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Farmers' Perception on Temperature, Rainfall Patterns and Water Stress in Matope Ward, Mt. Darwin District, Zimbabwe

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Abstract

The study aimed at assessing farmers' perceptions on climate change adaptation and water stress at farm-level Matope Ward in Mt Darwin district of Zimbabwe. The research was conducted through the mixed methods approach. The enquiry was done with the aim of gathering an in-depth understanding of smallholder farmers' perception on the rainfall and temperature patterns experienced in past four decades in Matope Ward. Data collected during the study revealed that residents of Matope Ward perceived changes in rainfall and temperature based on their daily experiences. They associate climate change with rising temperatures and late onset of rains accompanied by shorter rain season lengths. An empirical analysis of rainfall suggested decreasing rainfall trends between 1920 and 2008.The study recommends that there is need to educate farmers about climate change so that they are able to design adaptation strategies that take into cognizance existing local level knowledge and government needs to avail agricultural research results relevant to the small holder farmers and train them on how to use the results to make informed on-farm investment decisions.

Keywords: Climate change, livelihoods, perception, small holder farmers

1. Introduction and Background to the Study

Zimbabwe is a semi-arid country heavily reliant on regular rains (generally November to April). Mean annual rainfall is low and many rivers in the drier parts of the country are not perennial (Carlson and Shumba, 2012).

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Zimbabwe has made extensive investments in large, small, and medium dams, though current utilization is only about 22 percent of mean annual run-off. Rainfall exhibits considerable spatial and temporal variability (see Figure 5) characterized by shifts in the onset of rains, increases in the frequency and intensity of heavy rainfall events, increases in the proportion of low rainfall years, decreases in low intensity rainfall events, and increases in the frequency and intensity of mid-season dry-spells(Unganai, 2009). Extreme weather events, namely tropical cyclones and drought have also increased in frequency and intensity in the country (Mutasa, 2008).

Zimbabwe is experiencing more hot and fewer cold days than before, with the country's annual mean surface temperature having warmed by over four degrees Celsius from 1900 to 2000(O' Brien and Vogel, 2003). Davidson (2003) also concurred noting that Zimbabwe has of late been experiencing frequent droughts alternating with periods of very high rainfall, in some cases floods and mid-season prolonged dry spells are being experienced in same season. Davidson (2003) examined temperature trends for Zimbabwe from 1933 to 1993, in which data coverage for rural areas showed a rise in maximum temperatures, a decrease in minimum temperatures and a substantial rise in the diurnal temperature range.

In Zimbabwe's economy, the agricultural sector plays an important role through its impact on overall economic growth, households' income generation, and food security (Chanakira et al, 2012). Changing rainfall patterns, and increases in frequency of droughts and floods have always adversely affected yields of rain-fed crops and livestock productivity in the country. In 2002, Zimbabwe experienced its largest deficit in food productivity since independence in 1980 as there was a 70% shortfall in farm output due to early and abrupt end of rains in February, which exposed more than 70% of rural population to famine induced starvation (Mudimu, 2008). Agricultural production in many areas will likely be especially hard hit, with yields declining by 20-50% by 2050 according to IPCC estimates (IPCC, 2007).

