

Impacts of Climate Variability on Pastoralists and Their Adaptation/Coping Strategies in Fentale District of Oromia Region, Ethiopia

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Abstract

Background: Recently, more emphasis has been given to preparing and adapting communities to the adverse impacts of climate change than mitigating its risks. The present study was conducted in Fentale district, Central Ethiopia to determine the perceived adverse impacts of climate change and variability, the perception of pastoral households on the patterns of climate change and variability, and identify the adaptation /coping strategies of pastoralists to climate change impacts. A household questionnaire survey and focus group discussion were employed to collect primary data at a household level. A total of 130 pastoral households were sampled using random sampling. The collected data were analyzed using descriptive statistics.

Results: The findings revealed that the perception of pastoral households on rainfall and temperature patterns was in line with the results of the recorded meteorological data analysis of the present study except the *Kiremt* rainfall and the long-term annual rainfall trends. The results indicated that pasture and water availability became scarce and livestock assets and productivity were highly reduced, due to adverse impacts of climate change and variability. The most important strategies deployed by the local people included (i) integrating livestock with crop production, (ii) livestock mobility, (iii) livestock diversification and herd composition change, (iv) decreased consumption, (v) remittance, (vi) cash for work and (vii) food aid.

Conclusion: Therefore, the decision-makers should support and enhance household's indigenous adaptation strategies through the provision of market access, early warning information, affordable credit access, and development of water points.

1. Introduction

Climate change impacts weaken and even reverse the progress made in improving the socio-economic welfare of most African countries. The current and predicted climate influences indicate that a severe impact will be observed more in Africa than in other continents, as the livelihoods of African people are mainly based on rain-fed agriculture and due to low incomes and its geographic exposure Intergovernmental Panel on Climate Change [IPCC] (2014). The spatial and temporal variability of rainfall and continuous reduction in rainfall numbers was detected recently in Eastern African countries (Hession & Moore, 2011; Liebmann et al., 2014). Consequently, the people whose livelihood is mostly dependent on rain-fed agriculture, is becoming under great pressure (Conway & Schipper 2011; Hawinkel et al., 2016).

Like other African countries, the agricultural sector in Ethiopia is prone to the impacts of climate change and variability since the country's livelihood is mostly based on rain-fed agriculture (Conway 2000; Hulme et al., 2001; Seleshi & Sanke, 2004). According to Funk et al. (2005), precipitation in Ethiopia is anticipated to decrease and become more uneven in the future. The incidences of droughts have been increasing mostly in the pastoral communities of the country (Ferris-Morris, 2003). It has been observed that although change in climate is happening all over the world, its influence and extent may differ across

multiple levels and scales. The responses of communities to climate impacts can be expected to vary depending on the social and cultural environments. Therefore, it is reasonably essential to consider human dimensions that take into account the different ways in which people perceive and respond to negative impacts of climate change and variability.

Pastoralists are one of the most climate-change affected groups on the planet (Thornton et al., 2009). Increased climate variability could decrease herd sizes as a result of increased mortality and poorer reproductive performance of the animals. This decrease in animal numbers would affect food security and would compromise the sole dependence of pastoralists on livestock and their products, as well as the additional benefits they confer. As observed in pastoral communities of Fentale region, the rangeland environment and other associated livelihood resources are in general under increasing pressures (Coppock, 1994; Getachew, 2001). Fentale pastoralists have received less development attention than many other pastoral societies in Ethiopia. However, many pastoralists still try to retain flexibility in spite of increased constraints and risks (Galvin, 2009). Most studies on impacts of climate change and variability on livelihood of people and their climate adaptation strategies are conducted in highland areas of Ethiopia (Di Falco et al. 2011; Bryan et al., 2010; Mahmud et al., 2008; Temesgen et al., 2008). However, limited information is available in pastoral communities of the country particularly at local levels. According to McKee (2008), adaptation had been experienced in Ethiopia before the concept of climate change became more noticeable. However, these local adaptation/coping strategies have not been documented so far, and therefore, understanding and documenting the local adaptation strategies is a crucial entry point to enhance the resilience of local communities to climate change and variability. Understanding local adaptation/coping strategies is, hence, essential to inform decision makers for future interventions to reduce the impact of climate change.

This study aimed to offer research evidence-based policy findings that would contribute to increasing pastoralists' capacity to adapt to the impact of climate change in Fentale district, East Shewa of Oromia region, Central Ethiopia.

