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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 inconsistences 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 Rodríguez [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.

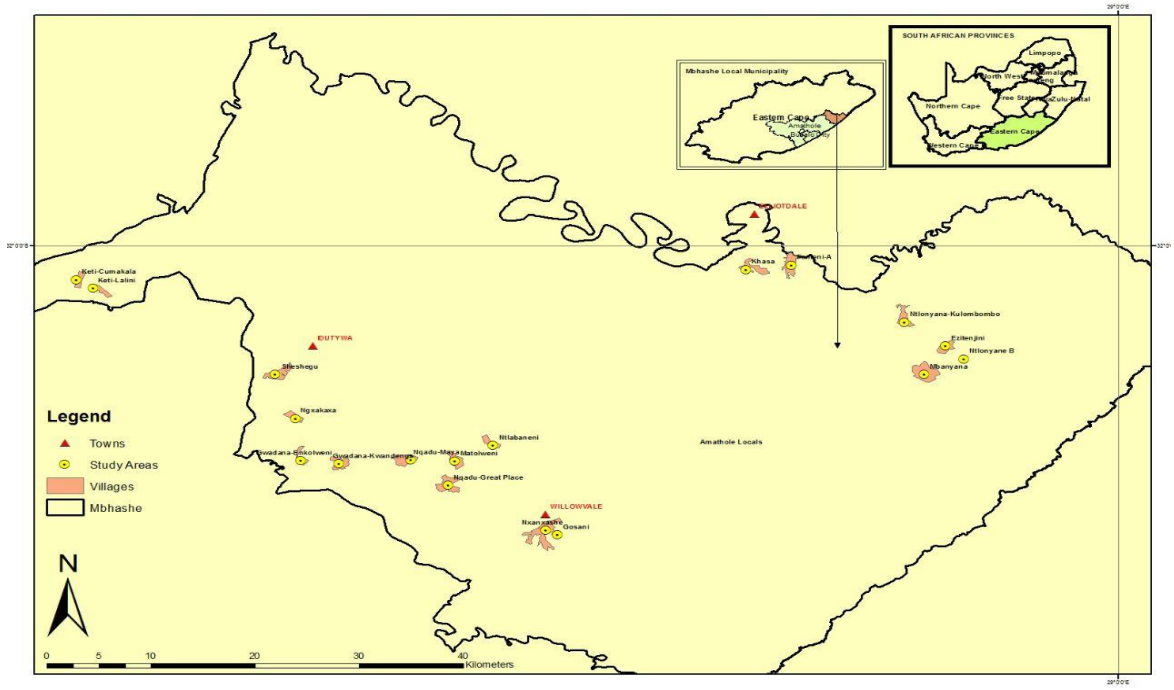

Figure 1. Map of the Mbhashe Local Municipality showing the study areas and selected villages. Designed by the Geography Department, University of Fort Hare, South Africa.

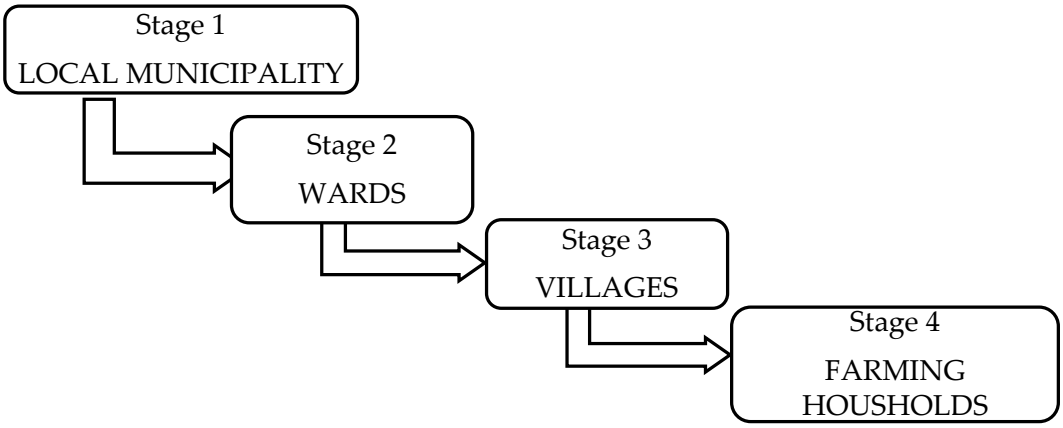

Figure 2. Four selection stages for data collection.

Table 1. Selected wards and villages for data collection.

Local Municipality	Units	Selected Wards	Selected Villages
Mbahashe	Elliotdale	13	Khasa; Fameli;
		16	Mbanyana; Ntlanyane Kulombombo;
		26	Ntlonyane Kulophungla; Ezithenjini;
	Willowvale	11	Nqadu Phezulu; Nqadu Kumaya;
		25	Ematolweni; Ntlabane;
		30	Nxanxashe; Kwesika Gosani;
	Idutywa	2	Ngxakaxa Sheshegu; Ngxakaxa Phesheya kwe dip;
		3	Gwadana Ngaphantsi; Gwadana Phezulu;
		31	Keti Cimakala; Keti Lalini;

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

of respondents who graded the constraint as severe; Pvs = 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 (%)	Yes		Mean Scores	SD	Rank
		Seldom (%)	Often (%)			
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	25	33	93	150	243	669	4th
Lack of assistance from other support groups	18	50	109	124	233	640	5th
Low level of education	64	56	72	109	181	527	6th
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—television, 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 direct interactions 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' abilities 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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References