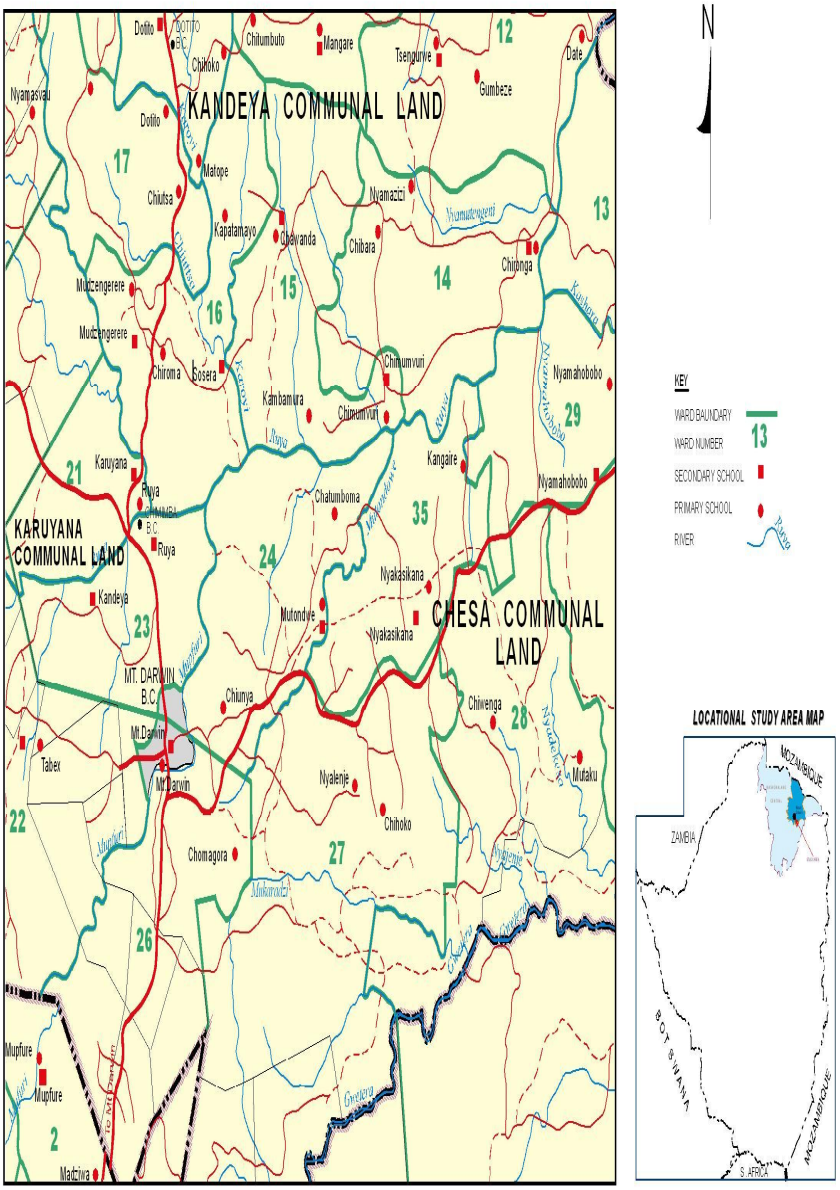
2. Study area: Matope Ward

2.1 Location

The study area Matope Ward 24 of Mt Dawin District is located in one of the seven districts located in Mashonaland Central province of Zimbabwe. The study area's locational co-ordinates is Latitude 16 47' Longitude 31 35'.

It is located approximately 155km from the capital city of Harare. Matope Ward (**Fig 1** below) consists of three villages namely Chiunye , Mutondwe and Chatumbama which all lie on the north- eastern side of Mt Darwin District town business centre. The study focuses on Chiunye and Mutondwe villages.

KANDEYA COMMUNAL AREA



Matope Ward is located in agro-ecological region III, a semi-intensive farming region covering 19% of Zimbabwe. Although rainfall in this region is moderate in total amount, severe mid season dry spells make it marginal for maize, tobacco and cotton, or for enterprises based on crop production alone. The farming systems are therefore based on both livestock (assisted by the production of fodder crops) and cash crops. The region experiences high temperatures (above 25 degrees Celsius) and rainfall that ranges between 650-800mm per year.

2.2 Socio- Economic Background of Study Area

The average rainfall of about 650-800mm per year per year makes the ward generally suitable for livestock rearing and for major crop types.

Local residents in Matope Ward 24 in Mt Darwin District keep mainly cattle and goats and grow some crops for subsistence use mainly. Non-arable land is used for grazing under communal tenure. Mt Darwin District has an approximate population of 212 190 people with an average household size of five people per household. Matope Ward has an estimated population of 7000 people, a population density of about 33 persons per km^2 with a population growth rate of 1.3% (Zimstat Census, 2012).

The District has 40 primary schools and 14 secondary schools. The teacher student ratio of 1;23 for secondary schools is in line with the MDG Goal of 1;28 pupils, whilst the primary school ratio of 1;43 is way above the required ratio. The inhabitants of this communal area are predominantly smallholder farmers who depend on rain-fed cropping and livestock rearing generally for subsistence . Livelihood is dependent mainly on farming and other off-farm activities to supplement income.

