

# Livestock Farmer's Perceptions of How Changes in Climate Variabilities Are Impacting The Production Systems in The Gambia

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## Research Article

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# Abstract

A questionnaire-based cross-sectional study was conducted in six administrative regions of The Gambia, in order to assess livestock owners' perceptions on climate variabilities changes and their impact on livestock rearing in The Gambia. A total of 440 study participants were interviewed and six focal group discussions were undertaken. Descriptive statistics, Pearson's chi-squares analysis and Binary logistic regression were used to analyze the data. Among them 351 (80%) were males, while 89 (20%) were females. This result reveals that, middle-aged farmers from 40-49 years old had ( $P$  value =0.035), livestock owners in NBR ( $P$  value=0.006), CRR-S ( $P$ =0.038), and CRR-N ( $P$ =0.001) were the main factors significantly influencing livestock owner's perception on rainfall. As for temperature, livestock owners residing in WCR ( $P$ <0.001), NBR ( $P$ =0.006), CRR-S ( $P$ <0.038), CRR-N ( $P$ <0.001) and Herdsmen ( $P$ <0.003) and crop farmers ( $P$ <0.004) were highly associated with knowledge on changes in temperatures. The research also revealed farmers were faced with low milk production and poor-quantity meat as they attributed it as the cause of climate change. Finally, the research has shown that, livestock owners are very much aware of climate change and the consequences it has on their livelihood.

## 1. Introduction

The notion of climate change and variability is perhaps the most discussed phenomena of our time. There is consensus in the scientific field that the land and sea temperatures are warming due to the rising effect of Greenhouse Gases and the warming is expected to continue at least, the next two decades regardless of human interventions (IPCC, 2007; Badjie et al.2019). Global average temperature has increased by 0.78C during the past century, and is as well forecasted to rise by an additional 1.1– 6.48C during the twenty-first century (IPCC, 2013). Countries in West Africa have seen prominent changes in temperature since the 1940's, and in the period 1970 to 2010, temperatures have increased with greater scale (Conway 2008; World Bank Group 2021). Climate Change and its variability have posed a serious health impacts on both man and animal. These ranges from direct effect from temperature upsurge posed by global warming, heat waves and floods and indirect effect such as fluctuations in ecosystem services, food productivity or species distributions (Montag et al. 2017; Marselle 2019; Kargbo and Kuye 2020; Mavhura et al. 2021). There is substantial evidence now, which clearly show that, climate change is unequivocal and happening at an unprecedented rate (IPCC 2013, Kimaro et al. 2018). Developing countries are especially vulnerable to climate change because of several predisposing factors such as poverty, geographic exposure, heavy dependence on rain fed agriculture and issues of poor governance and social infrastructure (IPCC, 2013; Kisauzi et al. 2012). However, In The Gambia, the mean annual temperatures have increased by 1.0°C since 1960, an average rate of 0.21°C per decade. This rate of increase has been most rapid in the months of October, November and December, at 0.32°C per decade (World Bank Group 2021). Sub-Saharan Africa is inhabited by an estimated 386 million people, including pastoralists who depend on natural resources for their livelihood (IPCC 2015; Kimaro et al. 2018). Climate variables such as temperature, precipitation, wind, and water are the key drivers of agriculture (crop production, livestock, fishery, and aquaculture) growth as these are directly linked to climate (Rosegrant et al. 2009; FAO 2009; FAO 2012; Alexandratos and Bruinsma 2012). If climatologists, scientists, politicians,

and others are to effectively support adaptive and mitigated behavior in livestock production, livestock farmers' perception about climate change must be understood. While many recognize the importance of understanding perception of livestock farmers on how climate variabilities are affecting animal production. However, very little research effort has been made in this field (Barnes and Toma 2011)., Therefore, this study seeks to address the knowledge gap on livestock farmers' perception and attitude towards climate change and its variability in The Gambia. This research investigates livestock farmers' perception of changes in climate variabilities and how these changes affect their production.

## 2. Materials And Method

### 2.1 Study location

The Gambia is located in the tropical sub-humid ecoclimatic zone, with annual rainfall ranging from 800 to 1200 mm annually (Jaiteh 2017). There are two seasons in the climate: a rainy season (June to October) and a dry season (November to April), which is six to seven months without rain (Barrow et al., 2020), During the dry season, the climate is dominated by dry, dusty winds that originate from the Sahara Desert (Jaiteh 2017). A total of twelve districts were included in this study and all of them are in the rural areas of The Gambia. The areas included in this study were: Kombo East District and Foni Bintang karanai District in West Coast Region (WCR), Kiang West District and Jarra West District located in Lower River Region (LRR), Lower Niuni District and Upper Badibu District located in North Bank Region (NBR), Sami District and Niani District located in Central River Region-North (CRR-N), Niamina East District and Upper Fulladu District located in Central River Region-South (CRR-S) and Fulladu East District and Jimara District located in Upper River Region (URR) were selected for this study (Fig. 1).

### 2.2 Method of data collection

A cross-sectional study was conducted from October to December 2020. Participants were carefully chosen using a random sampling approach. Gambia Bureau of Statistics (GBOS) 2017 showed the population of individuals with livestock in The Gambia as 724,952 individuals. Using Yamane 1967 formula, where  $x$  is the sample size,  $N$  is the population size and  $e$  is the level of precision (0.05).

$$x = \frac{N}{1 + N(e)}$$

Then from this formula, a sample size of 400 was obtained and this was further multiplied by 10% for sampling error to obtain 440 participants. Two districts and one village per district were randomly selected from WCR, LRR, NBR, CRR- S, CRR-N and URR in The Gambia (figure 1). A list of about 200 to 400 cattle owners in these villages was obtained from the livestock extension officers. Names that fall in even numbers were chosen based on the proportion used by GBOS in order to obtain the exact number of participants needed from each region for the study.

### 2.3 Interview section

After the livestock owners were interviewed, Six Focus Group Discussions (FGDs) consisting of 5–10 people were carried out and one focus group made of livestock farmers per region using semi-structured interview questions (Agwu et al. 2018). At least two livestock owners per village participated in the FGDs. The age of the livestock owners and number of years they are involved in livestock farming were the main criteria used in recruiting livestock owners for the FGDs

## **2.4 Data Collection**

The survey was conducted using a structured pre-tested questionnaire to interview 440 Livestock owners in The Gambia. The questionnaires were made of both closed and open-ended questions and was interpreted orally in the local language to the farmers (Mandinka, Fula, and Wolof) and later translated back to the English language in order to ensure consistency and enhance its applicability in various contexts. Ethical clearance for this research was obtained from the Department of livestock Services, Through the Ministry of Agriculture, The Gambia research ethics committee (protocol number 2014/455).