1. Benhin, J.K. South African crop farming and climate change: An economic assessment of impacts. *Glob. Environ. Chang.* **2008**, *18*, 666–678. [CrossRef]
2. Ahmed, M.; Asif, M.; Sajad, M.; Khattak, J.Z.K.; Ijaz, W.; Wasaya, A.; Chun, J.A. Could agricultural system be adapted to climate change? A review. *Aust. J. Crop Sci.* **2013**, *7*, 1642–1653.
3. Maponya, P.; Mpandeli, S. Climate change adaptation strategies used by Limpopo Province farmers in South Africa. *J. Agric. Sci.* **2012**, *4*, 39–47. [CrossRef]
4. Nkomwa, E.C.; Joshua, M.K.; Ngongondo, C.; Monjerezi, M.; Chipungu, F. Assessing indigenous knowledge systems and climate change adaptation strategies in agriculture: A case study of Chagaka village, Chikhwawa, Southern Malawi. *Phys. Chem. Earth* **2014**, *67*, 164–172. [CrossRef]
5. Shongwe, P.; Masuku, M.B.; Manyatsi, A.M. Cost benefit analysis of climate change adaptation strategies on crop production systems: A case of Mpolonjeni Area Development Programme (ADP) in Swaziland. *Sustain. Agric. Res.* **2014**, *30*, 37–49. [CrossRef]
6. Li, S.; An, P.; Pan, Z.; Wang, F.; Li, X.; Liu, Y. Farmers' initiative on adaptation to climate change in the northern agro-pastoral ecotone. *Int. J. Disaster Risk Reduct.* **2015**, *12*, 278–284. [CrossRef]
7. Mitchell, T.; Tanner, T. Adapting to Climate Change: Challenges and Opportunities for the Development Community. Available online: https://www.ids.ac.uk/publications/adapting-to-climate-change-challenges-and-opportunities-for-the-development-community/ (accessed on 15 July 2015).
8. Trevors, J.T. Climate change: Agriculture and hunger. *Int. J. Environ. Pollut. Water Air Soil Pollut.* **2010**, *205*, 105. [CrossRef]
9. DAFF. Policy Brief: Opportunities and Challenges for Climate-Smart Agriculture in Africa. Available online: https://ccafs.cgiar.org/sites/default/files/assets/docs/au_policybrief_opportunitieschallenges.pdf (accessed on 15 June 2016).
10. Juana, J.S.; Kahaka, Z.; Okurut, F.N. Farmers' perceptions and adaptations to climate change in sub-Sahara Africa: A synthesis of empirical studies and implications for public policy in African agriculture. *J. Agric. Sci.* **2013**, *5*, 121–135. [CrossRef]
11. Bathke, D.J.; Oglesby, R.; Rowe, C.; Wilhite, D.A. Understanding and Assessing Climate Change: Implications for Nebraska. Available online: http://snr.unl.edu/download/research/projects/climateimpacts/2014ClimateChange.pdf (accessed on 14 July 2015).