The sub-objectives are to:

- Assess the perception of the local people on climate change and variability;
- Analyze the trends of climate change and variability using observed data.
- Assess the perceived impacts of climate change and variability on the livelihood of pastoralists;
- Identify local adaptation/coping strategies to climate change and variability;

Research questions

This study was guided by the following research questions:

- i. What are the local people's perceptions about the region's climate change and variability and its impacts?
- ii. What are the adaptation strategies deployed by the local people to adapt or cope with climate change and variability?
- iii. What are the trends of climate variability and change in the Southern Afar region?

2. Materials And Methods

2.1. Study Area Description

This study was conducted from September, 2018 to November, 2019 in Fentale district which is situated in East Shoa Zone of Oromiya regional state, Ethiopia (Goerner et al., 2009). Geographically the study area is located at 80°42' to 90°00'N latitudes and 30°03' to 40°01'E longitudes. The study area involves 1 administrative town, Metehara, located at a distance of 200 km from Addis Ababa and 18 rural villages (FWARDO, 2007). The area involves undulating plains, hills and mountainous landscapes. The district's elevation varies from 862 m.a.s.l to 1997 m.a.s.l. Fentale district is characterized by arid and semi-arid environment. The mean minimum and mean maximum monthly temperature of the area varies from 12.80 °C to 21.90 °C and 28.0 °C to 36.70 °C, respectively. The area receives an annual rainfall amount ranging from 400 mm to 700 mm (Ayalew, 2001; CSA, 2007). Livestock production is the main source of income for the communities in the district followed by mixed crop-livestock production.

2.2. Sampling Methods

This study employed purposive and stratified random sampling to select sample villages and households. Based on vulnerability to drought, water scarcity and representativeness of the livelihood activities in the area, three villages were selected out of 18 kebeles in Fentale district. These villages were Banti Mogassa, Kobo and Gelcha. Households in each village were stratified based on wealth status and a total of 130 respondents were selected for this study. A semi-structured questionnaire was administered through individual interviews with the heads of the households from December 2018 to April 2019. Data were gathered concerning household' annual income and sources of income, access to credit, health, socio-demographic profile, climate change information and adaptation and coping strategies.

To complement the household questionnaire data, 15 individuals from sampled villages and various organisations were interviewed as key informants. Four focus group discussions were carried out from selected villages.

2.3. Methods of data collection

Both primary and secondary sources of data were used in this study. Primary data was obtained through household surveys using structured questionnaire, Key Informant Interviews (KII) and Focus Group Discussions (FGDs). Secondary sources of data included meteorological agency for rainfall and temperature data collection, articles and thesis. A preliminary survey was carried out with local

enumerators and key informants before the start of the actual survey, and the last questionnaire were modified and revised as needs be. The survey questionnaire was both open ended, dichotomous and multiple-response type. The questionnaire was translated to the household's local language and data on different perspectives was gathered through household interview by the local field assistants.

2.4. Determining trends of rainfall and temperature

The rainfall and temperature time series data were collected using merged gauge–satellite recorded data on a ten-daily time scale from Ethiopian National Meteorological Agency, [NMA] for the period 1983 – 2017. The monthly, seasonal and annual temporally distributed rainfall and temperature data trends were analysed using the Mann-Kendall statistical test at 0.1%, 1% and 5% level of significance. The Mann-Kendall test for monotonic analysis of trend together with nonparametric Sen's Slope Estimator can be used to estimate the magnitude of trend for time series data which are not normally distributed (Babar & Ramesh, 2013; Hamed, 2008; Mondal et al., 2012). The seasonal and annual rainfall distribution was analysed following Oliver's (1980) precipitation concentration index (PCI) equation. The inter-annual and seasonal fluctuations of rainfall and drought severity were estimated using the Standardised Precipitation Index (SPI) by McKee et al. (1995).

3. Results

3.1. Socio-economic and Institutional Characteristics of Households

Table 1 presents the average age, sex, and access to basic services of households. The findings showed that the average size of the family in the study area was 6.5. Access to basic services was very low and an extensive number of the respondents were seen as illiterate.

Table 1
Status of households regarding sex, age and access to basic services.