## **2.5 Statistical analysis**

Microsoft Excel spread sheet program was used to manage the raw data. STATA 11 statistical analysis tools were used to analyze and interpret the data. The data obtained was analyzed using descriptive statistics. The relationships between the predictor variable (age, gender, educational status, occupation and region of residence) with knowledge and attitude variables were examined using Pearson's chi-square and Binomial Logistic Regression. P-value < 0.05 was considered statistically significant.

## **3. Result**

### **3.1 Socio-demographic characteristics of the participants**

A total of 440 livestock owners participated in this study. Among them 351 (80%) were males, while 89 (20%) were females. About one-third of the respondents 132 (30%) were between 40 to 49 years old. Regarding the educational status, the highest number 146 (33.2%) of the respondents were illiterate. More than half of the respondents 222 (50.5%) were herdsmen. Regarding residential area, 111 (25.3%) study participants live in CRR-N (Table 1). Most of the participants 195 (44%) owned cattle. Besides, 225 (51%) keep between 50 to 100 animals while another 53 (12%) keeps between 151 to 200 animals (Table 2).

Table 1  
Shows the demography of participants

Characteristics	Frequency	Percentage
<b>Sex</b>		
Male	351	80
Female	89	20
Total	440	100
<b>Age</b>		
18-29	57	13
30-39	91	20.7
40-49	132	30
50-59	64	14.5
60-69	60	13.6
>70	36	8.2
Total	440	100
<b>Qualification</b>		
Primary	111	25.2
Secondary	49	11.1
Tertiary	10	2.3
Informal/ Madarasa	124	28.2
illiterate	146	33.2
Total	440	100
<b>Region</b>		
WCR	15	3.4
LRR	75	17
NBR	75	17
CRR-S	56	12.8
CRR-N	111	25.3

**Note:** WCR (West Coast Region), LRR (Lower River Region), NBR (North Bank Region), CRR-S (Central River Region- South), CRR-N (Central River Region-North), URR (Upper River Region), Others include: (Marabou, Praise singers, Business men, Pensioners)

Characteristics	Frequency	Percentage
URR	108	24.5
Total	444	100
<b>Main Occupation</b>		
Herdsmen	222	50.5
Crop Farming	19	4.3
Livestock Rearing	124	28.2
Crop and Livestock farming	1	0.2
Petty trading	73	16.6
Others	1	0.2
Total	440	100
<b>Note:</b> WCR (West Coast Region), LRR (Lower River Region), NBR (North Bank Region), CRR-S (Central River Region- South), CRR-N (Central River Region-North), URR (Upper River Region), Others include: (Marabou, Praise singers, Business men, Pensioners)		

Table 2  
Shows the species and the number of animals owned by Livestock owners'

	Variable	Frequency
<b>Specie of animal owned</b>	Cattle only	195 (44%)
	Cattle and small ruminants	147 (33%)
	Cattle and Equines	47 (11%)
	Cattle, small ruminants and Equines	51 (12%)
<b>Herds size</b>	50-100 animals	225 (51%)
	101-150 animals	138 (31%)
	151-200 animals	53 (12%)
	>200 animals	24 (6%)

## 3.2 Perception of respondents towards observed climate variables

Perception of respondents towards observed drought from the total participants, 94% of them had knowledge on the occurrence of drought, 95% observed change in rainfall while 86% reported that, there has been an increase in temperature in their communities over the past 30 years (Figure 2). In contrast most of the participants 43%, 26% and 24% respectively reported that, the change in rainfall, drought and

temperature was as a result of a natural causes while 42%, 27% and 49% respectively also reported that drought, rainfall and temperature increase is caused by humans in figure 3,4 and 5 respectively.

### **3.3 Perception of respondents towards perceived impact of climate variabilities on vegetable**

Participants in this survey were asked how well they understood the effects of drought, temperature, and rainfall on vegetation in the Gambia, and 85%, 61%, and 55% said drought, temperature, and rainfall had resulted in less pasture in their community, respectively (figure 6). Changes in drought, rainfall, and temperature have had a negative impact on livestock owners' herds, vegetation, and the farmer population in The Gambia. According to farmers in (FGDs), the effects of on animals include decreased fertility, increased animal illness, and overall decreased productivity and death.

### **3.4 Factors associated with Knowledge of the respondent towards climate variabilities and its impact on cattle production in The Gambia using Pearson chi-square test**

Table 4 shows Pearson chi-square result for perception of respondent on the occurrence of climate change perceive variation in the selected variables as a result of changes in climate in The Gambia. It appears that region, age, ethnic group, occupation and qualification all are significantly associated with livestock owner's perception of change in rainfall, while region, age ethnic group, occupation and qualification were also highly significant which the respondent's perception of change in temperature. As for drought, only gender, age and occupation were highly significant (Table 3). However, Table 4 shows the Pearson chi-square result of perception of respondent on the cause and impact of climate change on cattle rearing in The Gambia. Age and region were both repeated seen to be significant in all the variable.

Table 3  
Pearson chi-square result for perception of respondent on the occurrence of changes in  
climate variabilities

<b>Variables</b>	<b>Categories</b>	<b><math>\chi^2</math></b>	<b>df</b>	<b>P value</b>
Observed change Rainfall patterns	Region	33.33	5	<0.001*
	Gender	0.006	1	0.939 <sup>ns</sup>
	Age	19.586	5	0.001*
	Main occupation	34.546	4	<0.001*
	Qualification	20.086	4	<0.001*
Observed changes in Temperature	Region	103.641	5	<0.001*
	Gender	3.362	1	0.067 <sup>ns</sup>
	Age	33.939	5	<0.001*
	Main Occupation	31.324	4	0.002*
	Qualification	115.594	4	<0.001*
Observed frequent occurrence of drought	Region	3.247	5	0.662 <sup>ns</sup>
	Gender	8.349	1	0.004*
	Age	11.227	5	0.047*
	Main occupation	14.623	4	0.006
	Qualification	7.641	4	0.106 <sup>ns</sup>
* Significant difference at $p < 0.05$ , <sup>ns</sup> not significant				