The community depends on groundwater for domestic requirements with deep wells and boreholes as main source for drinking water and livestock watered during dry season. Mutondwe dam is owned by the community for irrigation purposes and the boreholes are for livestock and domestic purposes. Mutondwe irrigation scheme, an 11 hectare scheme engages an average of twenty farmers and is the sole irrigation scheme in Matope Ward. The study area has an electrified business centre and lacks a police station, clinic, post office and a GMB depot.

Mutondwe village is the sole village with a high school in the Ward, and it offers A level secondary school (Zimstat, 2012).There are 12 NGO's operating in the whole district of Mt Darwin District specializing in water and sanitation,orphans and vulnerable support (OV) support schemes, education and behavioural change.

3. Research Methodology

The Mixed Methods research design was used in this study. This design was quite appropriate as it enabled the researchers to obtain complementary quantitative and qualitative data on the same topic, bringing together the strengths of the two methods. The quantitative research method enabled the researcher to trace rainfall trends and relationships. In addition it allowed for comparisons using empirical rainfall statistics for the past hundred years for Mt Darwin District. The qualitative component of the design helped to elucidate the strengths of sensitivity to meaning and context in examining impacts of climate change to rain-fed agriculture. This combination of both quantitative and qualitative allowed for combination of the two sets of strengths and compensating for their weaknesses (Punch, 2009). Therefore a combination of both methods yielded more validity and reliability than using either method on its own.

3.1 Target Population

The sampled population was made up of villagers from Mutondwe and Chiunye villages of Mt Darwin. In each village, random samples of twenty-one households were selected and questionnaires administered. The researchers had key informants, which included the Headmen, Meteorological Officer, agricultural extension officers, Non-governmental organization representatives. The choice of community members was based on purposive sampling whereby interviewees were selectively picked depending on their role in society and whose views were elicited on climate change and the effects of water stress to the community. The research instruments used in this study include a survey questionnaire, in depth interview guide, focus group discussions and observation guide were chosen instruments for an in depth understanding and analysis of perceptions of smallholder farmers on climate change adaptation.

3.2 Data Collection

Questionnaires were distributed to 42 respondents in Mutondwe and Chiunye villages. Distribution of questionnaires was done during the day, with the researchers administering the questionnaire in person, whilst at other households the researchers had to drop off and collect on a later date. Maximum supervision of questionnaires' completion by the researchers team enabled 85% questionnaire return. Interviews were carried out during weekdays for the employed interviewees with the Headmen available mostly at the weekends. The focus group discussions were held in Chiunye village with twenty five members in attendance.

4. Results and Discussion

4.1 Farming systems in Matope Ward

Inhabitants of Matope are predominantly smallholder farmers who depend on rain-fed cropping and livestock rearing. Crops are cultivated on individually owned plots and livestock is grazed on communal land. Most households are male headed with the most of the household heads having at least basic or primary education. However more households in Mutondwe have secondary education in comparison possibly because Chiunye village lacks a secondary school in its area. In Matope Ward, farmers still ignorantly engage in wide-scale tree felling to create farm land and fuel wood.

Any chance of them planting trees, are affected by land shortage and a growing population Few households own cattle in Chiunye and Mutondwe village, this delays land preparation and crop establishment as cattle are an important source of draught power in smallholder agriculture. In addition, cattle provide milk and manure, and are an integral part of the farming system. The cropping component produces crop residues mainly maize stalks which are used as an important source of cattle feed during the dry season. Inadequate grazing lands and successive drought years in the area have led farmers to resort to selling livestock and have reduced the cattle numbers in the study area as remarked by farmers at the dip tank. However, most households in the study area keep goats and chickens. Both livestock species are easily convertible into cash (sold).