12. Madzwamuse, M. Climate Change Vulnerability and Adaptation Preparedness in South Africa. Available online: https://za.boell.org/sites/default/files/downloads/HBF_web_SA_28_2.pdf (accessed on 14 June 2016).
13. DEDEA. Eastern Cape Climate Change Response Strategy. Available online: http://www.dedea.gov.za/Policies/Draft%20EC%20Climate%20Change%20Response%20Strategy.pdf (accessed on 18 August 2016).
14. Calvosa, C.; Chuluunbaatar, D.; Fara, K. Livestock and Climate Change: Livestock Thematic Papers Tools for Project Design. Available online: https://www.uncclearn.org/sites/default/files/inventory/ifad81.pdf (accessed on 9 April 2016).
15. Turpie, J.; Visser, M. The Impact of Climate Change on South Africa's Rural Areas. 2013. Available online: www.ffc.co.za/.../300-chapter-4-impact-of-climate-change-on-southafricas-rural-area (accessed on 14 June 2016).
16. Hatfield, J.L.; Boote, K.J.; Kimball, B.A.; Ziska, L.H.; Izaurralde, R.C.; Ort, D.; Thomson, A.M.; Wolfe, D. Climate impacts on agriculture: Implications for crop production. *Agron. J.* **2011**, *103*, 351–370. [CrossRef]
17. Eitzinger, J.; Orlandini, S.; Stefanski, R.; Naylor, R.E.L. Climate change and agriculture: Introductory editorial. *J. Agric. Sci.* **2010**, *148*, 499–500. [CrossRef]
18. Terdoo, F.; Adekola, O. Perceptions, knowledge, adaptation and socio-economic cost of climate change in Northern Nigeria. *J. Agric. Sci.* **2014**, *6*, 60–71. [CrossRef]
19. Newton, A.C.; Johnson, S.N.; Gregory, P.J. Implications of climate change for diseases, crop yields and food security. *Euphytica* **2011**, *179*, 3–18. [CrossRef]
20. Mpandeli, S.; Nesamvuni, E.; Maponya, P. Adapting to the impacts of drought by smallholder farmers in Sekhukhune District in Limpopo Province, South Africa. *J. Agric. Sci.* **2015**, *7*, 115–124. [CrossRef]
21. Megersa, B.; Markemann, A.; Angassa, A.; Ogutu, J.O.; Piepho, H.P.; Zárate, A.V. Livestock diversification: An adaptive strategy to climate and rangeland ecosystem changes in Southern Ethiopia. *Hum. Ecol.* **2014**, *42*, 509–520. [CrossRef]
22. Kassie, B.T.; Hengsdijk, H.; Rötter, R.; Kahiluoto, H.; Asseng, S.; Van Ittersum, M. Adapting to climate variability and change: Experiences from cereal-based farming in the Central Rift and Kobo Valleys, Ethiopia. *Environ. Manag.* **2013**, *52*, 1115–1131. [CrossRef] [PubMed]
23. Alade, O.A.; Ademola, A.O. Perceived effect of climate variation on poultry production in Oke Ogun Area of Oyo State. *J. Agric. Sci.* **2013**, *5*, 176–182. [CrossRef]
24. Speranza, C.I. Drought coping and adaptation strategies: Understanding adaptations to climate change in agro-pastoral livestock production in Makueni District, Kenya. *Eur. J. Dev. Res.* **2010**, *22*, 623–642. [CrossRef]
25. Stringer, L.C.; Twyman, C.; Gibbs, L.M. Learning from the South: Common challenges and solutions for small-scale farming. *Geogr. J.* **2008**, *174*, 235–250. [CrossRef]
26. McDowell, J.Z.; Hess, J.J. Accessing adaptation: Multiple stressors on livelihoods in the bolivian highlands under a changing climate. *Glob. Environ. Chang.* **2012**, *22*, 342–352. [CrossRef]
27. Engle, N.L.; Lemos, M.C. Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil. *Glob. Environ. Chang.* **2010**, *20*, 4–13. [CrossRef]
28. Nkeme, K.K.; Ndaeyo, N.U. Impact of climate change on agricultural productivity. In *Globalization and Rural Development in Nigeria*; Nwachukwu, I., Ekwe, K.C., Eds.; Extension Centre, Michael Okpara University of Agriculture Umudike: Umudike, Nigeria, 2011; pp. 156–165.
29. Moser, S.C.; Ekstrom, J.A. A framework to diagnose barriers to climate change adaptation. *Proc. Natl. Acad. Sci. USA* **2010**, *107*, 22026–22031. [CrossRef] [PubMed]
30. Mwingira, C.E.; Pallangyo, M.E.; Felix, R.; Pima, N.; Meingataki, G.; Salum, S. Impacts of Climate Change on Biodiversity and Community Livelihoods in the Katari Ecosystem. Available online: http://fliphtml5.com/obij/cexa/basic (accessed on 18 September 2016).
31. Rehman, F.; Muhammad, S.; Ashraf, I.; Ch, K.M.; Ruby, T. Effect of farmers'socio economic characteristics on access to agricultural information: Empirical evidence from Pakistan. *J. Anim. Plant Sci.* **2013**, *23*, 324–329.
32. Yusuf, S.F.G.; Masika, P.; Ighodaro, D.I. Agricultural information needs of rural women farmers in Nkonkobe municipality: The extension challenge. *J. Agric. Sci.* **2013**, *5*, 107–114. [CrossRef]
33. Yaseen, M.; Xu, S.; Yu, W.; Hassan, S. Farmers' access to agricultural information sources: Evidences from rural Pakistan. *J. Agric. Chem. Environ.* **2016**, *5*, 12–19. [CrossRef]
34. Oladele, O.I. Multilinguality of farm broadcast and agricultural information access in Nigeria. *Nord. J. Afr. Stud.* **2006**, *15*, 199–205.

