Information Sources and Constraints to Climate Change Adaptation amongst Smallholder Farmers in Amathole District Municipality, Eastern Cape Province, South Africa

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Abstract: With current global climate change conditions, the urgency to provide agricultural knowledge on adaptation has risen. The dearth of climate change information is one amongst many agricultural production challenges faced by the majority of rural farming communities. This study aimed to identify smallholder farmers’ sources of climate change information and constraints to their coping and adaptation. Descriptive statistical tools, mean scores and the ‘problem confrontation index’ (PCI) were used to assess and describe the study’s findings. Analysis revealed that public extension services play a minute role in rural farmers’ climate change knowledge; they get their information elsewhere. The most critical constraint to climate change coping and adaptation in the study area was lack of access to agricultural extension services.

Keywords: knowledge; information sources; constraints

1. Introduction

Agricultural production profoundly depends on climate elements such as rainfall and temperature [1,2]. Evidences from studies [3–6] show increasing impacts of recurrent inconsistencies of climate variables on agricultural production. Due to climatic inconsistencies, global environment could be continually subjected to storms, floods, droughts, and other climate change threats with intense impacts on agricultural yields. There is a severe implication for agriculture [7–11]. Extreme weather events could cause increased heat stress to crops and livestock, fire outbreaks, which threatens grazing, and livestock rearing, loss of suitable land for production and reduced length of growing seasons [12–15]. Other implications on agricultural production include problems related to evaporation and absorption of nutrients; shortage or excessive soil moisture which can damage the realization of crop-yield potential [5,16,17]. High temperatures coupled with wet conditions creates conducive environments for the breeding and growth of pests and pathogenic organisms thereby increasing incidences of pests and diseases on crops, livestock and poultry [4–6,17–19]. An example is the red-water disease incidence which largely affected cattle in areas (previously disease free) within the Eastern Cape Province [13]. Climate risks affects livestock feed availability, grazing, production of milk and eggs, leading to loss of livestock weight, ill health, slow recovery or death and loss of revenue [3,20–24]. According to Turpie and Visser, [15] (p. 127), these impacts “may result in an already marginal farming communities becoming further impoverished” as the agricultural net revenue of smaller farms seem to be most severely affected by climate change. There is, therefore, severe economic consequences on the gross domestic products (GDP) of nations, income and consumption pattern of the most vulnerable population [10].
Stringer, Twyman and Gibbs [25] list the challenges faced by small-scale farmers as severe poverty, changes in agricultural and rural policies, output market dynamics, sustainability of livelihood strategies and biophysical barriers such as land degradation and climatic variations, amongst others. Having to adapt to the vagaries of climatic change brings with it additional burdens. McDowell and Hess [26] (p. 343) maintained that “adaptation occurs in response to, and in preparation for, multiple stressors that reconfigure access to resources required for response”. There are a number of factors, established by numerous researchers that promote adaptation capacity: economic assets, technology, information and skills, infrastructure, the presence of effective institutions, equity, social capital, and collective action [27]. These factors are considered critical to the adaptation responsiveness of farming communities, particularly resource-poor populations living in core rural communities. Appropriate climate change information dissemination is thus, a critical factor in effective adaptation. According to Nkeme and Ndaeyo [28], providing ample climate change information essentially equips farmers in acclimatizing to extreme climate conditions.

Access to climate change information is central to coping and adaptation responses [29]. Information is critical for production sectors such as agriculture, where stakeholders are highly dependent on the environment [30]. Access to agricultural information is considered a central component of a cutting-edge agricultural system and fundamental for increased agricultural productivity [31–33]. It is also critical for the overall development of the agricultural sector [34,35]. The provision of agricultural information to farming communities should be needs-based to be effective [36]. According to Mtega, Ngoepe and Dube, [37], access to information is primarily dependent on the infrastructure required for its dissemination, which is characteristically unevenly distributed within and amongst countries, resulting in some farming communities being more information rich than others. Thus, information sources are viewed as critically pertinent for the efficient dissemination of information. Information has been the subject of discourse over the years in relation to its access, availability, effectiveness, efficiency and overall impact on farmer productivity [38]. The rudimentary sources of rural farmers’ information have been neighboring farmers, input dealers, middlemen and conventional media such as radio, television and newspapers. All of these have limitations, such as the dissemination of non-specific information and their remoteness, which prevents interaction between the source of information and the farmers [39].

With current global climate change conditions, the urgency to provide agricultural knowledge on adaptation and mitigation measures has risen [37]. As expressed by Mosser [40] (p. 43), “the need for effective communication, public outreach and education to increase support for policy, collective action and behaviour change is ever present, and is perhaps most pressing in the context of anthropogenic climate change.” Cooper [41] further observes that the urgency to intensify ‘climate literacy’ is reflected through calls for climate science by federal institutions to disseminate climate change education.

The challenges of communicating climate change to the masses are, however, enormous [42]. Castilla, Quesada and Rodriguez [43] articulate their concerns on the serious gaps in climate change information dissemination and comprehension. Climate change information dissemination to rural farming communities is especially critical and its dearth could give rise to trepidation regarding the adoption of agriculture as a career, since one of the major factors retarding agricultural productivity is lack of information [33]. It is on the basis of this background that the study focused on the following key research objectives:

i. to identify smallholder farmers’ sources of information on climate change, policies, coping and adaptation practices; and,

ii. to identify constraints to smallholder farmers’ implementation of coping and adaptation strategies.