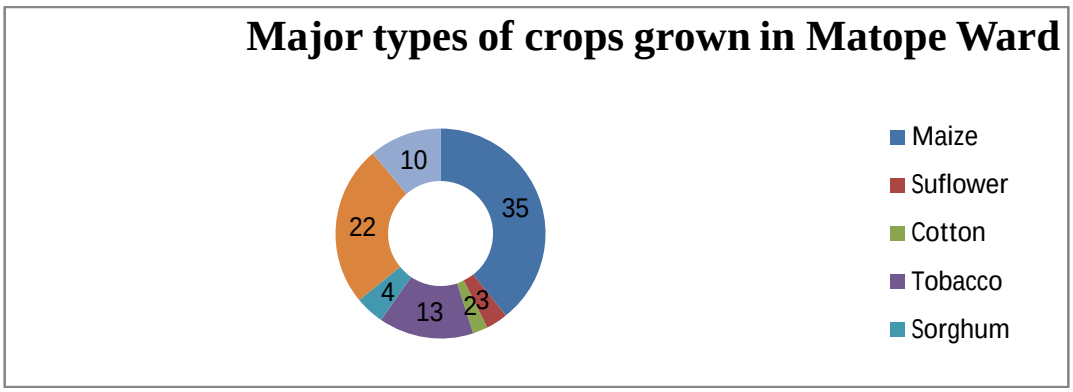
Parameter	Chiunye	Mutondwe
Male headed household, %	55	30
Household heads with no formal education,%	36	8
Household heads with primary education (7 years), %	64	53
Household heads with secondary plus education, %	19	69
Households owning cattle, %	12	22
Household owning goats, %	56	54
Household owning chickens,%	**21**	**30**

Table 1: Key Characteristics of Households in the Study Villages (Research Findings)

4.2 Crop Production

Study villages farmers' grow a wide range of crops. Based on the number of households growing particular crops and the areas planted, the top five crops are maize, groundnuts, tobacco, tomatoes and sorghum as illustrated in **Fig 2** The cropping patterns are biased towards food self sufficiency although there is significant cash cropping in both Mutondwe and Chiunye village. Farming activities in study area are inextricably linked to rainfall patterns. Changes in the amount, distribution and onset of rainfall beyond the conventional range of variability hold serious implications for food production and thus the livelihoods of small-scale farming communities in the area.