Description	Households states	Percentage
Sex	Male headed households	60
	Female headed households	40
Age	18–64	97
	65	3
Education	Illiterates	72.2
	Read and write	28.8
Access to basic services	Access to credit	20
	Access to market	15
	Access to climate information	8
	access to extension	32

3.2. Local Household’s Perception on Climate Change and Variability

In this study, perceptions of pastoral households were assessed on the trends of rainfall and temperature two/three decades ago. Ninety-eight percent of the respondents perceived that the rainfall has declined; rainfall comes early/late and ceases short from the normal rainy season, while 95% of the households clarified that the temperature has increased. Moreover, the findings indicated that there have been frequent droughts in the study areas as explained by 100% of the sampled households. As perceived by local respondents, the rising temperature, frequent drought occurrence and decreased *Belg* rainfall was in agreement with the findings of the observed data analysis. Notwithstanding, the *Kiremt* and long-term annual rainfall was not in accordance with their perception. In this study, the *Belg* rainfall occurs from March-April and the *Kiremt* rainfall occurs from July-September.

3.3. Trends of Rainfall and Temperature

The findings indicated that significant decreasing trend of *Belg* rainfall (-3.0 mm per season) and increasing trend of *Kiremt* rainfall (2.0 mm per season) was observed for the period 1983–2017 (at $\alpha = 0.05$) in the study area. The findings uncovered a significant increasing trend of monthly, seasonal and annual temperatures, involving mean, maximum and minimum temperatures. Besides, the SPI analysis indicated that around 16 years of the observed period 1983–2017 were characterized by below average rainfall (Fig. 1).

3.4. Impacts of Climate Change and Variability

3.4.1. Decreased Livestock Assets and Productivity

The majority of the respondents (90%) responded that the recurrent and prolonged droughts decreased number of livestock and productivity. The respondents complained that on average, the number of livestock per household under normal years was 44.2 Tropical Livestock Unit (TLU). However, recently, the number of livestock per household was 29.87 TLU. Besides, the drought also decreased the amount of yield per animal.

3.4.2. Decreased Forage Availability

The majority of the respondents (92%) complained that since the magnitude of drought has increased, the rangeland has been degraded and the palatable forages have recently been replaced by non-palatable plants. Respondents noted that before the grazing area recovered from the previous drought, another drought affected the new growth. This situation could cause loss of palatable forage species from the rangeland and reduces forage availability.

3.4.3. Drying up of Water Points

Eighty-five percent of respondents clarified that water points have either dried up or supply was diminished over the course of the recent decades. The shallow wells, ponds and cisterns were the main sources of water for pastoralists. The local households complained that they travelled long distances, more than 20 km, to get water from perennial rivers, even during normal dry seasons of the year.

3.4.4. Effects on Households' Terms of Exchange

Ninety percent of the respondents affirmed that during droughts, pastoralists had been compelled to sell their livestock at low price because of poor body conditions of animals and oversupply. In recent years, drought frequency has increased, droughts occurred every two three years and pastoralists had no time to recover from the effects of the past drought and, subsequently, the price of livestock continued to decrease while the food grain price was increasing.

3.5. Adaptation and Coping Strategies of Fentale Pastoralists

The major adaptation and coping strategies of pastoral households to adapt to adverse effects of climate variability are indicated in Fig. 2.

3.5.1. Integrating Livestock with Crop Production

Since livestock assets and productivity decreased over time, some households begun crop farming using small-scale irrigation along the banks of the Awash River. The results showed that some pastoral

households (25%) practiced small-scale crop cultivation using traditional irrigation practices such as furrows and channels using ground gravity (Fig. 2).

3.5.2. Livestock Diversification and Herd Composition Change

The findings indicated that goats were the dominant population in the herd, followed by camels. The numbers of cattle possessed were exceptionally small when compared with number of goats and camels. The respondents (72%) noticed that the explanation behind huge numbers of goats and camels was that camels and goats are tolerant to the effects of drought and can survive on browsing trees and bushes during feed shortage, while keeping large number of cattle was difficult since palatable forages have been lost due to frequent and prolonged droughts.

3.5.3. Livestock Mobility

The local households (90%) detailed that forages were temporally available and particularly the type of forages in the area were short-lived. Hence, before the forages disappear, the pastoralists would move their livestock on time and on the right place to use these short-lived forages.

3.5.4. Off-farm Activities

The findings showed that cash-for-work was the main off-farm activity practiced by 48% pastoral households in the Fentale district (Fig. 2). The cash-for-work programme which was offered by humanitarian assistance organisations gave temporary employment for the poor pastoralists. The second prevailing off-farm activity was charcoal and firewood selling. The other off-farm activities pursued by 23% of households were petty trading for, example, shopping, livestock and khat trading.

