Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 12
December 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2024; 24(12): 25143-25159 https://doi.org/10.18697/ajfand.137.25110

Date	Submitted	Accepted	Published
	14th July 2024	19th October 2024	16th December 2024

PERCEPTION OF RESOURCE-LIMITED LIVESTOCK FARMERS ON ADAPTATION MANAGEMENT STRATEGIES IN DROUGHT-PRONE RURAL AREAS IN EASTERN CAPE PROVINCE, SOUTH AFRICA

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SCHOLARLY, PEER REVIEWED
Volume 24 No. 12
December 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ABSTRACT

Livestock farming is a crucial source of income and livelihood. However, its sustainability is being adversely affected by the unpredictable climatic changes. It would be valuable to comprehend how livestock farmers perceive climate change (CC) and the adaptation strategies. This study evaluated farmers' views of climate change impact, adaptation measures, and the obstacles to these measures. A cross-sectional and multi-stage sampling method was employed. Data collected from 300 randomly chosen farmers were analysed using descriptive statistics and the Garrett ranking technique. Most of the respondents were male (71.67%) and between the ages of 21-60 (62%). Most respondents were married (67%) and had a form of education. Increased disease occurrence, decreased livestock production rate, increased poor vegetation, increased water scarcity, and ambient temperature were perceived by the respondents to have been impacted 'to a great extent' by 45%, 38%, 53%, 36% and 42%, respectively. Perceived and rated as 'to a great extent' by the respondents on climate change impact were 'increased distance covered by livestock for water and pasture (29%), decreased growth rate (28%), and increased ambient temperature (30%)'. Based on descending mean rank, the farmers' most favoured strategies for adapting to climate change included reducing their livestock numbers (58.98), collecting and storing water (55.66) and planning for supplementary feeding (55.35). The income management strategies under CC include off-farm employment (55.48), borrowing from self-help groups (54.48), and friends and relatives (50.72), in that order. The top barriers to CC, in descending order of mean rank, by the farmers include a high incidence of pests and diseases (61.47%), non-availability of improved forage seed (52.06), lack of appropriate water harvesting facilities (51.84), smaller/ fragmented land holding for forage (51.56) and scarcity of farm labour (47.75). The livestock farmers' perception of climate change impacts indicated that most of the factors examined were rated as significant. Most respondents are aware of climate change (CC) and its repercussions on livestock productivity.

Key words: Livestock productivity, management strategies, policies, sustainability, climate change, productivity, perception, farmers

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ISSN 1684 5374

INTRODUCTION

In the last ten years, a growing body of research has surfaced due to escalating concerns about the impact of climate change on Africa's agricultural sector [1]. This has placed the current livestock systems and their ability to meet the rising demand for livestock products and livelihood support in jeopardy. Africa has been recognized as one of the world's most susceptible regions to climate change effects [2]. The consequences of global warming and alterations in average climate variables and variability have impacts on feed and water resources, animal well-being, and production [3]. The outcomes of climate change manifest through shifts in rainfall patterns, an increasing occurrence of insufficient rainy seasons, and rising temperatures, which result in extended periods of drought and heat stress [4, 5].

Similar to other fragile states in sub-Saharan Africa [6], Southern Africa faces the impacts of climate variability due to its heavy reliance on rain-fed agriculture. This vulnerability is exacerbated by factors like widespread poverty, limited financial and structural capabilities. Consequently, agricultural productivity and yields, including livestock production in rangelands, have declined, leading to threats to food security and an elevated risk of famine. In South Africa, smallholder farmers, particularly in the Eastern Cape Province, encounter substantial challenges from the variability and unpredictability of the climate, which significantly constrains their choices and developmental prospects [7]. The Eastern Cape Province, characterized by arid to semi-arid conditions, experiences an average annual temperature of 17.6°C, with summer temperatures soaring up to 40°C. Rainfall averages between 350 and 550 mm per year [8, 9]. Persistent water shortages, affecting both rural and urban areas, prompted the province's declaration as a drought disaster zone in late 2019 [10]. This susceptibility to climate variations and extremes is further complicated by economic, social, geographical, cultural, institutional, governance, and environmental factors [11].