Fig 2

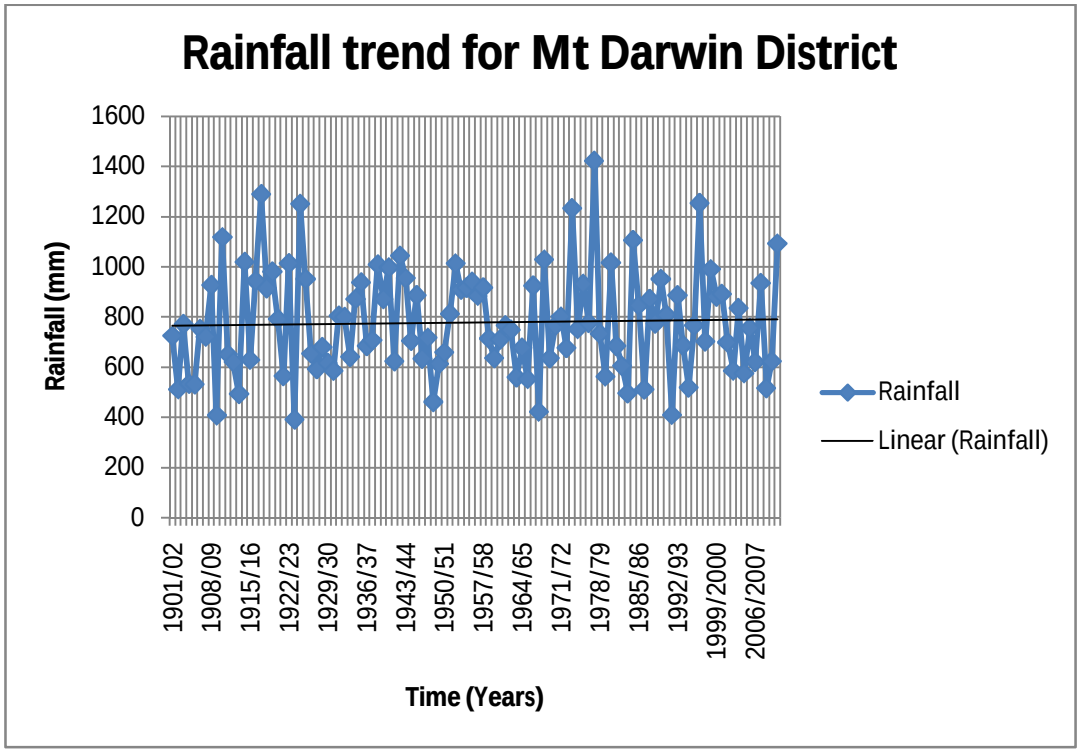


Source: Research Findings

4.3 Records of Climate Patterns for Mt. Darwin District

Rainfall statistics were obtained from the local Meteorological office. In this case, a comparative analysis was made between the amount and yearly distribution of rainfall for past 90 years in Mt Darwin District. The rainfall trends indicated by the graph shows that there are more successive years in which the District has received rainfall below the annual rainfall average of 777,6 mm(Met ,2012). Since the 1920s up to the year 2006, frequency of low rainfall totals received in the study District has increased, as represented graphically in Fig 3

Fig 3



Source: Meteorological Office, Zimbabwe 2014

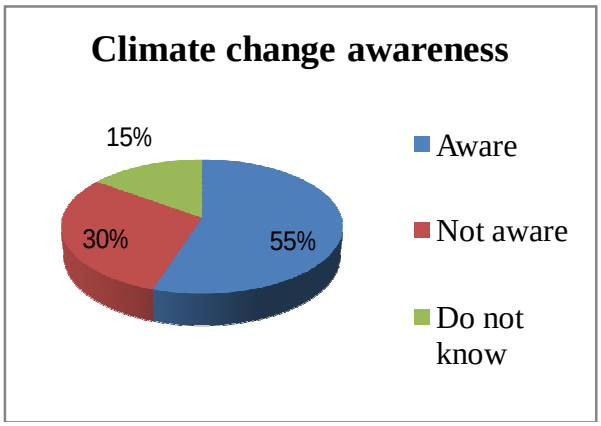
5. Farmers Awareness and Perceptions on Climate Change

5.1 Awareness Level

The respondents were asked whether they were aware of any changes in weather patterns over the years.

Out of the 40 respondents, 22 farmers who constitute 55% of the respondents revealed that they are aware of changes in weather patterns within their locality, while 12 farmers constituting 30% of the respondents revealed they were not aware of any changes in weather patterns .On the other hand 6 respondents constituting 15% of the farmers professed ignorance on climate change. Therefore, of the forty respondents, 55% is aware that climate is changing, while 30% is not aware and 18% do not know. This is represented graphically below(**Fig 4**);

Fig 4



Source; Research findings

5.2 Farmers' Perception on Climate Change

Communities under study exhibited a fair understanding of climate change. Ninety percent of the households indicated that late onset of rain season was a major indicator of climate change while 30% felt that the climate was not changing. The uneven rainfall distribution of the rainy season was given as the second sign of climate change, while a few mentioned less overall rainfalls during the focus group discussion as illustrated in Table 2, below. These perceptions are consistent with climate information presented earlier.

In what way is climate changing?	% farmers
Not changing at all	30
Less overall rainfall	38
Frequent droughts	55
Higher temperatures	62
Late start of rainfall season	90
Uneven rainfall distribution	65

Table 2: Farmers' Perceptions on Climate Change (Research Findings)

6. Indicators of Climate Change as Perceived by Farmers

To ascertain how the farmers relate to climate change locally, the interviewed respondents were asked to identify the local indicators of climate change in their study area. The indicators outlined by the farmers include

6.1 Rainfall Patterns

Twenty farmers from the focus group discussion on the 26th of January in Chiunye village revealed that they are able to identify that the climate changed basing on amount of rainfall received, its intensity and duration. Discussions on the historic timeline revealed that in the 80's the rainfall was predictable and it was traditional that the first rains received were on the 14th of October every year.