2. The Conceptual and Theoretical Framework

A number of studies have indicated that only about 12–13% of South Africa’s total land mass (122 million hectares) is suitable for rain-fed crop production out of which only about 3% is deemed significantly fertile for production [44,45]. Livestock production is, however, more rife in the country as
about 69% of its land area is conducive for grazing [45]. According to Mashabela [46], the contribution of agriculture to the South African economy declined by 13.2% in early 2019 with remarkable decrease in crop and livestock production partially due to adverse climate events like increased dry conditions affecting areas where grains are cultivated. Greyling et al. [45] points to literature, which corroborates that the country is a dry region experiencing episodic droughts with recurrent incidences of increased temperature and erratic precipitation patterns. These extreme weather conditions may continue to affect domestic production.

South Africa runs a dual agricultural sector. The large-scale cutting-edge commercial sector and the small-scale sector, which is mostly subsistent [15,44,45]. Producers in the smallholder farming sector have trouble in acquiring land, are mostly uneducated, lack skills, have limited access to resources, lack awareness and are incapable of adapting to rapid changing climate conditions [3,47]. According to Lin [48], smallholder-farming families particularly lack access to capital for investing in expensive adaptation strategies and this, intensifies the vulnerability of rural agricultural population to environmental threats induced by climate change. In Maponyas, Mpandeli and Oduniyi’s view [49] (p. 273):

Small holder farmers suffer the most because of major impediments such as their dependence on rain-fed agriculture, limited financial capacity, low adaptive capacity, high dependence on natural resources, inability to detect the occurrence of extreme hydrological and meteorological events due to low technology adoption, limited infrastructure, illiteracy, lack of skills, level of awareness and lack of capacity to diversify.

One of the pronounced challenges is the lack of access to critical climate change information, which consequently affects their level of awareness and adaptive capacities. According to Bello et al. [50], the ability of farmers to effectively cope with and adapt to climate change is largely dependent on their level of knowledge vis-à-vis their accessibility to climate change information. Access to adequate information on climate change conditions enhances awareness levels and potentially increases the adaptive capacities of farmers [5,22,28]. For example, Nkeme and Ndaeyo’s [51] study in Akwa Ibom, Nigeria, showed that farmers related their inability to utilize adaptation strategies to their lack of awareness and dearth in climate change information dissemination in the study area. In contrast, farmers in Limpopo Province, South Africa, utilize weather forecast information provided by the South African Weather Service (SAWS) through print and electronic media to plan their production activities and make critical production decisions [20]. Therefore, availability of climate change information from diverse media assists farmers in making knowledgeable, operative and rational decisions such that allows them to effectively adapt to climate change conditions [52,53]. Otherwise, adopting adaptation strategies becomes extremely challenging and increases the vulnerabilities of farmers to climate change threats [53]. According to Browning, Halcli and Webster [54], people act within specific, given limitations and based on whatever information they are privy to about the circumstances under which they are acting. Therefore, adaptation to climate change may be impractical if relevant up-to-date information is not aptly generated and disseminated to stakeholders [55]. Consequently, several studies [3,18,22] have called for the need to strengthen climate change information delivery and education in order to aid adaptive capacities of farmers.

Bello et al. [50] noted important climate change information needs of farmers, which includes basic information on the nature, causes and effects of climate change, and the diverse mitigation and adaptation practices. However, providing such information alone without providing other support mechanisms may not suffice for effective climate change adaptation. Juana et al. [10] reviewed the Food and Agricultural Organization [FAO] 2007 report, which suggests that adaptation to climate change comprises of: (i) being aware of climate change and having the capacity to adapt to it and; (ii) carefully planning and implementing adaptation responses to preclude maladaptation. According to the review, the first standpoint is realized through efficient climate change information dissemination and education whilst the second, is achievable through government interventions and technology
advancements. Mpandeli and Maponya [56] stressed that providing institutional support in the form of financial and technical assistance could enhance adaptation. Support mechanisms could include the provision of relevant infrastructure [5]. Aside from provision of information, Zougmoré et al. [57] surmised that the aptitude to adapt to changing climate conditions is reliant on available capital, infrastructures, technologies, social institutions and networks. There is, therefore, the need to recognize other significant adaptation support mechanisms.

Maponya and Mpandeli [3] buttress the need for providing critical climate change information to allow farmers to effectively adapt to the changing conditions. According to Umunakwe et al. [55], when people are adequately informed, they are at an advantaged position to prepare for potential climate threats. Oyekale and Oladele [58] advocate for more involvement of the media in providing relevant climate change information such that can assuage climate change impacts. Media has become very significant in disseminating mass information to the public and there has been recent upsurge in the use of media mechanisms by social institutions to connect people to information [59,60]. As such, the public is increasingly becoming dependent on media sources for the provision of information. The theory of media dependency, also known as the media system dependency theory, could explain the rationale behind people’s reliance on the media for up-to-date climate change information to meet their adaptation needs.

Propounded in 1976 by Sandra Ball-Rokeach and Melvin DeFleur [61,62], the theory posits that “for societies in states of crisis or instability, citizens are more reliant on mass media for information and as such are more susceptible to their effects” [63] (p. 162). This suggests that in the face of the recent climate change crisis, people may tend to rely on mass media to obtain climate change information. As inferred by Clayton et al. [64], perception of people to climate change could be informed through a number of sources; some of which include the mass media, direct experience or other people. Although, having a first-hand or direct experience of climate change events informs an individual’s attitude or behaviour towards it more powerfully than getting informed about it from second-hand sources [64–66], the place of mass media as a critical information tool cannot be displaced.

