadesse, F., and Taffesse, A. S. (2013). Gender differences in access to extension services and agricultural productivity. *J. Agric. Educ. Ext.* 19, 437–468. doi: 10.1080/1389224X.2013.817343

Saloshni, N., and Nithiseelan, N. R. (2022). Vulnerability of South African women workers in the covid-19 pandemic. *Front. Public Health* 10:964073. doi: 10.3389/fpubh.2022.964073

Sebeho, M. A. (2016). Perceptions and attitudes of farmers and extensionists towards extension service delivery in the Free State Province, South Africa. Pretoria: University of Pretoria.

South Africa Department of Agriculture, Forestry and Fisheries (DAFF) (2014). National policy on extension and advisory services. National Department of agriculture, forestry and fisheries. Pretoria: Republic of South Africa.

South Africa Department of Agriculture, Land Reform, and Rural Development. (2021). National Policy on extension and advisory Services in Agriculture, Forestry and Fisheries. Available online at: https://www.daff.gov.za/docs/policies/Extension_policy_final.pdf (Accessed October 12, 2022).

Statistics South Africa. (2016). General Household Survey, 2016. Statistics South Africa. [Online]. Available at: https://www.statssa.gov.za/publications/P0318/P03182016.pdf (Accessed March 12, 2023).

Stevens, J. B., and Van Heerden, P. S. (2016). Knowledge brokering and dissemination of irrigation management guidelines for training of extension advisors. *Report No. KV* 356:16.

Suleiman, R. A., Ikani, E. I., Mamma, S., Ariyo, O. C., Oladele, O. N., Adelani, O. D., et al. (2021). Assessment of extension communication channels among agroforestry farmers in Ekiti state, Nigeria. *Russian J. Agric. Socio-Econ. Sci.* 117, 102–116. doi: 10.18551/rjoas.2021-09.12

Van Niekerk, J. A., StroebeL, A., Van Rooyen, C. J., Whitfield, K. P., and Swanepoel, F. C. J. (2011). Towards redesigning a new agricultural extension service in South Africa: views and proposals of extensionists in the eastern cape. *S. Afr. J. Agric. Ext.* 38, 57–68.

Williams, B., Mayson, D., De Satgé, R., Epstein, S., and Semwayo, T. (2008). Extension and smallholder agriculture: Key issues from a review of the literature. Cape Town: Phuhlisani.

Worth, S. (2012). Agricultural extension in South Africa: Status quo report. Cape Town: Phuhlisani Solutions.

Yıldırım, A., and Şimşek, H. (2006). Sosyal Bilimlerde Nitel Araştırma Yöntemleri. *5th* Edn. Ankara: Seçkin Publications.

Zantsi, S. (2021). Why do agricultural co-operatives fail to attract youth and create rural employment? Evidence from a case study of Zanokhanyo in Butterworth, eastern cape. *South Afr. J. Agric. Ext.* 49, 183–197. doi: 10.17159/2413-3221/2021/v49n1a10785

Zikhali, Z. M., Mafongoya, P., Mudhara, M., and Jiri, O. (2019). Climate change mainstreaming in extension agents training curricula: a case of Mopani and Vhembe district, Limpopo province, South Africa. *J. Asian Afr. Stud.* 55, 44–57. doi: 10.1177/0021909619857098