6.2 Changes in Seasons

Respondents also revealed that they are able to identify changes in climate through observing seasonal variations. There was consensus amongst the farmers and key informant interviewee that the seasons have changed. Many experienced sentiments that the summers are longer and extremely hot while the winters are mild and shorter than in the past years. The farmers' observations in regard to temperature increases is in line with Southern Africa Environment Outlook (SADC, SARDC, IUCN, UNEP 2008), which argues that climate change is well underway, with average temperatures in Southern Africa having risen by 0.5 degrees Celsius, over the last century. Seventy percent of the farmers remarked that the raining season has become shorter in comparison to past years, arguing that this reduced duration of the rainy season has impacted negatively on the maturity of some of their grain crops, mainly maize.

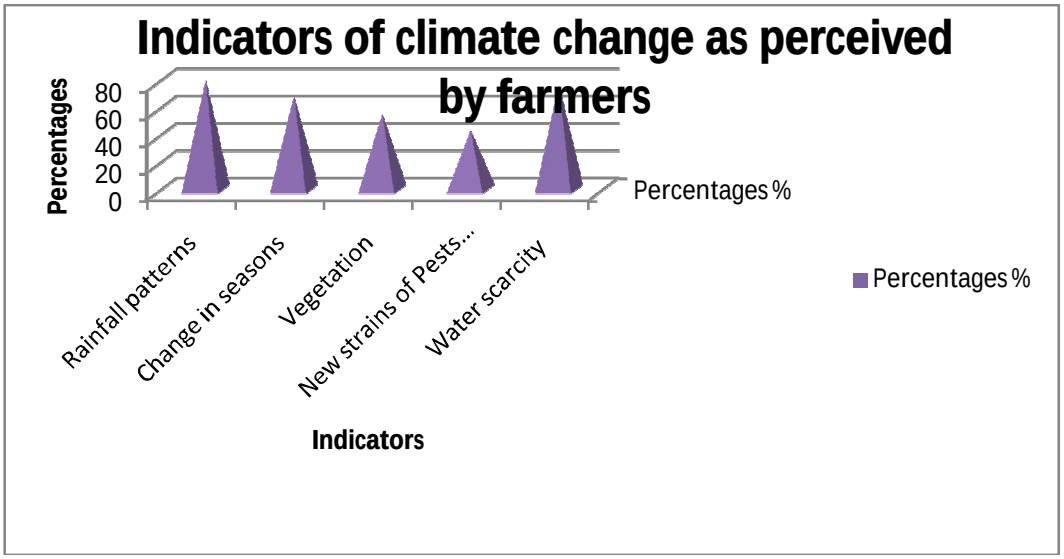
6.3 Vegetation Type

The vegetation cover is said to have changed over the years. Ninety percent of the interviewed participants remarked that the once densely forest in the study area is now sparsely vegetated and from the participant observation, the women have to walk for over four kilometers in search of firewood in the nearest village. Furthermore there are signs of desert encroachment as there are fewer trees still remaining in the area mostly fruit trees such as mangoes planted at most households.

6.3 New Strains of Pests and Diseases and Increasing Water Scarcity

Most of the key informants of the study pointed out the incidences of pests and diseases in the study area have increased. The Mutondwe irrigation farmers sighted that they were experiencing a new type of weed which destroys other crops. The other farmers practising dry land farming complained of a new strain of virus termed New castle which was said to have almost wiped out the entire villages' chickens, which the researcher observed as only a few number of chickens were seen during the study of the households in the study area.

Fig 5



Source: Research findings

7. Causes of Climate Change as Perceived by Farmers

The farmers in the study area seem mainly to concur that religious and environmental related explanations are the chief causes of climate change in their locality. The various views of the farmers are as depicted below:

Explanation	Identified Cause	Percentage
Religious	God	65%
	Ancestral spirits	77%
Environmentally related	Cutting down trees	24%
	Pollution	35%
	Scientist and modernity	10%
	Global wars	2%
	Change in wind patterns	3%
No explanation	Natural and normal	5%
	Do not know	12%