Table 4

Pearson chi-square result of perception of respondent on the cause and impact of changes in climate variabilities on cattle rearing

Items	Factors	$\chi^2$ values	df	P value
what had caused changes in temperature?	R	62.230	15	<0.000*
	G	8.626	3	0.035*
	A	49.868	15	<0.000*
	O	23.812	12	0.022*
	Q	72.665	12	<0.001*
If temperature pattern has changed, how has these changes affected your cattle rearing?	R	63.695	20	<0.001*
	G	5.538	4	0.236 <sup>ns</sup>
	A	68.484	20	<0.001*
	O	26.690	16	0.045*
	Q	68.777	16	<0.001*
what had caused changes in rainfall?	R	123.948	20	<0.000*
	G	9.226	4	0.056*
	A	71.566	20	<0.000*
	O	43.83	16	<0.000*
	Q	76.114	16	<0.001*
If Rainfall pattern has changed, how has these changes affected your cattle rearing?	R	28.460	15	0.019*
	G	1.672	3	0.643 <sup>ns</sup>
	A	52.353	15	<0.001*
	O	25.023	12	0.015*
	Q	26.594	12	0.009*

\* Significant difference at  $p < 0.05$ , <sup>ns</sup> not significant, A(age), G (gender), OC (occupation), Q (qualification) and R (region)

Items	Factors	$\chi^2$ values	df	P value
How did you perceive changes in rain fall patterns on the vegetation on the grazing area?	R	88.702	15	<0.000*
	G	2.611	3	0.456 <sup>ns</sup>
	A	29.776	15	0.013*
	O	31.926	12	0.001*
	Q	48.26	12	<0.001*
What changes have drought had on vegetation?	R	88.702	15	<0.000*
	G	2.611	3	0.456 <sup>ns</sup>
	A	29.778	15	0.013*
	O	31.926	12	0.001*
	Q	48.26	12	<0.001*

\* Significant difference at  $p < 0.05$ , <sup>ns</sup> not significant, A(age), G (gender), OC (occupation), Q (qualification) and R (region)

### 3.5 Binomial logistic regression result (general livestock owners' perception on climate change and variability)

Table 5 shows binomial logistic result of how livestock owners perceive variation in temperatures, rainfall patterns and occurrence of drought in The Gambia. This result also reveals that, middle-aged farmers that is 40-49 years old had (CL 0.871-0.023 & P value =0.035), as did livestock owners in the NBR (CL 76.69-2.05 & P value=0.006), CRR-S (CL 38.12-1.12 & P=0.038), and CRR-N (63.53-363 & P=0.001) were the main factors significantly influencing livestock owner's perception on rainfall. As for temperature, livestock owners residing in WCR (CL 46.57-5.52 & P <0.001), NBR (CL 76.69-2.05 & P=0.006), CRR S (CL 6.49-1.12 & P <0.038), CRR-N (CL 63.53-3.63 & P <0.001) and Herdsmen (CL 148.4-2.79 & P <0.003) and crop farmers (CL 237.2-2.79 & P <0.004) were highly associated with knowledge on changes in temperatures and finally, when it comes to drought, livestock owners aged 18-29 (CL 0.66-01 & P=0.019), 40-49 (CL 0.723-0.027 & P=0.019), 50-59 (CL 0.836-0.017 & P=0.032), education, particularly secondary level (CL 42.089-2.25 & P= 0.002), and crop farmers (42.089-2.25 & P= 0.002) were found to be the most influential.

Table 5

shows binomial logistic result of how livestock owners perceive variation in temperatures, rainfall patterns and occurrence of drought in The Gambia

Positive Knowledge on Temperature			Positive Knowledge on Rainfall			Positive knowledge on Drought			
Variables	Odd ration	(95% CL)	P value	Odd ratio	95% CL	P value	Odd ratio	95% CL	P value
<b>Sex</b>									
Male	0.737	2.39-0.23	0.612	0.645	2.53-0.16	0.535	0.37	1.025-0.134	0.056
Female			Ref			Ref			
<b>Age</b>									
18-29	0.243	1.2-0.5	0.08	0.286	1.52-0.05	0.141	0.082	0.66-0.1	0.019
30-39	0.53	2.47-0.12	0.421	0.244	1.41-0.04	0.116	0.285	1.432-0.057	0.128
40-49	0.353	1.59-0.078	0.175	0.138	0.871-0.022	0.035	0.139	0.723-0.027	0.019
50-59	0.366	2.07-0.065	0.255	0.103	1.29-0.01	0.078	0.012	0.836-0.017	0.032
60-69	0.843	3.77-0.188	0.188	0.599	2.42-0.15	0.471	1.24	5.23-0.293	0.773
>70			Ref			Ref			Ref
<b>Qualification</b>									
Primary	6.666	60.48-0.73	0.092	2.83	15.44-0.52	0.23	1.966	9.334-0.414	1.966
Secondary	43.966	2.96-0.2	0.431	73.52	27.5-0.45	0.23	9.732	42.089-2.25	0.002
Tertiary	5.943	59.81-0.59	0.13	0.000	0.00	9.999	1.899	33.397-0.108	0.661
Informal	0.000	0.00	9.99	1.93	13.32-0.28	0.503	1.764	7.214-0.432	0.429
None			Ref						
<b>Region</b>									

**Note:** WCR (West Coast Region), LRR (Lower River Region), NBR (North Bank Region), CRR-S (Central River Region- South), CRR-N (Central River Region-North), URR (Upper River Region), Others include: Marabou, Praise singers, Business men, Pensioners)