Despite existing complexities, the full extent of climate change's impact on the contributions of livestock to food security and sustainability remains incompletely understood, although its significance is anticipated. Moreover, resource-constrained smallholder farmers possess limited adaptive capabilities, primarily due to restricted access to climate-adapted technologies and resources and a lack of knowledge about climate and weather patterns. This hinders their ability to foresee and handle risks through appropriate strategies [12]. Amid ongoing scientific debate, there is insufficient information regarding the perceptions of smallholder livestock farmers regarding climate change effects on their agricultural practices [13].

For this particular group of livestock farmers, their attitudes toward climate change and variability play a pivotal role in recognizing their concerns and priorities. This

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SCHOLARLY, PEER REVIEWED
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ISSN 1684 5374

understanding supports the decision-making process and facilitates the implementation of more precisely targeted climate change adaptation policies, effective mitigation approaches, and the management of potential hazards [14, 15]. Tailoring intervention outcomes to the local context is feasible based on farmers' knowledge and practices [15], given that adjusting to actual or projected changes stands as a vital aspect of policy considerations. The behavioural shift of farmers toward adaptation and their willingness to act is equally crucial alongside policy determinations [16]. As such, this study focuses on comprehending the perception of climate change among livestock farmers with limited resources in drought-prone regions in the Eastern Cape, South Africa, and their strategies for managing it.

MATERIALS AND METHODS

Description of the study area

The regions under scrutiny encompass the districts of OR Tambo (31.4632^{o}S, 29.2321^{o}E) and Alfred Nzo (30.5483^{o}S, 28.8597^{o}E), both situated within the Eastern Cape province of South Africa. Alfred Nzo and OR Tambo are positioned on the Eastern Cape Province's northern and eastern coastal portions, respectively. The OR Tambo district enjoys a high level of sunshine, and in summer, the temperature ranges from 16^{o}C to 28^{o}C, whilst in winter, the temperature range from 7^{o}C to 20^{o}C. Alfred Nzo has a relatively amount of rainfall, averaging between 900mm and 1500mm each year. Throughout winter, temperatures generally fluctuate between 7°C and 10°C, while in summer, they span from 18°C to 24°C.

Research design and sampling method

This study employed a cross-sectional research design and purposive sampling method. Random sampling was used to select villages/towns from the two district municipalities and households with livestock.

Sampling size and data collection

Three hundred questionnaires were administered to identify livestock farmers within the municipalities. The structured, interviewer-administered questionnaire was used to gather information on socio-demographic variables, livestock populations and capacity, perceptions of climate change, and the adopted management strategies.

Data analysis

Data collected on socio-demographic variables, livestock population and capacity were analysed using the descriptive statistics of SPSS v. 17. Collected data on perception and adopted management strategies were analysed using the Garrett ranking technique. The process of ranking involves identifying the most prominent factor based on the respondent's response. The ranking of alternatives using the Garrett method is achieved by calculating the respondent's data relative to the percentage position value.

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Percentage Position (PP)= [100(Rij-0.5)]/Nj

Rij represents the value assigned to the i variable by respondents for j, with Nj indicating the count of variables assessed by j respondents. The outcomes of percentage positions are subsequently transformed into Garrett Values utilizing the Garrett ranking conversion table. To ascertain the Total Garrett Score, the Rij value is multiplied by the corresponding Garrett Value. The average Garrett Score is computed by dividing the Total Garrett Score by the number of alternatives. The ranking of alternatives is then determined by identifying the highest average value.

