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Local Community's Adaptive Strategies to Drought in the Sahel Zone of Burkina Faso

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Abstract

This study aims to analyze smallholder farmers' perceptions and responsiveness to climate disturbances in the Sahel region of Burkina Faso. The quantitative and qualitative research tools were used in this study including individual household survey and focus group discussions to collect the data from 133 household heads. The study respondents were randomly sampled by selecting 10-15% of the total households from five villages within three provinces in the Sahel region, namely Oudalan, Séno and Yagha. Descriptive statistics results showed that the main livelihood sources were crop and livestock farming reported by 59.4% of the respondents. Drought was reported as the major climate constraint affecting negatively local community livelihood according to 67.67% of respondents surveyed in this area. According to the individual survey, 63.91% and 39.10% of household heads indicated a severe effect of drought on crops and livestock respectively.

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The results of this research pointed out, smallholder farmer adaptive strategies to cope with long drought spells, as they modified their overall crop production system by adopting soil and water conservation techniques, the use of improved drought tolerant seeds, and applying fallow practices. For livestock, as adaptation strategy, it appeared that the pastoralists are smoothly shifting from livestock to crops or from cattle to small ruminants. So, local people perceived climate change has detrimental for their livelihood resources, and the impacts on their livelihood were reported by the study respondents. The study has recommended supportive measure that will pack together the best management of adaptation practices in the region as an integrated tool. As well, capacity building and sound policy and institutional support framework are key components that may likely help to deliver suited interventions measures to mitigate drought impacts on livelihood in the Sahel region.

Keywords: Climate Disturbances; Drought; Household's Perception; Adaptive strategies; Sahel.

1. Introduction

Extreme climate events are considered to be the most significant threat to crop and livestock farming system in Sub-Saharan African Region (SSA) as report by threat to crop and livestock farming [11,19]. In the SSA, Sahelian region is one of the most vulnerable areas to climate vagaries due to its acute aridity and fragile ecosystem.

The scientific community has agreed that climate change a real fact and human activities are its main causes. Many scientists pointed out that the change in climate is the result of combined effects from human activity and natural variability [7]. Most of the observed global temperature rising since the mid-20th century is due to the increase of anthropogenic greenhouse gasses (GHGs) concentrations in the atmosphere. However, farmers, fishers, and indigenous peoples who live close to nature for their survival are the most vulnerable to the effects of this climate stress.

Impacts of climate change could go beyond local people adaptive capacity causing loss of crops, and deaths livestock which are considered to be the basic livelihood resources for households. As reported by the [6], climate change is affecting Africa more than any other continent, and this is largely due to the fact that the region its livelihood system based on weather food and feed crops, and people have low adaptation capacity. Farmers in the region are already being forced to sell the livestock or abandon their crop farming system due to severe and recurrent droughts. Globally, climate change has significantly affected agriculture sector in the 21st century. In the Intergovernmental Panel on Climate Change (IPCC) assessment report, most of the countries will experience an increase in average temperature, more frequent heat waves, more stressed water resources, desertification, and periods of heavy precipitation [3]. These unpredictable events will affect crops cultivation and livestock production which are more sensitive to climate variability. According to [12], the analysis of local community vulnerability have evidenced that climate change will adversely affect millions of livelihoods around the world with.

Moreover, adverse climatic conditions can increase the plants being exposed to several stresses simultaneously such as drought and heat, salinity accumulation and nutrient deficiency or toxicities in different combinations of

abiotic and biotic stress [8]. In Burkina Faso, the country is landlocked with limited natural resources based to provide other sources of livelihoods and people have a very low level of adaptive capacity due to a higher incidence of poverty. Climate change is an abrupt hazard for vulnerable countries like Burkina Faso, with limited resources to cope with this change. However, the country's entire economy could be severely affected. The average range of loss in crop production was between US$577 and US$636 per household, per year [18]. The authors reported that an encountered high number of animals' mortality; the cost associated to these losses was estimated between US$1,922 and US$8,759 per herder in the region, in Northern Burkina Faso.

The country is highly dependent on the rainfed agriculture which is now facing a rapid climate negative impact. The northern part of the country, particularly Sahel region, is characterized by a shorter growing season, higher rainfall variability, and less diversified agriculture [15]. This has increased poverty and food insecurity has several unprecedented drought have occurred in the country. However, the agriculture sector in Burkina Faso contributes about 35% to the country's GDP and engages about 80% of the country workforce [10]. Climate disturbances have emerged as a key concern for vulnerable countries [16].

To assist local people, there is a real need to understand the existing adaptation strategies adopted by farmers and pastoralists, and local people perception in order to formulate a suited coping mechanism to climate impact. Smallholder farmers are the most important groups in Sahel region and the most vulnerable to climate disturbances. This group is highly exposed to climatic hazards as their options for diversifying their livelihood resources and income sources are very limited. Therefore, understanding their perception Vis-a Vis to climate change can be supportive to guide them on the choice of risk-reducing strategy.