3.5.5. Decreasing Consumption, Remittance and Food Aid

Fifty-six percent of the households indicated that in response to food deficiencies, pastoralists reduce their number of meals per day (Fig. 2). As indicated by the local people, during the most exceedingly awful occasions of the year some adult households ate only one meal per day (41%), others two meals per day (54%) and very few adult households had three meals per day (5%). With respect to kids' food consumption, most kids (68%) had only two meals per day and 32% three meals per day. The households further indicated that during the drought, the pastoral households diminished the expenditure for clothing, social events and medication.

3.5.6. Livestock Selling

The findings showed that 82% of pastoralists were involved in livestock selling within the 12 months preceding the survey period. Livestock selling is normal in the study area so as to satisfy their requirements; however, most households had been compelled to sell their livestock during the drought periods as the necessity for food grains raised because of the decrease of milk and butter yields from their cows and camels.

3.6. Discussion

In the present study, the average family size (6.5) was generally higher than the national average family size. Such enormous family size in the area may be connected with the polygamy culture that is commonly practiced in Fentale district. Similar results were reported in the studies conducted in Afar region and Sidama zone, Ethiopia (Muluken et al., 2019; Hameso, 2015). Besides, the result indicated that 97% of households were in the range of 18 to 64 years old implying that they were in the productive age category. The result is similar with the studies conducted in Sidama zone, southern Ethiopia which indicated that 96% of farmers in their study area were in the productive age category (Davies et al., 2009). This study revealed that household's level of education was very low, 72.2% illiterates and 28.8% literates. This implies that the vulnerability of communities to climate variability and change in the study area was high as illiterate households are reluctant to adopt new adaptive technologies and have low employment opportunities on non-farm activities as compared to their counterparts. This result is supported by the studies conducted in Afar region and dry lands of Africa which indicated that education enhances household's resilience to climate-induced shocks and stresses (Muluken et al., 2019; Kebede and Adane, 2011). Furthermore, basic services such as access to credit, market, climate information and extension services in the study area was very poor which could decrease the adaptive capacity of households to climate induced shocks. This result is in line with a study conducted in Africa which revealed that poor access to basic services reduces the capacity of rural households to diversify their livelihood strategies in light of climate change induced shocks (Hassan and Nhemachena, 2008).

On the other hand, this study also looked into perception of pastoral households to climate variability and change which is paramount to local decision makers to introduce appropriate adaptation measures and enhance climate resilience of the local people (Maddison, 2006; Bisrat et al., 2017). Accordingly, 98% of pastoral households perceived that the rainfall has decreased; rainfall comes early/late and ceases short from the normal rainy season, while 95% of the respondents complained that the temperature has increased. Besides, the results showed that there have been frequent droughts in the study areas as complained by 100% of the respondents. The result is in line with the studies conducted in Borana, Southern Ethiopia; Southern and Central Tigray and in Quara district, Gonder, northern Ethiopia Nega et al., 2015; Mohammed et al., 2018). The perception of local people on *Belg* rainfall, temperature and frequency of drought was in line with the results of the observed data analysis. However, their perception on trends of *Kiremt* rainfall contradicted with the findings of meteorological data analysis. In the present study, the results of the meteorological data analysis indicated significant decreasing trend of *Belg* rainfall, increasing trend of *Kiremt* rainfall, significant increasing trend of seasonal and annual temperatures and occurrence of 1 extreme drought, 2 severe drought, 2 moderate droughts, 13 mild droughts for the period 1983–2017 (at $\alpha = 0.05$). Consequently, the significant declining trend of *Belg* rainfall allied with its irregular rainfall distribution and increased temperature trends could have an adverse impact on Fentale pastoralists as they are reliant on the seasonal availability of rainfall to access forage and water for their livestock. Similar studies were reported in Ethiopia and other eastern African countries (Bewket and Conway, 2007; Ellis, and Swift, 1988).