RESULTS AND DISCUSSION

Demographics and socio-economic characteristics of the respondents

Table 1 presents the socio-demographic characteristics of the respondents. The distribution of gender revealed more males (71.67%) than females (28.33%). The reason for the high proportion of male respondents was probably due to the high physical energy required in livestock husbandry. Apart from the culture which expects women to take care of the home, men in addition to handling the more difficult task are known to be the household-head saddled with decision making. Similar gender differentials in favour of men have been reported [17, 18]. More than half of the participants (80%) were aged over 40, indicating a higher likelihood of possessing sufficient knowledge to recognise the impacts of climate change (CC) on livestock production, given their extensive experience. All the respondents have a form of education. This positive outlook suggests the farmers are well positioned and/or informed to determine the type of adaptation to CC that suits their needs. This is contrary to the reports of Abazinab *et al.* [19], Endeshaw [20] and Mohammed *et al.* [21], where the majority (78.3%, 75% and over 80%, respectively) of the respondents had no formal education. With some level of literacy, chances abound that farmers can access information based on their knowledge of CC impact, its effect on livestock production and adaptation strategies. According to Tagel and van Der Veen [22], educated farmers find it much easier to recall and forecast situations regarding CC. Most of the respondents (67%) were married and had a family size of more than 5.

Perception of the impact of climate change on livestock production

The perception of communal livestock farmers on climate change's direct and indirect impact is shown in Table 2 using a 5-Likert scale. Direct impact and indices of climate change, including scarcity of water resources (36%) and increase in ambient temperature (42%), were rated as 'to a great extent' being the highest by the respondents. The respondents' perception of the indirect effect of climate change on livestock production and management indices revealed that livestock growth rate decreased 'to a great and very great extent' (57%), distance covered in getting

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ISSN 1684 5374

pasture for livestock has increased 'to some extent' (37%), lands available for grazing have become limited 'to some extent' (44%), and vegetation for livestock have become increasingly poor and with a much higher disease occurrence 'to a great extent' by 53% and 45% of the respondents, respectively. It was proposed that climate change's potential effects on forage quality encompassed alterations in herbage quality and growth, shifts in vegetation's floristic composition, and changes in crop remnants used for animal feed [23]. In examining climate change's impact on forage quality, decreasing precipitation and rising temperatures has been shown to correlate with reduced forage crude protein, digestible organic matter, and overall quality [24, 25]. The study's perception of decreased livestock productivity agrees with the reported decrease in Fogera cattle herd sizes due to climate change impacts [26]. A study by Vitali *et al.* [27] showed that increasing temperatures make livestock more susceptible to diseases and higher mortality rates. Furthermore, extreme heatwaves decrease dry matter intake and subsequently lower milk yield [28].

Climate-change adaptive and income management strategies

Tables 4 and 5 show the results of the Garret ranking outcomes of the various climate-change and income management strategies by the respondents in the study areas. The study revealed that the top five management strategies (in descending order) practiced by the respondents in the study area are destocking (58.98), water harvesting and storage (55.66), planning for supplementary feeding (55.35), breed diversification or use of adaptable breeds (53.59) or forage conservation (52.74). Also, the top five income management strategies practiced by the respondents in the study area include off-farm employment (55.48), borrowing from self-help groups (54.48), borrowing from friends and relatives (50.72), farmers' loans from banks (48.59) and sales of livestock (45.37).

This highest ranking of livestock destocking by the livestock farmers aligns with the approach adopted by small ruminant farmers in Northern Ethiopia in response to climate variability [29]. The advantage of destocking is that it provides a swift option to sell off livestock if prolonged extreme weather events characterized by water scarcity and heat waves persist beyond a certain threshold. Other closely followed adaptive measures include; preparing for supplementary feeding during periods of inadequate grazing vegetation, implementing water harvesting and storage solutions, and opting for adaptable or diversifying breeds. In a study by Calciolari *et al.* [30] on Lithuanian livestock farmers' awareness and responses to climate change, the respondents (84.9%) identified reduced fodder production as one of the top three impacts of climate change on their farming activities. In the Eastern Cape, where communal livestock farming is prevalent, studies conducted have shown that the predominant indigenous goat breeds exhibit considerable adaptability to environmental variations, including heatwaves and water scarcity [3, 31, 32, 33].