As explained by Lin [61], media dependency theory conceptualizes a relationship between two entities where the gratification of the needs and aspirations of one entity is dependent on the resources of the other. Thus, the theory focuses on existing associations between the media and audience, where the latter gets to rely on the former to satisfy their information needs. Other studies [60,62,67] also noted that at the macro level, media dependency theory further examines the relationship between social institutions, media and audience termed as a “tripartite relationship” where it theorizes how social institutions and media influences the audience cognitively, affectively and behaviorally.

According to Riffe, Lacy and Varouhakis [67] (p. 1), “dependency on a source or medium does not require exclusive use of that medium, nor even daily use, but regular use indicates whether the medium constitutes an important part of the individual’s information mix.” In their review of a number of literatures, the authors (p. 2), highlighted three major areas of dependency “for solitary play and social play; for self-understanding and social understanding; and for action orientation and interaction orientation.” Relating this to climate change, this suggests that farmers may tend to rely on mass media for an in-depth understanding of climate change events and make decisions on the course of actions to take in order to cope with and adapt to the climate change events. This is in line with Balew et al.’s [53] inference, from their review of preceding climate change adaptation literatures, that easy access to climate change information allows farmers to actively make informed decisions such that will make them effectively adapt to climate change events.

3. Materials and Methods

3.1. Area of Study

The Eastern Cape Province covers an area of 169,000 sq. km (13.9% of South Africa’s land area), making it the second largest province in South Africa after the Northern Cape [68]. The dominant
land use in the majority of the Eastern Cape is grazing, along with dry-land agriculture in the eastern section of the province. According to the Eastern Cape Planning Commission [ECPC] [69], agricultural potential in the province remains under-tapped as arable lands are under-utilized mainly because there is insufficient capital to undertake land improvements for profitable farming. The Amathole District Municipality is situated within the Eastern Cape Province. It is classified as a Category C2 Municipality (largely rural character and low urbanization rate) which is made up of 7 Local Municipalities—Amahlathi, Nxuba, Nkonkobe, Ngqushwa, Great Kei, Mnquma and Mbhashe [70,71]. According to the Amathole District Municipality Agricultural Development Plan (ADM ADP) [70] review, agricultural businesses in Amathole include hydroponics, vegetables, field crops, poultry, pineapples and aquaculture; the region has varied natural resources (in terms of soils, vegetation, climate and topography). “The agricultural sector of the district is characterized by low productivity, higher farmer indebtedness, lack of access to finance for historically disadvantaged farmers, declining capital investment, and aging farmers. Thus, agricultural potential does not appear to be optimally utilized, and there has been limited investment in agriculture infrastructure resulting to a situation where by the agricultural potential of the district, has not been fully realized” [70] (p. 21). The Amathole District Municipality Integrated Development Plan (ADM IDP) [71] review corroborates that the constraints facing agriculture in most of the rural parts of Amathole has impinged agricultural development beyond the subsistence level.

Mbhashe Municipality is a category B4 (low density, rural settlements and mostly subsistence) municipality within the Amathole District Municipality consisting of 31 wards and 279 villages [70,72] (Figure 1). It is vastly populated by Black Africans (99.4%) and IsiXhosa speaking tribe (94%); and constitutes the highest illiterate population (60%) within the Eastern Cape Province with majority (61%) living within the poverty line [70–73]. The agricultural sector contributes the most to its rural economy as a majority of the households are into subsistence agricultural production [70,71,74,75]. Cattle rearing is the predominant agricultural practice in the region closely followed by maize, vegetable, goat and sheep production; there are also vast potentials for piggery and citrus production [72,73]. The region could experience increased temperature, rainstorm, and hail incidences with consequent impacts such as flooding, heat waves, and drought affecting agricultural production in the area [72]. On a national scale, studies [1,15,44] have shown that the average yearly rainfall of the country (450 mm) falls below the estimated global average rainfall of about 860 mm which makes it a naturally water stressed region. According to Turpie and Viser [15], there is a projected increase in temperature for the region, estimated to rise by 4.2 degrees Celsius by the year 2080, while rainfall is being predicted to decrease by 9.5% by the same period. Therefore, a major impact could be increased water scarcity; this exacerbates an already dire situation [15] especially for agricultural producers in the country.

3.2. Research Design and Sampling Procedure

The survey research design was used for this study. A cross-sectional household survey was conducted in the selected study area. This research approach can be utilized in examining the performance of farming households within a specific location under a given climate (temperature or rainfall) gradient [76]. It involves a systematic collection of data at a specific point in time. Structured questionnaires were used for the collection of data. A total of 36,377 agricultural households were accounted for in Mbhashe during the 2011 census [77]. The total sample population for the study was therefore drawn from the above figure using Yamane’s [78] (p. 258) econometric model for calculating estimated sample population which amounted to 396.

Using a multistage sampling procedure, Mbhashe Local Municipality was purposively selected at the first stage because of its high population of farming households. Three major areas (Dutywa, Elliotdale and Willowvale) were identified as facing climate change risks in the municipality [72]. There are 31 wards in the municipality. A random selection of three wards from each of the identified areas was done at the second stage. Stage three also involved the random selection of two villages from each ward while smallholder farming households were selected from the villages at the fourth
stage of selection using the snowball approach (Figure 2, Table 1). A total of 303 questionnaires were administered as a result of multiple challenges experienced on the field during data collection; 301 (99.34%) were analyzed as 2 (0.66%) were discarded due to discrepancies in the responses.

Figure 1. Map of the Mbhashe Local Municipality showing the study areas and selected villages. Designed by the Geography Department, University of Fort Hare, South Africa.