Positive Knowledge on Temperature				Positive Knowledge on Rainfall			Positive knowledge on Drought		
WCR	50.82	46.57-5.58	<0.001	50.82	462.6-5.58	<0.001	2.488	28.21-0.219	0.462
LRR	5.95	31.13-0.82	0.081	5.05	31.13-0.82	0.081	1.192	4.98-0.29	0.81
NBR	12.53	76.69-2.05	0.006	12.53	76.69-2.05	0.006	1.9	10.698-0.337	0.467
CRR-S	6.49	38.12-1.12	0.038	6.49	38.12-1.12	0.038	0.663	3.65-0.121	0.637
CRR-N	15.19	63.53-3.63	<0.001	15.19	63.53-3.63	<0.001	0.46	2.302-0.092	0.345
URR			Ref			Ref			Ref
<b>Main occupation</b>									
Herdsmen	20.09	148.4-2.72	0.003	57107	0.000	0.997	1.966	9.334-0.414	1.966
Crop farmer	25.714	237.2-2.79	0.004	52312	0.000	0.996	9.732	42.089-2.25	0.002
Livestock farmer	4.31	16.3-0.07	0.176	2048	0.000	1.00	1.899	33.397-0.108	0.661
Crop and livestock farmer	0.531	3.21-0.88	3.213	-	-	-	1.764	7.214-0.432	0.429
Petty trading	0.0	0.00	9.999	-	-	-	-	-	-
Others			Ref			Ref			Ref
<b>Note:</b> WCR (West Coast Region), LRR (Lower River Region), NBR (North Bank Region), CRR-S (Central River Region- South), CRR-N (Central River Region-North), URR (Upper River Region), Others include: Marabou, Praise singers, Business men, Pensioners)									

## 4 Discussion

The goal of this study was to learn about livestock owners' thoughts on climate change and how these changes affect their cattle husbandry. The findings of this study show that recent perceived climatic variability has had a significant impact on the environment. According to metrological evidence from NAPA 2007 and Cham et al. 2018, precipitation has decreased, the duration of the rainy season has decreased, minimum temperatures have decreased, maximum temperatures have increased, and the frequency of severe weather events such as drought and dust has increased in The Gambia over the last 60 years. This study reports that cattle farmers in The Gambia are well aware of changes in climate

variabilities (Figure 2). Farmers' views of climate change and variability are consistent with weather data evidence and observations from other authors' studies in Burkina (Sanfo et al. 2015; Sanou et al. 2018), Ghana (Fagariba et al. 2018; Dakureh 2020), Ethiopia (Getachew et al. 2014), Benin (Idrissou et al. 2020), Zimbabwe (Mavhura et al. 2021) and even in The Gambia by (Bagagnan et al. 2019) where farmers in the CRR recorded a rise in the average annual temperature, severe weather events such as frequency in drought and flood, and a decrease in the annual average precipitation. Farmers' perceptions of drought, rainfall, and temperature in The Gambia were questioned, and some respondents religiously linked these variables to human actions, as shown in Figure 4. According to some livestock owners in one FGD, "Allah (God) is angry because of our bad deeds and actions that is why we are experience change in climate". They went on to say that there are many atrocities going on now in our society and this is against the teachings of the holy scriptures. Ashraf & Routray 2014 and Iqbal et al. 2018, found similar results in which some components were linked to religious beliefs. Religious belief is considered an essential factor in recognizing and reacting to natural hazards, according to Cooper et al. 2008. Others claim that natural disasters have historically been viewed as "acts of God" or exoteric powers against which mankind had no protection, and that religion and culture can affect interpretation more than experience in purely religious cultures (Fara 2001). This finding is similar with that of Lumborg et al. 2021, who reported that farmers argue that shrinking and degradation of grazing lands, as expressed by communities and animal health workers, is a major concern for Hamer pastoralists in terms of drought. Chi-square analysis test (Table 4) shows that; region of residence ( $\chi^2=33.33$ ,  $df=5$  &  $p$  value=  $<0.001$ ), age ( $\chi^2=19.586$ ,  $df=5$  &  $p$  value=  $0.001$ ), occupation ( $\chi^2=34.546$ ,  $df=4$  &  $p$  value=  $<0.001$ ) and qualification ( $\chi^2=20.086$ ,  $df=4$  &  $p$  value=  $<0.001$ ) were highly significant in determining livestock owners perception of changes in rainfall in their communities. As for their perception on changes in temperature, the region of residence of the livestock owner ( $\chi^2=103.641$ ,  $df=5$  &  $p$  value=  $<0.001$ ), age ( $\chi^2=33.939$ ,  $df=5$  &  $p$  value=  $<0.001$ ), occupation ( $\chi^2=31.324$ ,  $df=4$  &  $p$  value=  $<0.001$ ) and qualification ( $\chi^2=115.594$ ,  $df=4$  &  $p$  value=  $<0.001$ ) showed statistical association with livestock owner's perception of temperature and finally, only gender ( $\chi^2=8.349$ ,  $df=1$  &  $p$  value=  $0.00$ ) and age ( $\chi^2=11.227$ ,  $df=5$  &  $p$  value=  $0.047$ ) were again the only demographic variables that had a statistical significance with livestock owner's perception of the occurrence of drought in their communities. The results of binomial logistic regression show that age and residence of livestock owners were the main factors influencing livestock farmers' perceptions of rainfall, while region of residence and main occupation of livestock owners were the main factors influencing livestock farmer' perceptions of temperature. Age, level of qualification, and occupation were the main factors influencing the occurrence of drought. This finding is consistent with previous findings that socio-demographic characteristics affect farmers' perceptions of the causes and impact of climate variabilities (Kapoury et al. 2016; Olayemi 2012; Sahu and Mishra 2013; Mavhura et al. 2021). However, this result differs from that of Odewumi et al. (2013), who found out that there was no effect of any of the demography variables on the perception of farmers towards Climate change and climate variabilities. This result further suggests that age is a strong indicator of farmers' perceptions of changes in rain fall pattern, occurrence of drought, and changes in temperature in The Gambia. Indeed, older farmers have been subjected to changes in climate variabilities more than younger farmers and this result is consistent with the findings of (Kapoury et al. 2016; Varadan et al. 2014), but the findings contradict that of Sahu

and Mishra (2013). Furthermore, the region of residence of farmers is also a good predictor associated with the farmers' perception of the occurrence and decrease of rain fall pattern, drought and temperature in The Gambia. Farmers living in NBR, LRR, CRR-N, CRR-S and URR of The Gambia better perceived climate changes more because they are more prone to the adverse effect of climate change since there are less vegetation and these areas are prone to bush burning [personal observation by researcher].