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ISSN 1684 5374

Therefore, the respondents' inclination to stick with or transition to more adaptable breeds is reasonable.

Biophysical and socioeconomic constraints affecting climate change adaptation in the study area

The results of the Garrett ranking, presented in Table 6, outline the assessment of different biophysical and socioeconomic limitations influencing climate change adaptation. This study highlighted that the foremost challenges faced by livestock farmers in the study area are primarily the elevated occurrence of pests and diseases, ranking at 61.47. Subsequently, the absence of improved forage seeds scores 52.06, followed by a lack of appropriate water harvesting facilities (51.84), smaller and fragmented land holdings (51.56), deficiency of farm labour (47.75), and insufficient or unavailable farm credit (47.28). Among the respondents, the most favored non-production management strategy for generating income was securing off-farm employment through rural-urban migration. This preference might arise from previous experiences of adverse weather conditions in the province over recent years, leading to unproductive outcomes for livestock and crops.

However, as pointed out by Moser and Ekstrom [34], relying on long-term off-farm income management and adaptive strategies, such as rural-urban migration, can generally present greater challenges and higher costs. The foremost barrier livestock farmers face in their efforts to practice CC adaptation is the elevated occurrence of pests and diseases. As highlighted by Slayi *et al.* [35], an increase in death rates and unplanned livestock sales has become common in numerous rural communities, where farmers are compelled to sell a portion of their livestock during challenging periods.

Ranked after this is the absence of improved forage seeds and suitable water harvesting facilities. Studies have suggested that the lack of appropriate water harvesting facilities might stem from factors such as the inadequate performance of valley dams and insufficient water sources in rangelands [36]. Others have also reported comparable barriers to CC adaptation, notably the absence of improved forage seeds and deficient water harvesting facilities [19].

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The study's findings indicated that a significant majority of the respondents are aware of climate change (CC) and its repercussions on livestock productivity. The respondents pointed out that water scarcity and/or seasonal droughts and elevated ambient temperature are some of the important CC indices they are face with. According to the respondents, these indices negatively impact forage feed availability and quality, general livestock performance and farmers' income. The respondents actively implement a range of adaptive strategies aimed at mitigating

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ISSN 1684 5374

the impact of CC including reduction in flock size, borrowing money and in extreme cases finding other jobs. Despite the concerted efforts by livestock farmers to adapt, certain barriers persist in the adaptation process, including occurrence of pests and diseases, the absence of improved forage seeds, and limited availability of water harvesting and storage facilities.

AUTHORS' CONTRIBUTIONS

All authors participated the study design, practical work and writing of the manuscript and approved the final manuscript.

FUNDING

None

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise

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Table 1: Socio-demographic of the respondents

Variable	Class	Number of respondents	
		Frequency	Percentage (%)
Gender	Male	215	71.67
	Female	85	28.33
Age	21-40	60	20.0
	41-60	126	42.0
	>60	114	38.0
Family size	<5	99	33.0
	>5	201	67.0
Highest education	Primary education	60	20.0
	Secondary education	123	41.0
		117	39.0
Marital status	Married	201	67.0
	Single	45	15.0
	Widow	21	7.0
	Widower	9	3.0
	Divorced	24	8.0
Work experience, yrs	<5	75	25.0
	5-10	159	53.0
	>10	66	22.0
Workplace position	Manager	90	30.0
	Supervisor	111	37.0
	Attendants	54	18.0
		45	15.0
Tribe	Black	285	95.0
	Coloured	15	5.0
Religion	Christianity	300	100
Annual income (in Rands)	0-50000	138	46.0
	Over 50000	162	54.0