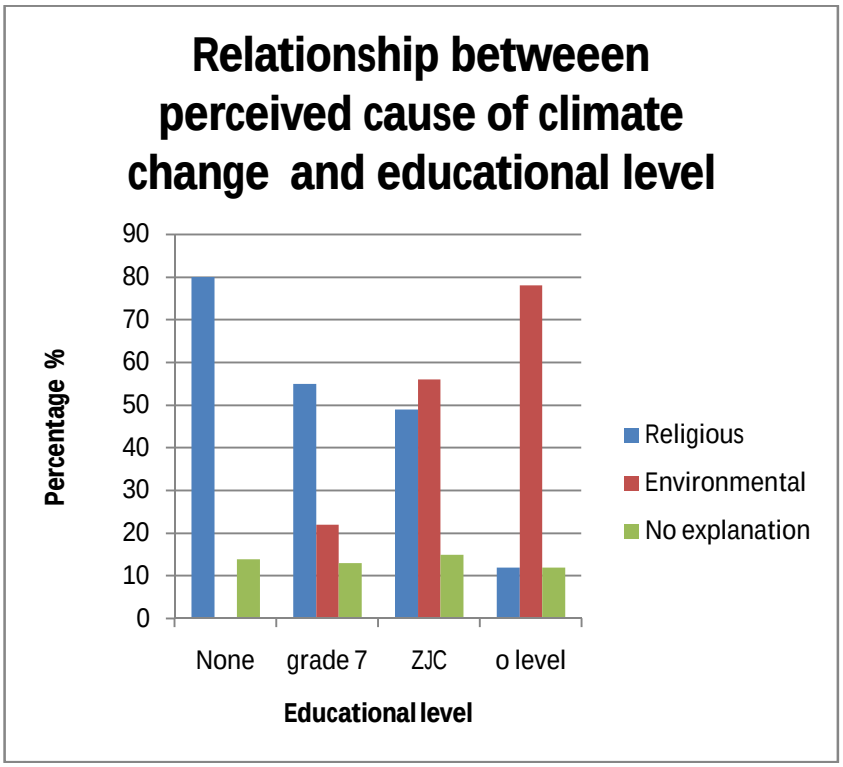
Table 3: Farmers' Perceptions on Causes of Climate Change (Research Findings)

Table **6,** depicts the proportion of farmers who believe in different explanations to account for the cause of climate change in their study area. Most of the farmers are of the belief that climate change is mainly due to environmental and or religious reasons, while a few do not have a solid explanation to account for the cause of climate in their locality. The religious explanations highlighted were mainly of individuals breaking custom rules and issues of incest.

7.1 Relationship Between Perceived Causes of Climate Change and Level of Education

The highest proportion of the farmers who believe that the cause of climate change in the study area is due to religious explanations are those mostly without educational qualifications and this trend decreases as level of education increases. The proportion farmers who are of the belief that the cause of climate change is due to environmental explanations is highest for those with educational qualifications , and this trend increases with level of education from grade 7 to Ordinary Level ('O' Level). However , although most of the farmers are either of the belief of religious explanation or environmental explanation, they are those who still have no explanation to account for the cause of climate change in their locality.