According to the cattle farmers interviewed in FGDs, climate change and variabilities has negative consequences for animals (nutrition, reproduction, health, and production), natural resources, and the cattle rearing community, which could be linked to rising aridity, which affects feed availability and quality. Given how reliant agricultural activities are on the weather, this result is in agreement with the finding of (Ayanlade et al. 2010; Mavhura et al. 2021; Lumborg et al. 2021). Farmers' reports of decreased fertility, milk production and meat as a result of Climate Change and variability on animals in this study [FGDs] and this result corroborates with that findings of several authors (Kima et al. 2015; Sanou et al. 2018; Lumborg et al. 2021). Increased morbidity and mortality in livestock are also a result of a rise in certain vector-borne diseases (Courtin et al., 2010; Sanfo et al. 2015; Idrissou et al. 2020). Ninety-one percent of the participants in FGDs mentioned that they are experiencing more cases of animal disease, droughts, intrusion of salt into the river Gambia and bush fires now than they were previously. As a result, animals have had to travel long distances in search of sufficient feed and fresh water due to high aridity and salinity of The River Gambia during the dry season. According to Idrissou et al. (2020) environmental changes is influenced by factors such as human activities and climate change. Farming practices such as repeated bush fires, deforestation, slash and burn, overgrazing and the reduction of fallow duration result in the degradation of vegetation and soil, favoring the release of greenhouse gases e.g. CO<sub>2</sub> into the atmosphere (Idrissou et al. 2020). Farmers in The Gambia viewed the social effects of Climate Change as the greatest threat on food security because of its threats on the livestock animals and this finding is in agreement with that of (Idrissou et al. 2020; Mavhura et al. 2021). Chi-square analysis test (Table 4) shows that region of residence, age and occupation were the only demographic variable showed that there is a statistically significant association with all the questions asked on the impact of climate variability on animal husbandry. This finding suggests that livestock owners in The Gambia are well aware of the profound impact of climate variables on their livelihood.

## 5. Conclusion

In conclusion, this study indicates that livestock owners have a good understanding of climate variability changes and are conscious of climate change, based on their experiences and observations over the last three decades. Results showed that climate change is not a distant problem any longer and it is perceived by most of the livestock owners in The Gambia. Climate variability have been shown to have major economic consequences because they affect poor livestock owners' key economic activities in The Gambia. Reduced rainfall, frequent droughts, and rising temperatures have been identified as major challenges to cattle production due to their impact on pasture and water supply, as well as disease threats. Cattle malnutrition and disease outbreaks, both of which result in cattle deaths, as well as a decline in milk production and market price, are serious consequences faced by livestock owners in The

Gambia. As a result, we recommend that an integrated early warning and preparedness policy be put in place to deal with the consequences of changes in climate variability on livestock development, and to also create public awareness and activism on changes of climate variability impacts and future adaptation and mitigation strategies. This can be achieved by institutionalizing an integrative approach involving the Meteorological Agency, climatologists, ecologists, epidemiologists, and veterinarians can be used to achieve these goals.

## **Declarations**

### **Ethics approval and consent to participate**

This study was permitted by the Ethics Committee from the Ministry of Higher Education Science Research and Technology, The Gambia (reference number AFG 85/272/01) and a signed consent form was obtained from each participant in this study.

### **Consent for publication**

Not applicable

### **Availability of data and materials**

Will be made available upon request.

### **Competing interests**

The authors declare that they have no competing interests.

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### **Authors' contributions**

AK conceived the project idea. AK, HK and RK prepared the research instruments. AK, AB, EJ, AIA and MN collected all the necessary data, analyzed and drafted the manuscript. The study was guided and supervised by HK and RK. All co-authors reviewed and discussed the results, helped in the interpretation of the results, and contributed to the draft and final manuscript. All authors read and approved the final manuscript.