35. Ronald, B.; Dulle, F.; Honesta, N. Assessment of the Information Needs of Rice Farmers in Tanzania: A Cases Study of Kilombero District, Morogro. Available online: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2666&context=libphilprac (accessed on 14 July 2015).
36. Adejo, P.E.; Okwu, J.O.; Saliu, O.J. Assessment of postharvest information needs of maize farmers in Kogi state, Nigeria. *J. Agric. Food Inf.* **2016**, *17*, 260–273. [CrossRef]
37. Mtega, W.P.; Ngoepe, M.; Dube, L. Factors influencing access to agricultural knowledge: The case of smallholder rice farmers in the Kilombero district of Tanzania. *S. Afr. J. Inf. Manag.* **2016**, *18*, 1–8. [CrossRef]
38. Olajide, B.R. Assessment of farmers' access to agricultural information on selected food crops in Iddo district of Oyo state, Nigeria. *J. Agric. Food Inf.* **2011**, *12*, 354–363. [CrossRef]
39. Mittal, S.; Mehar, M. Socio-economic factors affecting adoption of modern information and communication technology by farmers in India: Analysis using multivariate probit model. *J. Agric. Educ. Ext.* **2016**, *22*, 199–212. [CrossRef]
40. Mosser, S.C. *Communicating Climate Change and Facilitating Social Change*; Dilling, L., Ed.; University of Colorado, Boulder: Boulder, CO, USA, 2007.
41. Cooper, C.B. Media literacy as a key strategy toward improving public acceptance of climate change science. *BioScience* **2011**, *61*, 231–237. [CrossRef]
42. Akpan, C.; Anorue, L.; Ukonu, M. An analysis of the influence of the Nigerian mass media on public understanding of climate change. *J. Altern. Perspect. Soc. Sci.* **2012**, *4*, 688–710.
43. Castilla, E.B.; Quesada, M.; Rodríguez, L.T. From Kyoto to Durban. Mass media editorial position about climate change. *Rev. Lat. Comun. Soc.* **2013**, *68*, 420–435.
44. Goldblatt, A. Agriculture: Facts and Trends, South Africa. Available online: http://awsassets.wwf.org.za/downloads/facts_brochure_mockup_04_b.pdf (accessed on 18 September 2015).
45. Greyling, J.C.; Vink, N.; Mabaya, E. South Africa's agricultural sector twenty years after democracy (1994 to 2013). *Prof. Agric. Work. J.* **2015**, *3*, 10–14.
46. Mashabela, T. Agriculture among Key Sectors That Contributed to Contraction of the Economy. 2019. Available online: https://www.bizcommunity.com/PDF/PDF.aspx?l=196&c=358&ct=1&ci=191620 (accessed on 18 January 2020).
47. Obi, A. Integration of crops and livestock in the smallholder farming system of the former homelands of South Africa. *J. Agric. Sci.* **2013**, *5*, 183–198. [CrossRef]
48. Lin, B.B. Resilience in agriculture through crop diversification: Adaptive management for environmental change. *BioScience* **2011**, *61*, 183–193. [CrossRef]
49. Maponya, P.; Mpandeli, S.; Oduniyi, S. Climate change awareness in Mpumalanga Province, South Africa. *J. Agric. Sci.* **2013**, *5*, 273–282. [CrossRef]
50. Bello, M.; Salau, E.S.; Galadima, O.E.; Ali, I. Knowledge, perception and adaptation strategies to climate change among farmers of Central State Nigeria. *Sustain. Agric. Res.* **2013**, *2*, 107–117. [CrossRef]
51. Nkeme, K.K.; Ndaeyo, N.U. Climate change and coping strategies among peasant farmers in AkwaIbom State, Nigeria. *Int. J. Basic Appl.* **2013**, *2*, 24–28.
52. Kitinya, K.T.; Onwonga, R.N.; Onyango, C.; Mbuvi, J.P.; Kironchi, G. Climate change and variability: Farmers' perception, experience and adaptation strategies in Makueni County, Kenya. *Asian J. Agric. Rural Dev.* **2012**, *2*, 411–421.
53. Balew, S.; Agwata, J.; Anyango, S. Determinants of adoption choices of climate change adaptation strategies in crop production by small scale farmers in some regions of central Ethiopia. *J. Nat. Sci.* **2014**, *4*, 78–93.
54. Browning, G.; Halcli, A.; Webster, F. *Understanding Contemporary Society: Theories of the Present*; Sage Publications: London, UK; Thousand Oaks, CA, USA; New Delhi, India, 1999.
55. Umunakwe, P.C.; Nnadi, F.N.; Chikaire, J.; Nnadi, C.D. Information needs for climate change adaptation among rural farmers in Owerri west local area of Imo State, Nigeria. *Agrotechnology* **2014**, *3*, 1–6.
56. Maponya, P.; Mpandeli, S. The role of extension services in climate change adaptation in Limpopo Province, South Africa. *J. Agric. Ext. Rural Dev.* **2013**, *5*, 137–142.
57. Zougmoré, R.; Partey, S.; Ouédraogo, M.; Omitoyin, B.; Thomas, T.; Ayantunde, A.; Ericksen, P.; Said, M.; Jalloh, A. Toward climate-smart agriculture in West Africa: A review of climate change impacts, adaptation strategies and policy developments for the livestock, fishery and crop production sectors. *Agric. Food Secur.* **2016**, *5*, 1–26. [CrossRef]

58. Oyekale, A.S.; Oladele, O.I. Determinants of climate change adaptation among cocoa farmers in southwest Nigeria. *ARPN J. Sci. Technol.* **2012**, *2*, 154–168.
59. Randjelovic, N.; Pirsl, D.; Pirsl, T. Issues on disability advertising imaging in media. *Sport Mont* **2012**, *10*, 536–541.
60. Maxian, W. Power to the people? Emotional components of media power, mobile ICTs, and their potential to alter individual-media dependency relations. *Mass Commun. Soc.* **2014**, *17*, 274–298. [CrossRef]
61. Lin, Y. *Media Dependency Theory*; Encyclopædia Britannica Inc.: Chicago, IL, USA, 2015. Available online: https://www.britannica.com/topic/media-dependency-theory (accessed on 16 January 2020).
62. Luo, M.M. Internet use in Cambodia: A media dependency theory perspective. *IJMAS* **2018**, *4*, 100–103.
63. Loveless, M. Media dependency: Mass media as sources of information in the democratizing countries of Central and Eastern Europe. *Democratisation* **2008**, *15*, 162–183. [CrossRef]
64. Clayton, S.; Devine-Wright, P.; Stern, P.C.; Whitmarsh, L.; Carrico, A.; Steg, L.; Swim, J.; Bonnes, M. Psychological research and global climate change. *Nat. Clim. Chang.* **2015**, *5*, 640–646. [CrossRef]
65. Spence, A.; Poortinga, W.; Butler, C.; Pidgeon, N.F. Perceptions of climate change and willingness to save energy related to flood experience. *Nat. Clim. Chang.* **2011**, *1*, 46–49. [CrossRef]
66. Rudman, L.A.; McLean, M.C.; Bunzl, M. When truth is personally inconvenient, attitudes change: The impact of extreme weather on implicit support for green politicians and explicit climate-change beliefs. *Psychol. Sci.* **2013**, *24*, 2290–2296. [CrossRef] [PubMed]
67. Riffe, D.; Lacy, S.; Varouhakis, M. Media system dependency theory and using the Internet for in-depth, specialized information. *Web J. Mass Commun. Res.* **2008**, *11*, 1–14.
68. Hamann, M.; Tuinder, V. Introducing the Eastern Cape: A Quick Guide to Its History, Diversity and Future Challenges. A Report for the Stockholm Resilience Center: Research for Governance of Social-Ecological Systems. 2012. Available online: http://www.sapecs.org/wpcontent/uploads/2013/11/Eastern-Cape-Background-Report.pdf (accessed on 24 August 2016).
69. ECPC. Eastern Cape Vision 2030 Provincial Development Plan: Flourishing People in a Thriving Province. Eastern Cape Planning Commission. 2014. Available online: http://www.ecdc.co.za/media/1643/ec-vision-2030-plan_271014-2.pdf (accessed on 4 September 2016).
70. ADM ADP. Amathole District Municipality Agricultural Development Plan Review, 2012–2017. Available online: http://www.amathole.gov.za/old/attachments/article/324/final%20idp%202012-2017.pdf (accessed on 1 February 2016).
71. ADM IDP. Amatole District Municipality Integrated Development Plan Review 2015–2016. Available online: http://www.amathole.gov.za/attachments/article/334/ADM%2020152016%20DRAFT%20IDP.pdf (accessed on 2 February 2016).
72. MLM IDP. Mbahashe Local Municipality Integrated Development Plan Review, 2016–2017. Available online: http://www.mbhashemun.gov.za/web/download/reviewed-2016-2017-intergrateddevelopment-plan-adopted-25052016_2.pdf (accessed on 31 August 2016).
73. MLM IDP. Mbhashe Local Municipality Integrated Development Plan Review, 2014–2015. Available online: http://www.mbhashemun.gov.za/web/wpcontent/uploads/2014/09/mbhashe_rievewed_idp_2014-15.pdf (accessed on 31 August 2016).
74. MLM IDP. Mbahashe Local Municipality Integrated Development Plan, 2012–2017. Available online: http://www.mbhashemun.gov.za/web/documents/idp/ (accessed on 31 August 2016).
75. MLM IDP. Mbahashe Local Municipality Integrated Development Plan Review, 2015–2016. Available online: http://www.mbhashemun.gov.za/web/documents/idp/ (accessed on 31 August 2016).
76. Mendelsohn, R.; Dinar, A. *Exploring Adaptation to Climate Change in Agriculture: The Potential of Cross-Sectional Analysis*; World Bank: Washington, DC, USA, 2005.
77. SSA. Census 2011 Agricultural Households/Statistics South Africa. Available online: http://www.statssa.gov.za/census/census_2011/census_products/Agricultural_Households.pdf (accessed on 29 October 2015).
78. Yamane, T. *Statistics, an Introductory Analysis*, 2nd ed.; Harper and Row: New York, NY, USA, 1967.
79. Ndamani, F.; Watanabe, T. Farmers' perceptions about adaptation practices to climate change and barriers to adaptation: A micro-level study in Ghana. *Water* **2015**, *7*, 4593–4604. [CrossRef]
80. Lineman, M.; Do, Y.; Kim, J.Y.; Joo, G.J. Talking about climate change and global warming. *PLoS ONE* **2015**, *10*, e0138996. [CrossRef]