Figure 2. Four selection stages for data collection.
3.3. Measurement of Variables

- Objective one: To identify smallholder farmers’ sources of information on climate change, policies, coping and adaptation practices.

Respondents were asked to select ‘Often’, ‘Seldom’ or ‘Never’ response to assess their sources of information. A value of 3 was assigned to ‘Often’, 2 to ‘Seldom’ and 1 to ‘Never’. An addition of the values \((3 + 2 + 1 = 6)\) was done; the total value of 6 was further divided by 3 to obtain a mean score of 2.0. Mean scores were computed. The information sources were then ranked based on the most dependent source(s) for obtaining climate change information.

- Objective two: to identify constraints to smallholder farmers’ implementation of coping and adaptation strategies.

To identify the constraints faced by the smallholder farmers in taking up adaptation practices, a ranking was carried out using the ‘Problem Confrontation Index (PCI)’. Ndamani and Watanabe’s [79] (p. 4596) study utilized the PCI to ascertain and rank the constraints to adaptation. In their study, the PCI was stated as:

\[
PCI = Pn \times 0 + Pl \times 1 + Pm \times 2 + Ph \times 3
\]

where PCI = Problem Confrontation Index; Pn = number of respondents who graded the constraint as no problem; Pl = number of respondents who graded the constraint as low; Pm = number of respondents who graded the constraint as moderate; Ph = number of respondents who graded the constraint as high.

In this study, respondents were asked to identify and rate their perceived constraints on a 3-point Likert scale of ‘Not Severe’ = 1; ‘Severe’ = 2; ‘Very Severe’ = 3; while ‘No Constraint’ was given a score of 0. Following the above model, the PCI value was calculated as below:

\[
PCI = Pnp \times 0 + Pns \times 1 + Ps \times 2 + Pvs \times 3
\]

where PCI = Problem Confrontation Index; Pnp = number of respondents who graded the constraint as no problem; Pns = number of respondents who graded the constraint as not severe; Ps = number

### Table 1. Selected wards and villages for data collection.

| Local Municipality | Units | Selected Wards | Selected Villages |
|--------------------|-------|----------------|------------------|
| Elliotdale         | 16    | Mbanyana; Ntloanyane Kulombombo; | |
|                    |       | Ntlonanyane Kulophungla; Ezithenjini; | |
| Mbahashe           | 11    | Nqadu Phezulu; Nqadu Kumaya; | |
| Willowvale         | 25    | Ematolweni; Ntlabane; | |
|                    | 30    | Nxaxashe; Kxesika Gosani; | |
| Idutywa            | 2     | Ngxakaxa Sheshegu; Ngxakaxa Phesheya kwe dip; | |
|                    | 31    | Gwadana Ngaphantsi; Gwadana Phezulu; | |

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of respondents who graded the constraint as severe; \( P_{vs} \) = number of respondents who graded the constraint as very severe.

4. Results

4.1. Demographic Profile

Results obtained indicated that there was a higher percentage (58.80%) of males involved in farming in the area and about 69.77% of the respondents were over the age of 50. About 47.8% were married and majority (61.12%) did not study beyond the secondary school level. 91.03% indicated their farming experience was 30 years or less.

4.2. Smallholder Farmers’ Sources of Information about Climate Change, the National Climate Change Response Policy, and Coping and Adaptation Responses

Table 2 shows sources of information about climate change, the national climate change response policy, and coping and adaptation responses for the smallholder farmers in the study area. Results show that television ranked as the top source of information, followed by radio, informal meetings and local newspapers (Table 2).

Table 2. Smallholder farmers’ sources of climate change information.

| Sources of Information            | Never (%) | Seldom (%) | Often (%) | Mean Scores | SD  | Rank |
|----------------------------------|-----------|------------|-----------|-------------|-----|------|
| Television                       | 30        | 28         | 42        | 1.12        | 0.84 | 1st  |
| Radio                            | 32        | 32         | 36        | 1.05        | 0.83 | 2nd  |
| Informal Meetings                | 75        | 18         | 7         | 0.33        | 0.61 | 3rd  |
| Local Newspapers                | 86        | 9          | 5         | 0.19        | 0.50 | 4th  |
| Public Extension Services        | 85        | 12         | 3         | 0.17        | 0.44 | 5th  |
| Cooperative Societies            | 90        | 8          | 2         | 0.12        | 0.37 | 6th  |
| National Newspapers              | 92        | 7          | 1         | 0.09        | 0.33 | 7th  |
| Farmers’ Associations            | 92        | 7          | 1         | 0.09        | 0.32 | 8th  |
| Billboards                       | 100       | 0          | 0         | 0.01        | 0.13 | 9th  |
| Cellphones                       | 93        | 5          | 2         | 0.08        | 0.33 | 10th |
| Internet                         | 95        | 3          | 2         | 0.07        | 0.32 | 11th |
| Private Extension Services       | 99        | 1          | 0         | 0.01        | 0.10 | 12th |
| Bulletins                        | 99        | 1          | 0         | 0.01        | 0.11 | 13th |
| NGO                              | 100       | 0          | 0         | 0.00        | 0.00 | 14th |
| Universities                     | 100       | 0          | 0         | 0.00        | 0.00 | 14th |
| Agricultural Research Institutes | 100       | 0          | 0         | 0.00        | 0.00 | 14th |

4.3. Constraints to Smallholder Farmers’ Implementation of Coping and Adaptation Strategies

The problem confrontation index (Table 3) indicates that lack of access to agricultural extension services (PCI = 705) was ranked the most critical problem, followed by insufficient information (PCI = 690) and the dearth of knowledge about appropriate technologies (PCI = 680), among others.
Table 3. Perceived constraints of smallholder farmers to coping and adaptation.