This study also identified perceived impacts of climate variability on pastoral households in Fentale district. Accordingly, majority of households (90%) experienced decreased number of livestock and

productivity associated with recurrent droughts and disease outbreaks. Comparable findings were reported in a study conducted in southern low lands of Ethiopia which revealed that rate of livestock reproduction and productivity have been declining from time to time in pastoral communities, due to the negative effects of climate related shocks, particularly drought (Amsalu and Adem, 2009). The local people (92%) further complained that the rangeland had become degraded and replaced by unpalatable species as a result of declining rainfall and recurrent droughts leading to scarcity of livestock feed. This result is in agreement with a study conducted in Fentale Pastoral Woreda of Oromia Regional State, Ethiopia which revealed that the increased magnitude of the drought negatively affected availability of palatable grasses and browse (Bekele, and Amsalu, 2012). The authors further revealed that productivity of arid and semi-arid rangelands of Ethiopia reduced and has failed to support the existing livestock. As reported by 90% of respondents, due to the drying up of watering points and feed scarcity, livestock have been becoming very emaciated and couldn't be sold at reasonable price. Hence, the price of livestock continued to decrease while the food grain price was increasing in the study area. Similar results were found which revealed that the price of livestock decreased by 50–60%, related with the drought of 2002, while the price of maize raised by about 235% (Davies, and Bennett, 2007).

Furthermore, this study assessed the main adaptation and coping strategies employed by the local pastoral households in the face of climate change and variability. Accordingly, the results indicated that mixed crop-livestock production, livestock diversification and herd change, mobility, off-farm activities, decreasing consumption, remittance and food aid and livestock selling were the main strategies adopted by the local people to adapt and cope with climate change induced shocks. The results are in line with the studies conducted in Borana region, southern Ethiopia and other horn of Africa (Habtamu, 2012; Mengistu, 2016).

This study implies that rainfall has been becoming more variable and *Belg* season rainfall showed a significant declined trend, drought frequency and temperature of the study area have been increasing indicating sustainability of pastoralism as livelihood for pastoral households in the study is becoming at greater risk. Hence, the local decision makers and other concerned partners should develop and introduce appropriate adaptive strategies to reduce the adverse effects associated with recurrent droughts, rainfall variability and increasing temperatures. The survey results indicated that mixed crop-livestock using small scale irrigation, herd mobility and livestock diversification were the main adaptation strategies adopted by the local pastoral households. Therefore, households should be provided with improved agricultural technologies such as a water pump for irrigation, and improved seed varieties with short growing periods and resistant to diseases. It is also paramount to support those households who adopted herd mobility as adaptation strategy such as reducing conflicts with neighboring ethnic groups (Afar and Somali ethnic groups) and improving peace among them. In this study, access to credit, market, education, extension services and climate information was very low. Hence, there is a need to improve these basic public services if pastoral households need to be climate resilient. Further study is required to explore constraints of adaptation strategies and factors that increases vulnerability of pastoral households to climate induced shocks.

4. Conclusion

This study confirmed that long-term reduced trend of *Belg* rainfall, recurrent droughts, rainfall variability and increased temperature along with household's poor access to basic services adversely affected pastoralists. Therefore, the local decision makers and other partners should develop appropriate adaptation strategy to climate change induced shocks such as enhancing and scale up of irrigation crop farming. There is a need to improve access to basic services if pastoralists need to be climate resilient.

List Of Abbreviations

CSA: Central Statistical Agency

FAO: Food and Agriculture Organisation

FWARDO: Fentale Woreda Agriculture and Rural Development Office

IPCC: Intergovernmental Panel on Climate Change

NMA: National Meteorological Agency

PCI: Precipitation Concentration Index

SPI: Standardized Precipitation Index

TLU: International Livestock Unit

UN-EUE: United Nations Emergencies Unit for Ethiopia

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

All data generated during analysed during this study are included in this article

Competing Interests

The Authors declare that they have no competing interests.

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Authors' Contributions

Muluken Mekuyie designed the data collection tools, undertook fieldwork and most of the analysis, and developed the manuscript. Desta Mulu participated on data collection and writing-up of findings and made editorial comments on the draft manuscript.