81. Semenza, J.C.; Ploubidis, G.B.; George, L.A. Climate change and climate variability: Personal motivation for adaptation and mitigation. *Environ. Health* **2011**, *10*, 46–53. [CrossRef]
82. Pandve, H.T.; Chawla, P.S.; Fernandez, K.; Singru, S.A.; Khismatrao, D.; Pawar, S. Assessment of awareness regarding climate change in an urban community. *Indian J. Occup. Environ. Med.* **2011**, *15*, 109–112. [CrossRef]
83. Yadav, A.R. Media lacking aggression to report environment-related issues. *Int. J. Multidiscip. Approach Stud.* **2014**, *1*, 147–155.
84. Davidsen, C.; Graham, D. Newspaper reporting on climate change, green energy and carbon reduction strategies across Canada 1999–2009. *Am. Rev. Can. Stud.* **2014**, *44*, 151–168. [CrossRef]
85. Murphy, R. The media construction of climate change quiescence: Veiling the visibility of a super emitter. *Can. J. Sociol.* **2015**, *40*, 331–354. [CrossRef]
86. Prakash, G.; Anand, E. Indian news media and natural calamities: Case of Chennai floods. *Int. J. Multidiscip. Approach Stud.* **2016**, *3*, 166–177.
87. Brulle, R.J.; Carmichael, J.; Jenkins, J.C. Shifting public opinion on climate change: An empirical assessment of factors influencing concern over climate change in the US, 2002–2010. *Clim. Chang.* **2012**, *114*, 169–188. [CrossRef]
88. Liang, X.; Tsai, J.Y.; Mattis, K.; Konieczna, M.; Dunwoody, S. Exploring attribution of responsibility in a cross-national study of TV news coverage of the 2009 United Nations climate change conference in Copenhagen. *J. Broadcast. Electron. Media* **2014**, *58*, 253–271. [CrossRef]
89. Maibach, E.; Witte, J.; Wilson, K. "Climategate" undermined belief in global warming among many American TV meteorologists. *Bull. Am. Meteorol. Soc.* **2011**, *92*, 31–37. [CrossRef]
90. National Science Board. *Science and Engineering Indicators*; National Science Board: Arlington, VA, USA, 2012.
91. Bloodhart, B.; Maibach, E.; Myers, T.; Zhao, X. Local climate experts: The influence of local TV weather information on climate change perceptions. *PLoS ONE* **2015**, *10*, e0141526. [CrossRef]
92. Placky, B.W.; Maibach, E.; Witte, J.; Ward, B.; Seitter, K.; Gardiner, N.; Herring, D.; Cullen, H. Climate matters: A comprehensive educational resource program for broadcast meteorologists. *Bull. Am. Meteorol. Soc.* **2016**, *97*, 709–712. [CrossRef]
93. Frison, S.; Dekimpe, M.G.; Croux, C.; De Maeyer, P. Billboard and cinema advertising: Missed opportunity or spoiled arms? *Int. J. Res. Mark.* **2014**, *31*, 425–433. [CrossRef]
94. Anne DiFrancesco, D.; Young, N. Seeing climate change: The visual construction of global warming in Canadian national print media. *Cult. Geogr.* **2011**, *18*, 517–536. [CrossRef]
95. Taylor, C.R.; Franke, G.R.; Bang, H.K. Use and effectiveness of billboards: Perspectives from selective-perception theory and retail-gravity models. *J. Advert.* **2006**, *35*, 21–34. [CrossRef]
96. Fortenberry, J.L.; Elrod, J.K.; McGoldrick, P.J. Is billboard advertising beneficial for healthcare organizations? An investigation of efficacy and acceptability to patients. *J. Healthc. Manag.* **2011**, *55*, 81–96. [CrossRef]
97. Edquist, J.; Horberry, T.; Hosking, S.; Johnston, I. Effects of advertising billboards during simulated driving. *Appl. Ergon.* **2011**, *42*, 619–626. [CrossRef]
98. Nyarko, I.K.; Tsetse, E.K.; Avorgah, S.K.M. Is billboard advertising an effective tool in the marketing of home appliances? *Asian J. Soc. Sci. Manag. Stud.* **2015**, *2*, 101–108.
99. Deshpande, N.; Ahmed, S.; Khode, A. Web based targeted advertising: A study based on patent information. *Procedia Econ. Financ.* **2014**, *11*, 522–535. [CrossRef]
100. Oates, S. *An Introduction to Media and Politics*; Sage: London, UK, 2008.
101. Gavin, N.T. Pressure group direct action on climate change: The role of the media and the web in Britain—A case study. *Br. J. Politics Int. Relat.* **2010**, *12*, 459–475. [CrossRef]
102. Gakuru, M.; Winters, K.; Stepman, F. Inventory of Innovative Farmer Advisory Services Using ICTs. 2009. Available online: https://idl-bnc-idrc.dspacedirect.org/handle/10625/42598 (accessed on 15 July 2016).
103. Asenso-Okyere, K.; Mekonnen, D.A. The Importance of ICTs in the Provision of Information for Improving Agricultural Productivity and Rural Incomes in Africa. 2012. Available online: http://www.undp.org/content/dam/rba/docs/Working%20Papers/ICT%20Productivity.pdf (accessed on 18 February 2017).
104. Aker, J.C.; Ghosh, I.; Burrell, J. The promise (and pitfalls) of ICT for agriculture initiatives. *Agric. Econ.* **2016**, *47*, 35–48. [CrossRef]
105. Mittal, S.; Gandhi, S.; Tripathi, G. Socio-Economic Impact of Mobile Phones on Indian Agriculture. 2010. Available online: http://www.icrier.org/pdf/WorkingPaper246.pdf (accessed on 21 June 2017).