| Perceived Constraints                                      | No (%) | Yes (%) | % | PCI | Rank |
|-----------------------------------------------------------|--------|---------|---|-----|------|
|                                                                 | Not Severe (a) | Severe (b) | Very Severe (c) | D = (b + c) |     |
| Lack of access to agricultural extension services          | 14     | 29      | 98 | 160 | 258  | 705  | 1th |
| Poor information about climate change                       | 14     | 27      | 117| 143 | 260  | 690  | 2th |
| Inadequate knowledge about appropriate climate change coping and adaptation responses | 16     | 32      | 111| 142 | 253  | 680  | 3th |
| Lack of access to modern climate change adaptation technologies | 14     | 27      | 117| 143 | 260  | 690  | 2th |
| Lack of assistance from other support groups                | 18     | 50      | 109| 124 | 233  | 640  | 5th |
| Low level of education                                      | 64     | 56      | 72 | 109 | 181  | 527  | 66th |
| Restricted access to markets for sale of produce            | 92     | 20      | 94 | 95  | 189  | 493  | 7th |
| Lack of credit facilities or savings                        | 105    | 38      | 90 | 68  | 158  | 422  | 8th |
| Age factor                                                 | 148    | 39      | 50 | 64  | 114  | 331  | 9th |
| Poor health status                                          | 159    | 49      | 57 | 36  | 93   | 271  | 10th |
| Limited access to input markets                             | 214    | 42      | 29 | 16  | 45   | 148  | 11th |
| Lack of secure land or property rights                      | 220    | 39      | 30 | 12  | 42   | 135  | 12th |
| Lack of access to land                                      | 221    | 47      | 29 | 4   | 33   | 117  | 13th |
| Gender issues                                               | 244    | 32      | 20 | 5   | 25   | 87   | 14th |
5. Discussion

Public information about climate change has primarily been geared towards explaining the concept, ultimately leading to acceptance or skepticism [80]. Adaptation to climate change, however, is mostly dependent on the availability of and accessibility to relevant and practical climate change information [81,82].

The analysis of climate change information sources indicated that television, radio, informal meetings, local newspapers and public extension services ranked top in order of importance among the 16 sources of information identified in the study area. The implication is that mass media—in this case, television, radio and newspapers—play a more significant role in climate change information dissemination than public extension services in the study area.

Media is a major driving force that brings about change in diverse societies and the world in general by creating awareness on specific matters, thereby shaping public interests, opinions and ultimately government legislation [83–85]. It is the most influential and expeditious means of information conveyance [86] and extremely significant in shaping people’s perceptions of climate change [87]. The content of information disseminated is seen as critical in influencing public outlook on who is responsible for climate change mitigation and adaptation [43,88]. Akpan, Anorue and Ukonu [42] (p. 691) reasoned that “public action towards climate change will not begin until the public understands climate change and their place in the fight against it, especially in the area of forcing the authorities to make and execute meaningful policy about it”. The media must, therefore, continually adopt a pro-active approach in raising environmental concerns for the masses and for government [84].

A study in Ghana by Ndamani and Watanabe [79] revealed that television and radio broadcasts were the major sources of weather information for smallholder farmers. A study by Pandve et al. [82] in an urban community in India rated television as the primary climate change information source. Maibach, Witte and Wilson’s [89] review of the literature shows that in the United States of America, television meteorologists are considered by American adults as their most important source of climate change education. They also viewed the weather segment to be the most significant part of the television news report, and considered television weather forecasters their most reliable climate change information sources. This could be because television remains the dominant means of obtaining science and environmental information for most people [88,90]. According to Bloodhart et al. [91], the provision of climate change information by local television weather forecasters is one major way in which the masses may come to the realization that their local climate is changing. The authors further viewed local weather television forecasts as an effortlessly accessible means of science and climate change information which is devoid of any political slant; it is therefore highly trusted. In 2016, an evaluation was conducted of a pilot programme run in the United States of America, which proved that television weather forecasters were effective climate educators [92]; as a result, the programme ‘Climate Matters’ was launched, which provided locally relevant information on climate change. Further analysis indicated that the program’s market share for news had grown significantly and, within a year of commencement, its viewers had an advanced science-based understanding of climate change. Consequently, it may be said that many viewers effectively learn about climate change from television weather forecasts.

The various media—televison, radio, newspapers, billboards, internet and bulletins—differ vastly in their levels of effectiveness [93]. Radio, which ranked second as a source of climate change information for smallholder farmers in this study, was reviewed by Olajide [38] and found to be far cheaper than other information sources; its numerous distinct advantages have, according to this author, made it a highly utilized and preferred information source amongst smallholder farmers. Newspapers (local and national) are also revealed as significant sources of climate change information in the study area; according to Davidsen and Graham [84] (p. 152), newspaper “represents both a mirror and a central influence on the formulation of mainstream opinions, including societal priorities, overall visibility and awareness of emerging topics.” Newspaper reporting has been consistently identified by several studies as a crucial source of in-depth climate change information for the
masses [94]. In addition, newspapers provide intense imagery and language interaction, which is able to attract readers’ attention and enable effective text contextualization.