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Figures

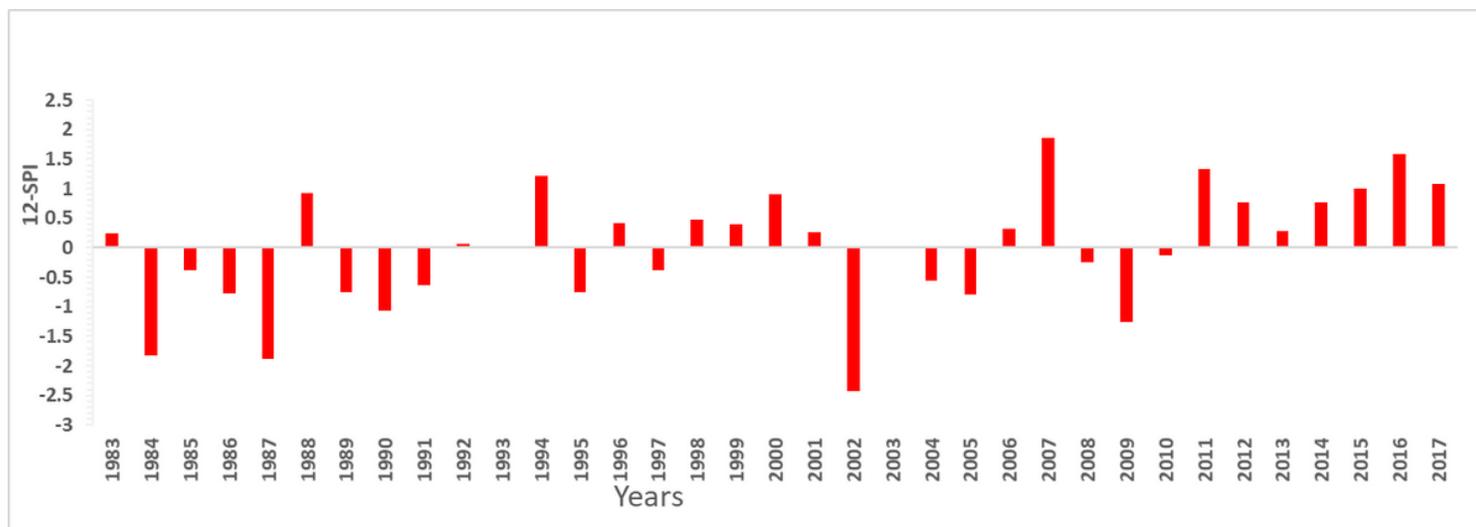


Figure 1

Twelve-months SPI in Fentale district for 1983-2017.

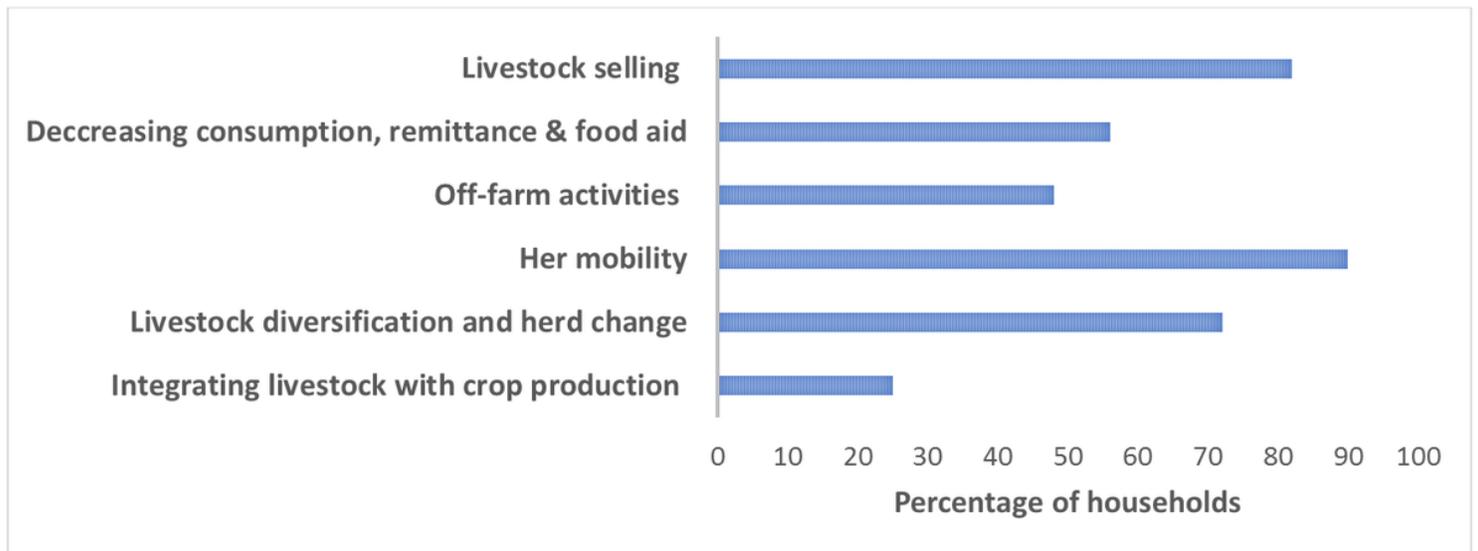


Figure 2

Adaptation/coping strategies employed by pastoral households in Fentale district.