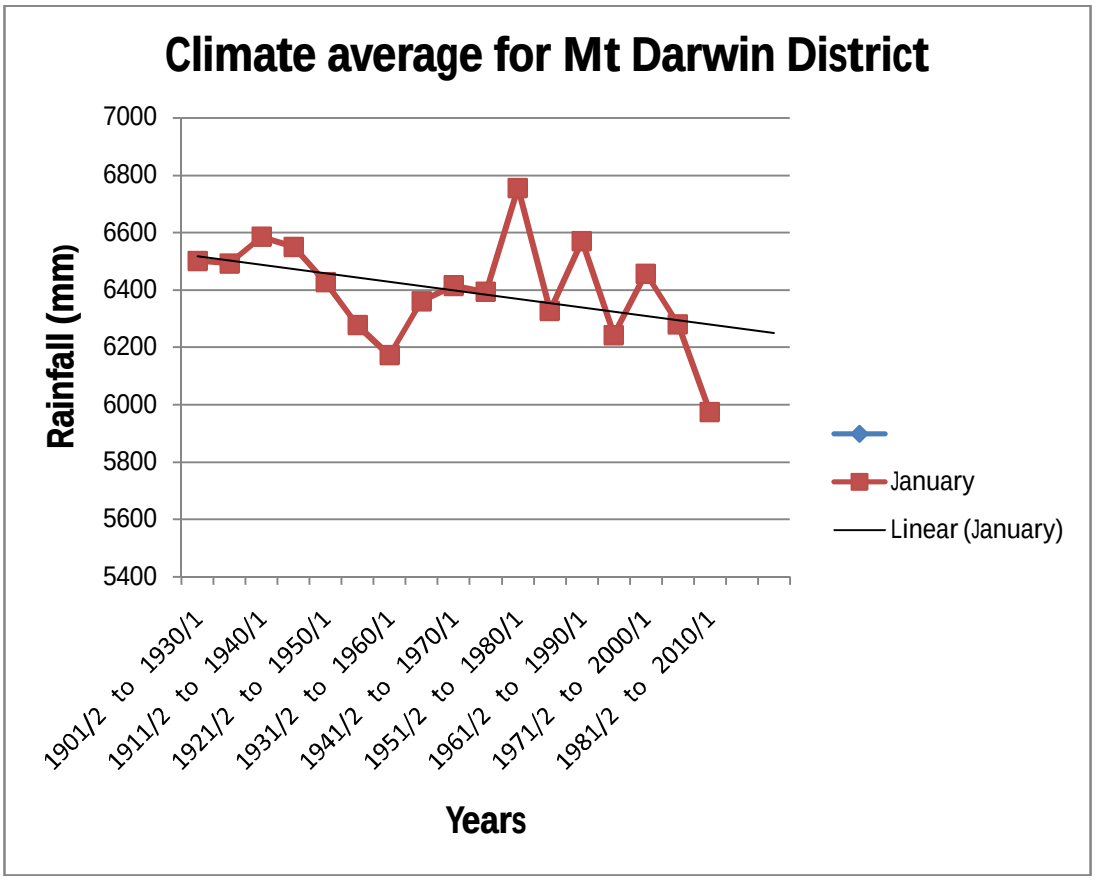
Fig 6



Source: Research findings

To further augment the indicators obtained from the farmers, rainfall statistics were obtained from the Meteorological Office. In this case, a comparative analysis was carried out using January's monthly rainfall totals and using rolling averages of 5 year differences for the past 100 years in Mt Darwin District, so as to trace the rainfall trend, as illustrated in **Fig 7** below

Fig 7



Source;Meteorological Office, Zimbabwe 2014

As illustrated in the graph below the monthly January rainfall amount received seems to indicate a decrease in monthly rainfall amount received for the month of January in Matope Ward, in comparison to year of 1901.This is clearly indicated by the trend line in the graph. While these rainfall patterns are for past 100 years they do appear to reflect patterns indicated by the farmers.

8. Conclusions

Residents of Matope Ward have a general fair understanding of climate change. They generally associate it with rising temperatures, late onset of rainy season and reduction in the rainy season length.

Indicators for climate change are rainfall patterns, change in seasons, vegetation type and water scarcity In addition , residents concur that religious and environmental related explanations are the chief causes of climate change in their locality. Inhabitants of Matope are predominantly smallholder farmers who depend on rain-fed cropping and livestock rearing. Consequently any adverse weather changes negatively impacts on their livelihoods.

Using an empirical rainfall time series, for the past 100 years in Mt Darwin district revealed that the frequency of years with low rainfall totals has increased. This was further evidenced by the empirical analysis of climate rolling average graphs for Mt Darwin District. Therefore, it is evident that farmers' observations and perceptions are in consensus with the scientific evidence obtained for climate change. This study has found that other intervening variables such as access to extension services, information and the vulnerability context along with farmers' perceptions, do influence farmers' adoption and coping strategies to climate change. Conclusively, the complication of rural life cannot be properly understood through a single theoretical viewpoint as perception varies with the socio-economic, cultural, gender, environmental and historical context and to some extent personal experiences of the risks.

9. Recommendations

The researchers recommend that there is need to increase the number of agricultural extension officers in Matope ward to help educate farmers on water conservation techniques. In addition, there is also need to integrate farmers in all phases of developing the traditional knowledge base, as well as in capitalization and validation of technical, socio-economic and organizational solutions that are available in research.

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