Billboards, although ranked ninth as a climate change information source in this study, have also been recognized for their numerous advantages. Some of these include their high viewership or exposure rate and reach, their 24-h presence, the low cost of production, high visual impact, message creativity or conspicuousness as a result of size, colour and location, and their efficiency in creating awareness or sensitization on whatever they promote [95–98]. The internet was not a popular source of information among respondents in this study, probably due to the educational and income levels of the farmers. However, internet is becoming an increasingly prevalent tool for the general public for the sourcing of information due to rapid information and communication technology (ICT) development [99]. There is also a line of thought which points out that the internet provides a more level playing field with regards to ideas than the conventional media do. It provides wider opportunities for groups to effectively relay their messages across population groups [100,101] and it provides significant opportunities for otherwise information-deprived people [101]. The International Bank for Reconstruction and Development and the World Bank in 2011 reported that telecommunications technology had outpaced the internet in terms of reach. Mobile phones and their applications have been used successfully in some African countries to obtain weather-related information and general agricultural advisory services [102,103]. Mobile phones are recognized as a critical media for information circulation, enhancing farmers’ access to public information [104]. In China, for instance, the government invested about US$1.13 billion to establish mobile infrastructure in rural communities that enable farmers to access weather forecasts and keep track of weather conditions nationally [105]. This underscores the critical role of mobile phone technology as an important information-gathering tool for rural farmers.

The use of mass media as a major climate change information source is, however, not without challenges. According to Völker and Scholl [106], scientific reports are the best possible representation or description of reality; if the media’s description of reality deviates too far from scientific description, it may be considered deficient, since any false, inaccurate or biased information will negatively influence people’s decisions, with possibly far-reaching consequences. According to Debrett [107] (p. 149) “reporting on the topic of climate change and the findings of climate scientists raises specific difficulties for journalists, because of the disjuncture between scientific precision, and its language of ‘probability and percentages, significant difference and estimation of error’ and the media’s hunger for an easily communicable truth”. Young and Dugas’s [108] review of the literature highlighted the difficulties of environmental news journalism; a limited number of journalists have formal education in natural sciences and even those who are so educated face the constant challenge of having to wade through masses of complex information that encompasses many disciplines and contexts. Broadcast meteorologists face the challenge of inadequate time to prepare, insufficient high-quality content on which to base reports, and difficulty with accessing climate scientists for advisory services and interviews [92]. As expressed by Debrett [107], delivering climate change information is a problem for the media, as climate change information has a tendency to confound and demoralize readers, whom newspapers prefer not to alienate, but to retain. Furthermore, the scientific research cycle takes years and requires constant review and validation; this usually constrains the media as it has a cycle of, at most, 24 h; as a result, it shows a lack of aggression and willpower in reporting on environmental matters [83].

In this study, the public extension service was ranked fifth as a source of climate change information by smallholder farmers. From the figures, it is clear that public extension plays an exceedingly limited role in educating rural farmers about climate change issues and assisting with appropriate coping and adaptation responses. There are severe implications of this. Although the mass media were found to be the basic sources of climate change information for the majority of the study population, the relevance of direct extension services cannot be disregarded. According to Ali, Jan and Anwar [109], initiating and changing intensely held attitudes is best achieved through interpersonal channels, which involve
face-to-face interactions of two or more individuals; education via extension services is an extremely significant driver of behaviour change, one which has been largely overlooked. The strength of the public extension system is its wide reach and broad networking potential [110,111]. It is an engine for promoting agricultural development [112]. This aspect, however, has not been demonstrated with regard to climate change information. Ajieh [113] concurs that poor performance by the public extension system has been the primary reason for the call for private extension services to play a greater role in extension service delivery. Pakistan and India have actively drawn the private sector into extension services to rural farming communities for sharing, augmenting and supplementing the public extension system [114,115]. Results from this study indicate that the private sector in South Africa has yet to actively support the public extension system in providing climate change education and engaging with rural populations to teach coping and adaptation strategies. Non-governmental organizations (NGOs), universities and agricultural research institutes all ranked last in delivering climate change information services to the study area. This is somewhat discouraging, as there is a great need to synergize the efforts of multiple parties and create an active support system for climate change literacy that works. There is currently a lack of connection between the university and the communities from which it obtains a significant proportion of its research information as universities have become a “cyclic burden” to the communities, often sourcing information amongst communities but never giving back [116]. There is, thus, a drastic need to encourage strong collaboration between the public and private sectors to aid agricultural development in poor farming communities, especially in addressing climate change issues.

Cooperative societies and farmers’ associations ranked sixth and eighth, respectively, with regard to the provision of climate change information to the study population; the establishment of such organizations has proven critical, particularly with regard to expanding producer opportunities for economic development [117]. Cooperative societies and farmers’ associations are dynamic, autonomous and democratic forms of social enterprise [118], focused on social and economic goals [119]. One of their primary functions is educating and providing consultancy services to members [120–122]. There is, therefore, a need to motivate for the increased establishment of cooperative societies and farmers’ associations within rural communities, particularly for the provision of climate change related services to aid farmers in coping and adapting to climate change risks within the study area.

A critical aspect of future research direction for the study area is assessing the use of digital applications built into contemporary ICT’s like the mobile/smart phones and computers. The internet is a modern-day technology that provides a platform for information access and interaction [123] and is packed with several applications like social media [124]. Barau and Afrad [125] (p. 50) defined social media as “a contemporary channel of digital communication that is composed of various evolving tools for discussion, interaction and sharing of information among people.” It allows for information sharing, participatory and collaborative interactions among groups of users [126]. Social media has provided varieties of innovative interaction systems [127,128] and meets the need for instant access to information [129]. These media applications have been found by many studies [124,130–132] as critical contemporary information tools. Attaining a significant presence [133], its impact is indeed impressive; from changing the manner of information access and sharing [134], to improving interaction abilities, engagement and influence [135,136]. It has become widespread and is increasingly used as a connectivity, networking, interactive and learning tool [137–139]. Its use is rapidly expanding [140], becoming conventional [141] and a part of people’s day-to-day lives [142,143]. It will remain with us [144].