106. Völker, J.; Scholl, A. Do the media fail to represent reality? A constructivist and second-order critique of the research on environmental media coverage and its normative implications. *Constr. Found.* **2014**, *10*, 140–149.
107. Debrett, M. Reporting on climate change: An Australian perspective. *Int. J. Soc. Syst. Sci.* **2011**, *2*, 149–159. [CrossRef]
108. Young, N.; Dugas, E. Representations of climate change in Canadian national print media: The banalization of global warming. *Can. Rev. Sociol.* **2011**, *48*, 1–22. [CrossRef]
109. Ali, S.; Jan, M.; Anwar, M. Media usage: Understanding the extension services in diffusion of agricultural innovations. *Dialogue* **2011**, *6*, 173–186.
110. Tiwari, M.K.; Pandey, K.N.S. Privatization of Indian extension services. *Agric. Ext. Rev.* **2001**, *13*, 23–39.
111. Kumar, P.; Nain, M.S.; Peshin, R. Changing face of agricultural extension: From AP to 4PS—A review. *Agric. Rev.* **2012**, *33*, 170–174.
112. Ignat, G.; Brezuleanu, C.O.; Ungureanu, G. Consultancy and extension services in agriculture under the new CAP. *Lucr. Stiintifice Ser. Agron.* **2011**, *54*, 397–400.
113. Ajieh, P.C. Farmers' knowledge and perception of privatization and commercialization of agricultural extension services in Delta state, Nigeria. *Indian J. Agric. Sci.* **2014**, *48*, 35–40. [CrossRef]
114. Ali, S.; Ahmad, M.; Ali, T.; Hassan, S.W.; Luqman, M. Role of private extension system in agricultural development through advisory services in the Punjab, Pakistan. *Pak. J. Sci.* **2011**, *63*, 70–73.
115. Kaur, J.; Shehrawat, P.S.; Peer, Q.J.A.; Javeed, Q. Attitude of farmers towards privatization of agricultural extension services. *Agric. Sci. Dig.* **2014**, *34*, 81–86. [CrossRef]
116. Egeru, A.; Nampala, P.; Massa-Makuma, H.; Osiru, M.; Ekwamu, A. Innovating for skills enhancement in agricultural sciences in Africa: The centrality of field attachment programs. *Gatew. Int. J. Community Res. Engagem.* **2016**, *9*, 159–171. [CrossRef]
117. Gherman, R.; Iancu, T.; Dincu, A.M.; Brad, I. Professional associations and agricultural cooperatives from Romania and UE–key factor in the development of agriculture. *J Anim. Sci. Biotechnol.* **2016**, *49*, 265–269.
118. Antonovici, C.G.; Savulescu, C.; Sandu, C. The agricultural cooperatives in Romania: From conceptual framework to profitable local production. *J. Public Adm. Financ. Law* **2016**, *8*, 7–15.
119. Stoll, J.; Poon, J.P.; Hamilton, T. Sustainable practice? An examination of Canada's agricultural and energy cooperatives. *Prof. Geogr.* **2015**, *67*, 187–194. [CrossRef]
120. Ortmann, G.F.; King, R.P. Agricultural cooperatives II: Can they facilitate access of small-scale farmers in South Africa to input and product markets? *Agrekon* **2007**, *46*, 219–244. [CrossRef]
121. Hanisch, M. *Constraints on Rural Governance in the European Union: A Role for Cooperative Associations? Institutions and Sustainability, Part II*; Springer: Dordrecht, The Netherlands, 2009; pp. 127–152.
122. Nedanov, A.; Zutinic, Đ. Cooperative organization as a factor of competitiveness and sustainability in Croatian agriculture. *Poljopr. Sumar.* **2015**, *61*, 113–120. [CrossRef]
123. Toma, C.M. Living on a virtual planet. Predictors of Facebook addiction. *Rom. J. Cogn. Behav. Ther. Hypn.* **2018**, *5*, 1–11.
124. Li, Z. Psychological empowerment on social media: Who are the empowered users? *Public Relat. Rev.* **2016**, *42*, 49–59. [CrossRef]
125. Barau, A.A.; Afrad, S.I. An overview of social media use in agricultural extension service delivery. *J. Agric. Inform.* **2017**, *8*, 50–61. [CrossRef]
126. Henderson, A.; Bowley, R. Authentic dialogue? The role of "friendship" in a social media recruitment campaign. *J. Commun. Manag.* **2010**, *14*, 237–257. [CrossRef]
127. Bouvier, G. What is a discourse approach to Twitter, Facebook, YouTube and other social media: Connecting with other academic fields? *J. Multicult. Discourses* **2015**, *10*, 149–162. [CrossRef]
128. Thelwall, M.; Vis, F. Gender and image sharing on Facebook, Twitter, Instagram, Snapchat and WhatsApp in the UK: Hobbying alone or filtering for friends? *Aslib J. Inf. Manag.* **2017**, *69*, 702–720. [CrossRef]
129. Indu. Implications of social media (Facebook and Whats App) among the students of Maharishi Dayanand University, Rohtak. *Indian J. Health Wellbeing* **2018**, *9*, 50–52.
130. Boyd, D. *It's Complicated: The Social Lives of Networked Teens*; Yale University Press: New Haven, CT, USA, 2014.
131. Da Cunha Júnior, F.R.; Van Oers, B.; Kontopodis, M. Collaborating on Facebook: Teachers exchanging experiences through social networking sites. *Cult. Hist. Psychol.* **2016**, *12*, 290–309. [CrossRef]