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## Figures

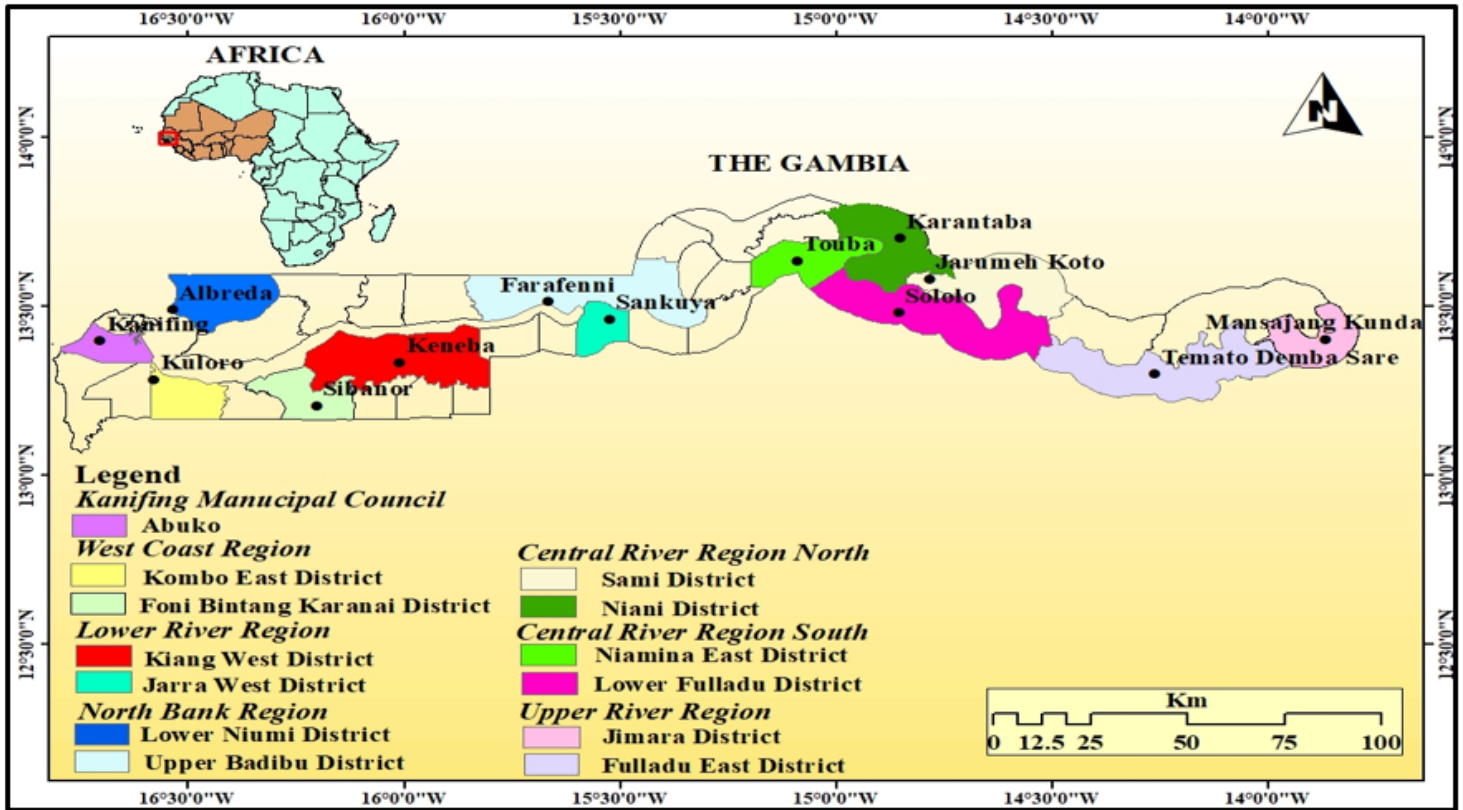


Figure 1

Map of the study area

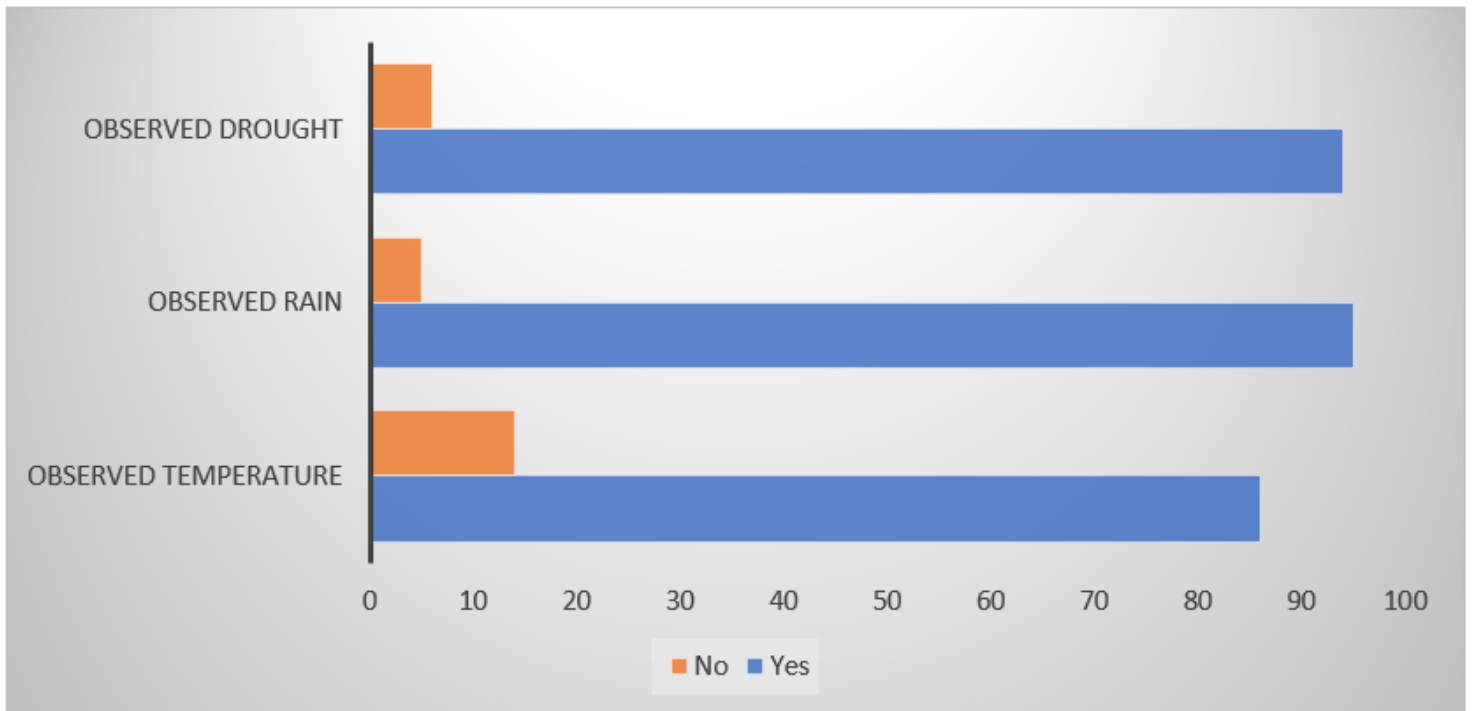