According to Barau and Afrad [125], the use of social media amongst agricultural stakeholders is on the rise. For instance, Jayashree’s [139] review of literature pointed out the use of Twitter by agronomists to disseminate appropriate agricultural information and disclose available opportunities to the scientific community. Literatures [145–148] have explored the potential use of social media in promoting agricultural businesses, researches and the industry in general. The number of agriculturists making use of social media for agricultural purposes is increasing [145]; such that the agricultural community now have a large group of active social media users [149]. According to Stanley [150],
some of its core benefits for the community includes the reduction of social isolation; allows for
interaction with agricultural experts; pooling of agricultural information from vast sources;
and, networking with other local and international agricultural stakeholders and agribusinesses.
Thus, taking a critical look into how developing the use of social media applications for smallholder
farmers in the study area could significantly broaden their channels of obtaining climate change
adaptation information.

Results, as presented in Table 2, reveal that the most critical constraint to climate change coping
and adaptation in the study area was lack of access to agricultural extension services. Institutions are
important mechanisms for climate change information dissemination, education and capacity building;
they are crucial determinants of adaptive capacity and buoyancy [27]. In essence, extension services
are fundamental to aiding smallholder farmers cope and adapt to climate change. The smallholder
farmers interviewed for this study viewed insufficient information about climate change and a dearth
of knowledge about appropriate coping and adaptation responses as serious lacks. This problem was also
identified in Nigeria [151], Ghana [152] and Pakistan [153] where analyses of constraints to smallholder
farmers’ coping and adaptation responses showed that the majority lacked information about climate
change and suffered a knowledge gap in appropriate coping and adaptation responses. For instance,
Gandure, Walker and Botha [154] pointed out that lack of access to climate change early warning
systems and deficiencies in seasonal forecasts restricted effective coping and adaptation. As pointed
out by Girvetz et al. [155], a significant barrier precluding informed climate change adaptation planning
and execution is the strain associated with accessing, evaluating and understanding climate change
information. Playing into this difficulty with access might well be the lack of tools to translate and
simplify climate change science and models so that farmers can easily comprehend and work with the
data [155,156]. There is a need to address the specific factors that inhibit the flow of climate change
information to smallholder farmers, so that they may become acquainted with the science and the
strategies of climate change and climate change responses.

Lack of access to modern climate change adaptation technologies and lack of assistance from
support groups other than government also critically affected smallholder farmers’ ability to effectively
respond to climate change in the study area. As opined by Tessa and Kurukulasuriya [157] (p. 17),
“the transfer of technology—which in the broadest sense includes not only materials and equipment,
but also the technical and commercial information and human skills needed to properly understand
and use it—is presented as one of the main pillars to increase the resilience of vulnerable communities
and their ecosystems to climate risks.” Communities that are resource-dependent are ill-equipped
to cope with or adapt to climate change. Consequently, there is a need to ensure that smallholder
farmers in rural communities have unimpeded access to contemporary technologies to ameliorate
their vulnerability to climate change risks. Developing and disseminating technological solutions to
lessen climate change threats are likely to have two outcomes: increased agricultural productivity
and accurate discernments about future climate change responses [158]. Support groups (institutional
actors and stakeholders/partners) are all required for the productive development and execution of
sustainable adaptation responses. According to Nkomwa et al. [4] (p. 7), there is need for several
stakeholders—“international, multilateral and bilateral organizations, different tiers of government,
grassroots groups and local communities, private enterprises and institutions, non-governmental and
civil society organizations, networks and individuals” to collaborate for the effective implementation
of climate change responses. These relationships are, however, currently weak in South Africa [159].
Focus must be placed on motivating for increased partnerships between support groups to aid
enhancement of climate change adaptation in rural farming communities.

Other perceived barriers to appropriate climate change responses include low levels of education,
restricted access to markets for the sale of produce, lack of credit facilities or savings, the age factor,
poor health status, limited access to input markets, lack of secure land or property rights, lack of access
to land, and gender issues. All these are mentioned in the literature as elements that determine and
constrain farmers’ coping and adaptation responses to climate conditions [10,18,53,160–162]. There is
need to address a number of these challenges, particularly those considered critical by the smallholder farmers in this study, so as to fortify their coping and adaptation capacities. One obvious fact is that if an individual’s capacity to respond to climate change is strengthened, that individual becomes better equipped to adapt to current climatic shocks and stresses [163,164].

Research on climate change impacts on agricultural production activities in the study area revealed that smallholder farmers were faced with numerous production challenges caused by extreme weather events, particularly long periods of dry spells [165–167]. Amongst the identified impacts are water paucity, increased irregularities in planting seasons, pest and diseases, and decreased soil fertility affecting the quality and yields of crops [165]. Others include reduction in the weight, development, milk production and reproduction of livestock, coupled with reduction in vegetation and available land area for grazing [166]; and, marked decrease in the size, quantity and quality of poultry eggs [167]. Further assessment of the adaptation responses of smallholder farmers in the area showed that there was an extremely low implementation of adaptation measures and a majority of the farmers perceived existing coping and adaptation measures as significantly ineffective [165–167]. As such, present agricultural production in the area is highly constrained. There is, therefore, an urgent need to provide information on contemporary climate change adaptation measures to smallholder farmers in the area. Juana et al. [10] reviewed diverse studies published between years 2006 and 2011 to capture and compile coping and adaptation measures adopted by Sub-Saharan African farmers. The use of indigenous seeds capable of tolerating extreme weather conditions like drought and flood, diversifying production system, and changing timing of planting are some of the adopted climate friendly practices. Others include water, soil and nutrient conservation practices, intensification of irrigation practices, planting of diverse varieties of the same type of crops, planting of tree crops, planting of short-duration crops, livestock diversification and engaging veterinary officers as support systems.