132. Calancie, O.; Ewing, L.; Narducci, L.D.; Horgan, S.; Khalid-Khan, S. Exploring how social networking sites impact youth with anxiety: A qualitative study of Facebook stressors among adolescents with an anxiety disorder diagnosis. *Cyberpsychol. J. Psychosoc. Res. Cyberspace* **2017**, *11*, 1–20. [CrossRef]
133. Capriotti, P.; Losada-Díaz, J.C. Facebook as a dialogic communication tool at the most visited museums of the world. *EPI* **2018**, *27*, 642–650. [CrossRef]
134. Collins, K.; Shiffman, D.; Rock, J. How are scientists using social media in the workplace? *PLoS ONE* **2016**, *11*, e0162680. [CrossRef] [PubMed]
135. Stone, S. Breaking the ice: Facebook friending and reference interactions. *Ref. User Serv. Q.* **2014**, *54*, 44–49. [CrossRef]
136. Ferris, A.L.; Hollenbaugh, E.E. A Uses and Gratifications approach to exploring antecedents to Facebook dependency. *J. Broadcast. Electron. Media* **2018**, *62*, 51–70. [CrossRef]
137. Hussain, I.; Cakir, O.; Ozdemir, B.; Tahirkheli, S.A. Getting closer being apart: Living in the age of information and communication technologies. *New Horiz.* **2017**, *11*, 145–160.
138. Stvilia, B.; Gibradze, L. Examining undergraduate students' priorities for academic library services and social media communication. *J. Acad. Librariansh.* **2017**, *43*, 257–262. [CrossRef]
139. Jayashree, B. Social media and communication by scientists: MS Swaminathan on Twitter. *Curr. Sci. TSI* **2018**, *114*, 1–6.
140. Cervenkova, E.; Simek, P.; Vogeltanzova, T.; Stoces, M. Social networks as an integration tool in rural areas-agricultural enterprises of the Czech Republic. *AGRIS Online Pap. Econ. Inform.* **2011**, *3*, 53–60.
141. Callaghan, G.; Fribbance, I. The use of Facebook to build a community for distance learning students: A case study from the Open University. *Open Learn. J. Open Distance E Learn.* **2016**, *31*, 260–272. [CrossRef]
142. Phua, J.; Jin, S.V.; Kim, J.J. Gratifications of Using Facebook, Twitter, Instagram, or Snapchat to follow brands: The moderating effect of social comparison, trust, tie strength, and network homophily on brand identification, brand engagement, brand commitment, and membership intention. *Telemat. Inform.* **2016**, *34*, 412–424. [CrossRef]
143. Brody, N. Opting out of social media: Online communication attitudes mediate the relationship between personality factors and Facebook non-Use. *South. Commun. J.* **2018**, *83*, 75–88. [CrossRef]
144. Turner, M.L. Like, love, delete: Social media's influence on college choice. *J. Coll. Admiss.* **2017**, *237*, 31–33.
145. Vassiliadou, S.; Vogiatzi, M.; Amygdalas, T.; Mpoutakidis, D. The Use of Social Media among Students of Technology Agriculture and Their Role in Promoting Agribusiness. Available online: http://ceur-ws.org/Vol-1152/paper17.pdf (accessed on 15 July 2016).
146. Chisenga, J.; Kedemi, R.; Sam, J. The use of social media in agricultural research workflows in Ghana and Kenya. *Agric. Inf. Worldw.* **2015**, *6*, 48–57.
147. Andres, D.; Woodard, J. *Social Media Handbook for Agricultural Development Practitioners*; United States Agency for International Development (USAID): Washington, DC, USA, 2013.
148. Balkrishna, B.B.; Deshmukh, A.A. A study on role of social media in agriculture marketing and its scope. *Glob. J. Manag. Bus. Res.* **2017**, *17*, 34–36.
149. Lathiya, A.; Arvind, R.; Kuldeep, C. Role of social media in agriculture. *Int. J. Commer. Bus. Manag.* **2015**, *8*, 268–273. [CrossRef]
150. Stanley, S. Harnessing Social Media in Agriculture. A Report for the New Zealand Nuffield Farming Scholarship Trust NZ Nuffield Scholar. 2013. Available online: https://www.dropbox.com/s/kyhxdzp5qo9mqaz/S_Stanley_executive_summary.pdf?dl=0 (accessed on 18 January 2020).
151. Onyeneke, R.U.; Madukwe, D.K. Adaptation measures by crop farmers in the Southeast rainforest zone of Nigeria to climate change. *Sci. World J.* **2010**, *5*, 32–34. [CrossRef]
152. Acquah, H.D.G.; Onumah, E.E. Farmers perception and adaptation to climate change: An estimation of willingness to pay. *Agris Online Pap. Econ. Inform.* **2011**, *3*, 31–39.
153. Abid, M.; Scheffran, J.; Schneider, U.A.; Ashfaq, M. Farmers' perceptions of and adaptation strategies to climate change and their determinants: The case of Punjab Province, Pakistan. *Earth Syst. Dyn.* **2015**, *6*, 225–243. [CrossRef]
154. Gandure, S.; Walker, S.; Botha, J.J. Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. *Environ. Dev.* **2013**, *5*, 39–53. [CrossRef]
155. Girvetz, E.H.; Zganjar, C.; Raber, G.T.; Maurer, E.P.; Kareiva, P.; Lawler, J.J. Applied climate-change analysis: The climate wizard tool. *PLoS ONE* **2009**, *4*, e8320. [CrossRef]