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Table 2: Perception of communal livestock farmers towards drought-related issues

Questions	To no extent	To a little extent	To some extent	To a great extent	To a very great extent
Growth rate of livestock has decreased	7%	12%	24%	29%	28%
Milk production rate has decreased	6%	22%	25%	31%	16%
Distance covered in getting pasture and water for livestock has increased	8%	6%	20%	37%	29%
There is an increase in disease occurrence	0%	13%	39%	45%	3%
Reproduction rates of livestock have been reduced	0%	20%	31%	38%	11%
Poor vegetation for livestock feeding has increased	11%	0%	13%	53%	23%
Grazing lands for livestock have become limited	0%	3%	44%	35%	18%
There has been decrease in livestock weight	11%	29%	25%	26%	9%
There has been increase in livestock deaths	11%	23%	18%	24%	24%
There is a scarcity of water resources	9%	18%	13%	36%	24%
There is an increase in ambient temperature	6%	10%	12%	42%	30%

https://doi.org/10.18697/ajfand.137.25110

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ISSN 1684 5374

Table 3: Ranking management strategies used by resource-limited farmers in the study area

Factor	Rank										Total score	Total mean	Rank
	1 (82)	2 (71)	3 (64)	4 (58)	5 (53)	6 (48)	7 (43)	8 (37)	9 (30)	10 (19)			
Breed diversification or use of adaptable breeds	16	0	36	5	0	4	0	13	26	0	5359	53.59	4
Destocking	20	20	0	0	27	8	21	0	4	0	5898	58.98	1
Water harvesting and storage	25	8	8	24	0	5	0	13	0	17	5566	55.66	2
Using dose treatments	0	8	0	28	12	0	12	5	13	22	4337	43.37	9
Storage of grasses (silage)	8	12	0	8	24	17	17	9	5	0	5274	52.74	5
Increased use of veterinary services	0	0	0	13	13	29	4	16	8	17	4162	41.62	10
Dipping of livestock in liquid treatments	17	0	0	0	8	13	18	20	12	12	4544	45.44	8
Vaccination	0	17	21	14	0	12	0	4	20	12	4915	49.15	7
Dietary change for livestock	17	14	0	13	16	0	16	4	0	20	5206	52.06	6
Planning for supplementary feeding	0	21	35	0	0	12	12	16	4	0	5535	55.35	3

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Table 4: Ranking income management strategies by farmers in the study area

Strategy	Rank						Total score	Total mean	Rank
	1	2	3	4	5	6			
Borrowing from self-help groups	15	43	8	9	8	17	5448	54.48	2
Borrowing from friends and relatives	20	8	27	12	16	17	5072	50.72	3
Insurance purchase	6	5	20	30	27	12	4537	45.37	6
Sales of livestock	14	13	10	20	29	14	4775	47.75	5
Farmers' loans	7	16	25	23	14	15	4859	48.59	4
off-farm employment	41	12	10	6	8	25	5548	55.48	1

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PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
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Table 5: Ranking biophysical and socioeconomic constraints affecting drought adaptation in the study area

Factor	Rank								Total score	Total mean	Rank
	1	2	3	4	5	6	7	8			
Non-availability of improved forage seed	20	6	14	12	12	18	3	15	5206	52.06	2
Problem of infertility in livestock	3	11	13	9	18	21	19	6	4716	47.16	7
Marketing of produce	8	16	4	14	12	11	10	25	4596	45.96	8
Scarcity of farm labour	4	8	13	17	22	12	16	8	4775	47.75	5
Smaller/fragmented land holdings for forage production	13	6	21	19	11	6	14	10	5156	51.56	4
Lack of appropriate water harvesting facilities	7	20	17	16	6	13	10	11	5184	51.84	3
High incidence of pest and diseases	36	24	3	10	5	6	7	9	6147	61.47	1
Inadequate/non-availability of farm credit	9	12	15	3	14	13	18	16	4728	47.28	6

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