Figure 2

Livestock owner' perception of changes in climate variabilities

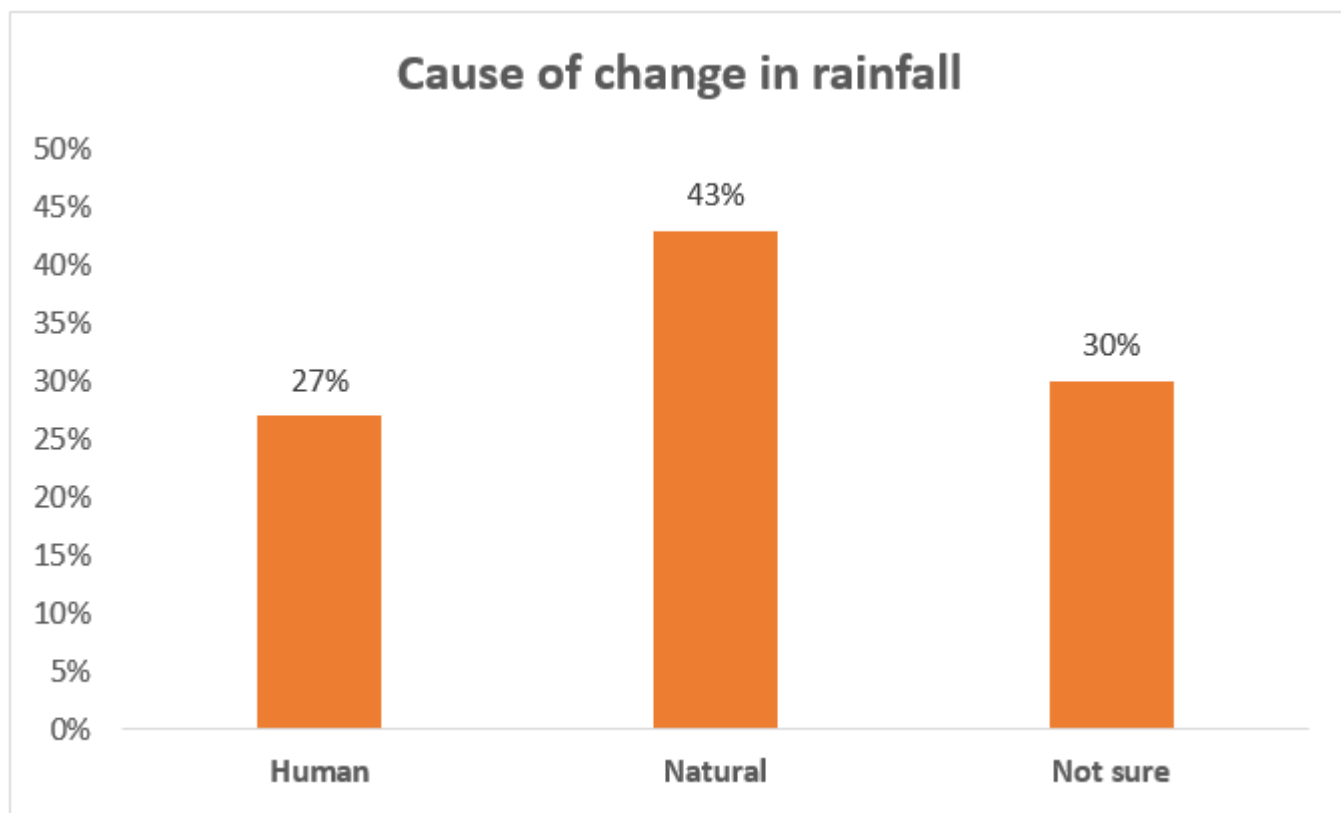
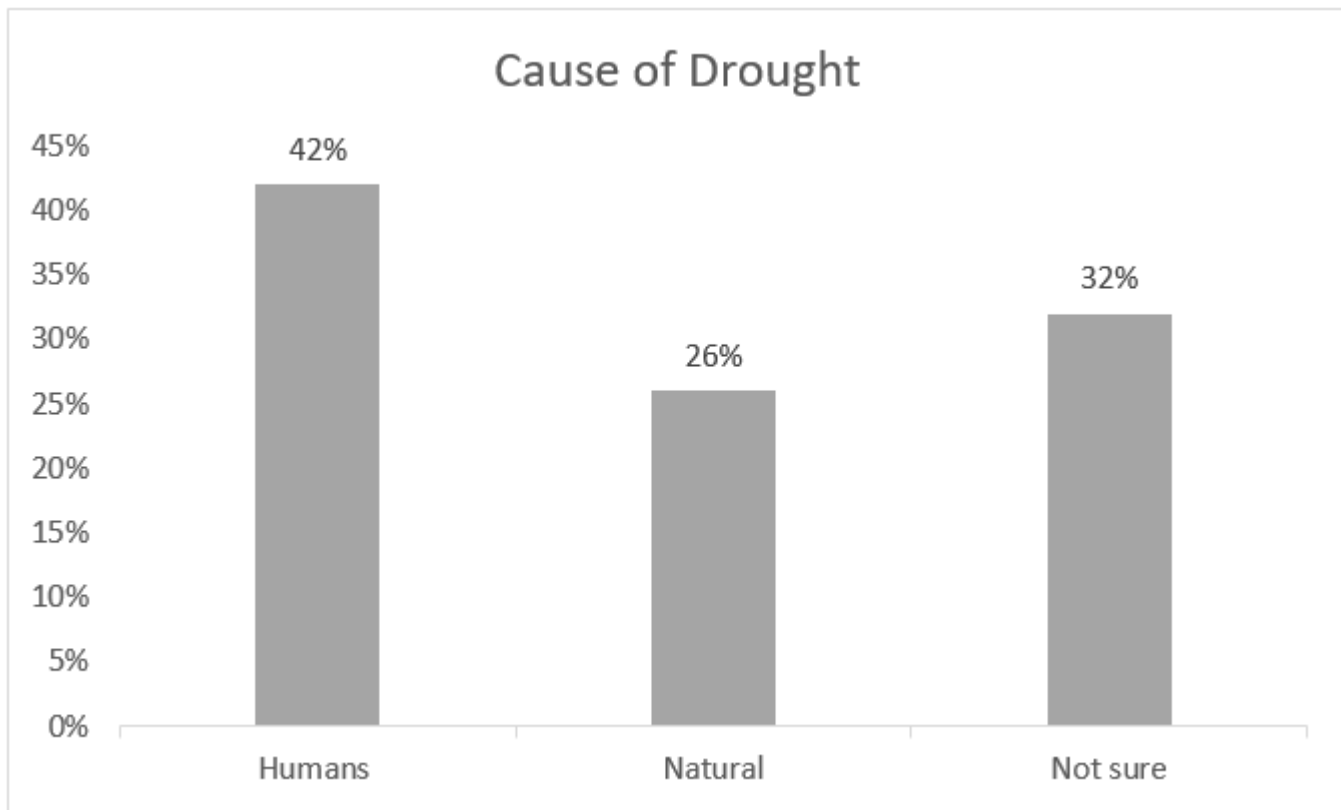