Some of the climate change adaptation information needs of smallholder farmers in the study area, as identified in the above studies, include improved breeding practices, improved cultivars usage, mitigating pest and disease incidences, appropriate livestock treatment, and, summarily, the practice of improved farm management systems; such that can allow farmers to effectively adapt to the existing climate conditions. There is also a need for the national government to promote intervention/development schemes such as veld rehabilitation, provide trainings on climate smart technologies and offer infrastructural and resource support.

One of such support schemes is the National Climate Change Response Policy (NCCRP) initiative set up by the South African government [168]; some of its mapped-out strategies in building the climate change resilient capacity of the country’s agricultural sector include:

i. Enhancing climate change resistance of agricultural production using improved nutrient, soil and water conservation technologies.

ii. Financing the promotion of climate-smart agricultural models.

iii. Utilizing early warning systems in providing information on weather conditions and related extreme weather events, and possible pests and disease occurrences.

iv. Providing up-to-date climate change information and decision support tools.

v. Investing in the education, awareness creation and sensitization of climate change in rural communities and addressing the climate change information needs of the most vulnerable population.

vi. Providing linkages to agricultural extension services to assist farmers in understanding and adapting to climate change conditions.

The successful implementation of such a support scheme in the study area could, for instance, effectively address major climate change challenges of smallholder farmers in the region.
6. Conclusions and Recommendation

There are rising concerns that increased climate inconsistencies will severely impede agricultural production with profound impacts on crop yields and livestock breeding, consequently affecting domestic economies. The smallholder farming sector is especially faced with the challenges of having to cope with and/or adapt to changing climate conditions as they are at a more disadvantaged position due to multiple factors one of which is their lack of access to agricultural information. Current climate crisis affecting the agricultural sector requires that stakeholders, particularly the smallholder farmers, be provided with up-to-date information on climate change as this potentially raises their awareness and adaptation capacity levels. Access to climate change information may thus, improve the perception level of smallholder farmers to climate change. It could increase their level of consciousness to global, national, and/or local weather events and impacts on agricultural productivity. In addition, a dearth of information on appropriate coping and adaptation responses may bring about constraints to coping and adaptation. Accessibility to climate change information is dependent on a number of factors amongst which are the channels or sources of dissemination.

Information dissemination sources are viewed as pertinent as they have been found to effectively connect people to surrounding events, which they may otherwise not be privy to. As such, people are becoming increasingly dependent on information sources. In this study, we consider those information sources as critical to assist smallholder farmers in obtaining climate change information and in meeting their adaptation needs. These sources may influence the extent to which smallholder farmers are exposed to or are aware of contemporary adaptation responses. This study’s analysis of climate change information sources revealed that media sources like the television, radio and local newspapers were identified as leading information sources in the area. They were found to be more effective in climate change information dissemination than the public and private extension services. The most critical constraint to coping and adaptation in the study area was identified as lack of access to agricultural extension services. Insufficient information about climate change and poor knowledge about appropriate coping and adaptation responses were also critical, as was the lack of access to modern climate change adaptation technologies and assistance from private support groups.

This study recommends that efforts to create awareness, knowledge and skills in relation to climate change be intensified through an enhanced use of leading media in the study area.

The enhanced use of radio and television for climate change information dissemination could, for instance, complement extension service delivery in the area. The government could use the radio, television and local newspaper sources to carry out increased climate change awareness. Television and radio live programs on climate change mitigation, coping and adaptation could be developed to educate the farming community in the study area. Smallholder farmers could also be encouraged to call in during such live programs to ask questions and contribute to ongoing discussions. Program anchors could, for instance:

i. Liaise with climate change experts to obtain current climate change information.
ii. Collate relevant up-to-date agricultural information and prepare for dissemination on air.
iii. Invite agricultural experts, including extension professionals, and interview them to address specific agricultural issues within the farming communities.
iv. Provide key contemporary agricultural information and advisory services on appropriate use of technologies and farm management techniques/practices.
v. Provide information on technological innovations and agricultural extension support systems available in communities.
vi. Organize open air agricultural plays/dramas to disseminate critical information.

Remedial actions are required for public extension services in the study area to relieve smallholder farmer’s vulnerability to climate change. Extension roles in the area should be pronounced to enhance their relevancy especially in providing efficient sensitization, training, education and other climate change support programs. There is also a need to facilitate participations of cooperative societies,
farmers’ associations, private extension services, NGO’s, universities and agricultural research institutes in promoting climate change education and adaptation in the study area. These institutions could jointly address the climate change information and adaptation needs of the smallholder farmers in the area. Collaborative efforts in developing and implementing intervention schemes could enable climate change adaptation and boost agricultural productivity in the area. Efforts should be made to initiate the use of specific social media applications among smallholder farmers in the study area. For instance, sensitization and training programs could be implemented on the extensive use of mobile/smart phones in accessing agricultural information via social media applications that are user friendly and actively utilized by the agricultural community. Numerous studies have provided evidences of mobile/smartphone adoption by smallholder farmers in many African countries with significant impacts on their production activities.

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