156. CCSP. *Climate Change Science Program. Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources*; Environmental Protection Agency: Washington, DC, USA, 2008.
157. Tessa, B.; Kurukulasuriya, P. Technologies for climate change adaptation: Emerging lessons from developing countries supported by UNDP. *J. Int. Aff.* **2010**, *64*, 17–31.
158. Chhetri, N.B.; Easterling, W.E. Adapting to climate change: Retrospective analysis of climate technology interaction in the rice-based farming system of Nepal. *Ann. Assoc. Am. Geogr.* **2010**, *100*, 1156–1176. [CrossRef]
159. Ziervogel, G.; New, M.; Archer van Garderen, E.; Midgley, G.; Taylor, A.; Hamann, R.; Stuart-Hill, S.; Myers, J.; Warburton, M. Climate change impacts and adaptation in South Africa. *Wiley Interdiscip. Rev. Clim. Chang.* **2014**, *5*, 605–620. [CrossRef]
160. Sacramento, A.; Matavel, A.; Basılio, M.; Bila, S. Climate Change Impacts and Coping Strategies in Chicualacuala District, Gaza Province, Mozambique. 2012. Available online: http://www.unep.org/climatechange/adaptation/Portals/133/documents/Chicualacuala_ReportClimate_Change_Impacts_n_Coping_Strategiespdf (accessed on 14 July 2015).
161. Komba, C.; Muchapondwa, E. Adaptation to Climate Change by Smallholder Farmers in Tanzania. Available online: https://econrsa.org/system/files/publications/working_papers/wp299.pdf (accessed on 24 August 2016).
162. Fujisawa, M.; Kobayashi, K.; Johnston, P.; New, M. What drives farmers to make top down or bottom-up adaptation to climate change and fluctuations? A comparative study on 3 cases of apple farming in Japan and South Africa. *PLoS ONE* **2015**, *10*, e0120563. [CrossRef] [PubMed]
163. Smit, B.; Wandel, J. Adaptation, adaptive capacity and vulnerability. *Glob. Environ. Chang.* **2006**, *16*, 282–292. [CrossRef]
164. Wiid, N.; Ziervogel, G. Adapting to climate change in South Africa: Commercial farmers' perception of and response to changing climate. *S. Afr. Geogr. J.* **2012**, *94*, 152–173. [CrossRef]
165. Popoola, O.O.; Monde, N.; Yusuf, S.F.G. Perceptions of climate change impacts and adaptation measures used by crop smallholder farmers in Amathole District Municipality, Eastern Cape Province, South Africa. *GeoJournal* **2018**, *83*, 1205–1221. [CrossRef]
166. Popoola, O.O.; Monde, N.; Yusuf, S.F.G. Perception and adaptation responses to climate change: An assessment of smallholder livestock farmers in Amathole District Municipality, Eastern Cape Province. *S. Afr. J. Agric. Ext.* **2019**, *47*, 46–57. [CrossRef]
167. Popoola, O.O.; Monde, N.; Yusuf, S.F.G. Climate change: Perception and adaptation responses of poultry smallholder farmers in Amathole District Municipality, Eastern Cape Province of South Africa. *S. Afr. J. Agric. Ext.* **2019**, *47*, 108–119. [CrossRef]
168. DEA. *National Climate Change Response Plan White Paper*; Department of Environmental Affairs: Pretoria, South Africa, 2011.