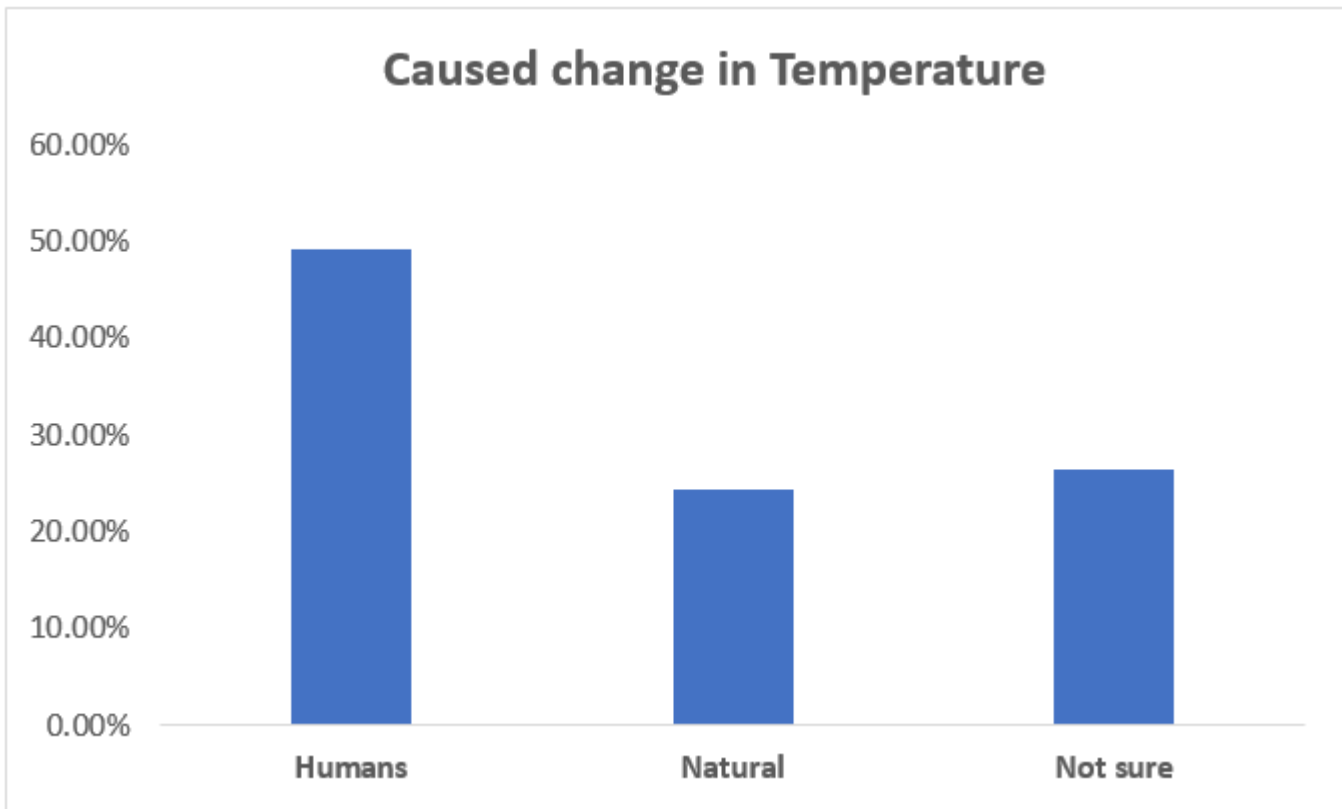
Figure 3

Livestock owner's perception of the cause of change in rainfall



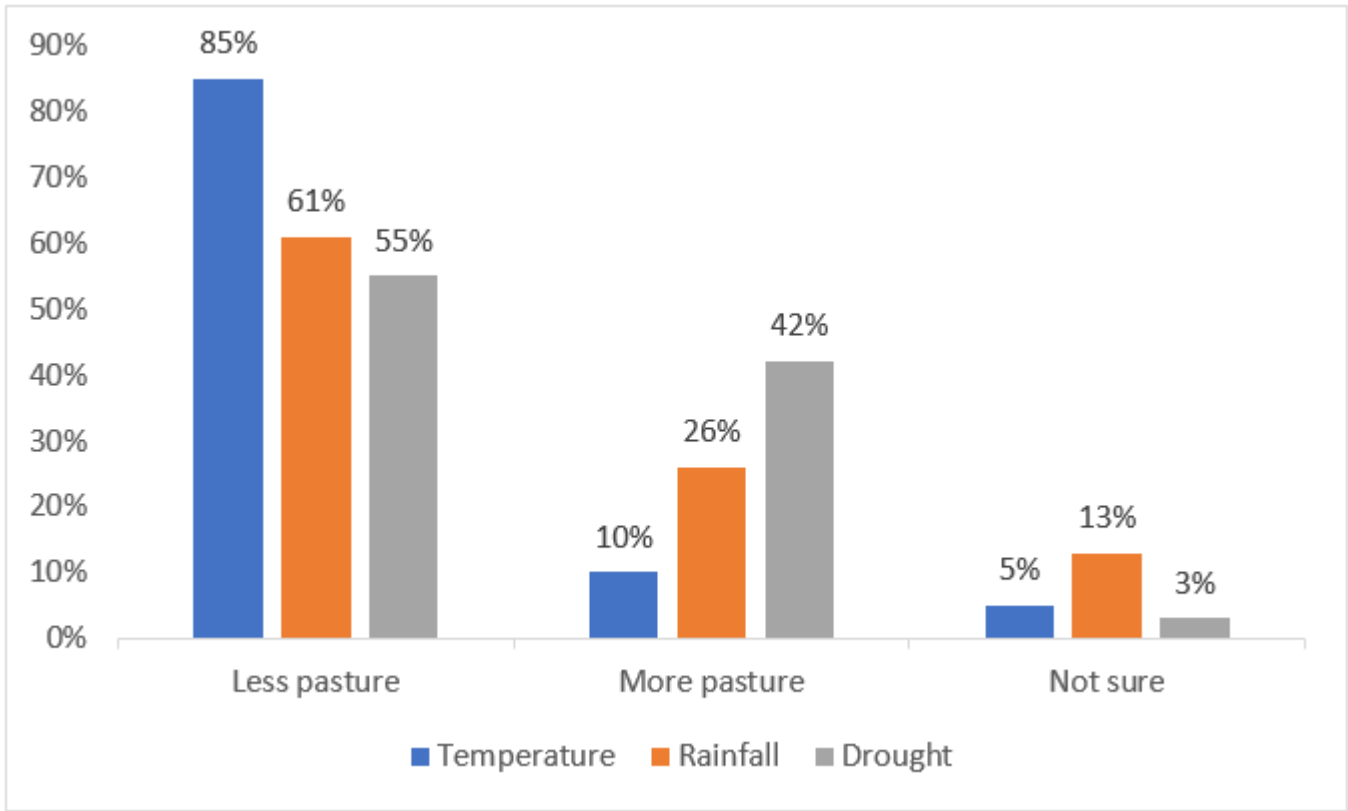
**Figure 4**

Livestock owner's perception of the cause of occurrence of drought



**Figure 5**

Livestock owner's perception of the cause of change in temperature



**Figure 6**

Livestock owner's perception of the effects of change in temperature, rainfall and drought on cattle rearing