Generally, there is a broad consensus in the scientific literature that the climate change impacts in the Sahel region are negatively affected local people livelihood causing poverty, water and food insecurity. Smallholder farmers' risk perception and risk responses are key to support to provide support on the type of intervention measures that would be considered across households and ecosystems [1]. Therefore, the main objective of the study is to analyze rural communities particularly smallholder farmers' perceptions and responsiveness on climate disturbances in the Sahel region of Burkina Faso. Such a research is needed which at least look at rural communities perception, impacts of climate change and adaptation strategies. For this study, five villages were selected within the three provinces in the Sahel region, namely Oudalan, Séno and Yagha. Important data were collected toward quantitative and qualitative research appraisal tools.

2. Methods

2.1 Research area

Burkina Faso is a landlocked country located in West Africa in a semi-arid area with a dry tropical climate. The country's area is about 274,200 square kilometers and geographically divided into 13 regions (**Figure 1**). The country population is estimated at 19 million inhabitants in 2016 with an annual average growth rate of 3.1% [10].

The study was carried out in the northern part of the Sahel Region of Burkina Faso located between the 13th and 15th degree parallels north. Extending over 34,766km^2, Sahel region comprises four provinces, namely Oudalan, Seno, Soum and Yagha. Dori, located in the Seno province, is the capital of the region and **Figure 2** shows a provincial map of the Sahel. Sahel is one of 13 administrative regions of Burkina Faso created in 2001. In term of area, this region represents around 13% of the country size. The [9] estimated the region population at 1.2 million inhabitants in 2014.

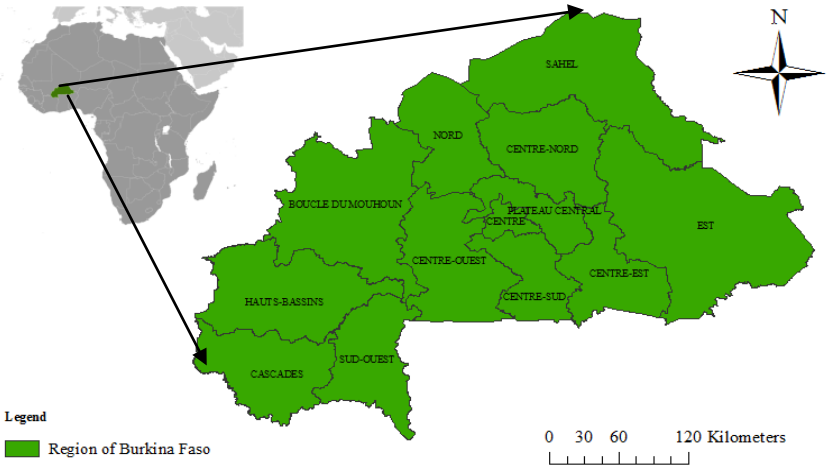

Figure 1: Map of Burkina Faso showing the country location and regional subdivision

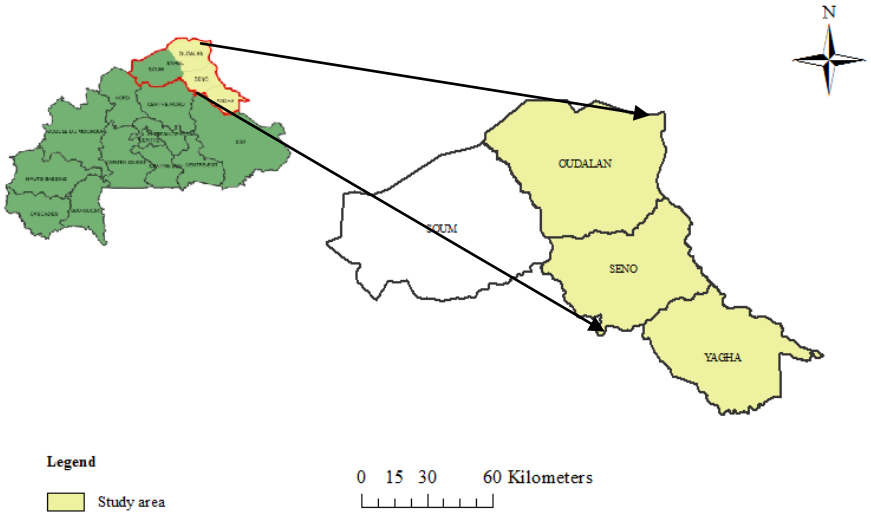

Figure 2: Provincial map of the Sahel Region of Burkina Faso

2.2 Sampling and data collection

The agro-pastoralist households were the main target population in the five selected villages (Bagawa, Oursi, Sambonaye, Djomga and Titabé). Cluster sampling method was used to select a total of 133 households, randomly sampled and representing 10-15% of total household. **Table 1** shows the sampled households from each village surveyed between September and December 2013. As well, an additional group discussion was held

on January 2014.

Table 1: Household Surveyed in Sahel at Northern Burkina Faso

Province	Village	Number of Households	Respondent
Oudalan	Bagawa	179	25
	Oursi	161	24
Seno	Sambonaye	129	20
	Djomga	117	18
Yagha	Titabé	450	46
Total			133

2.3 Statistical Analyses

Various statistical analysis were applied in the study including frequencies, means and the standard deviation. The data from qualitative survey such as focus group discussion were clustered by key words to retrieve information to describe household heads characteristics, main livelihood sources, people perception on climate disturbances and identify the adopted adaptive measures in the study areas.

3. Results and Discussions

3.1 Household characteristics

The results of this study were based on a sample of 133 households from Bagawa, Oursi, Sambonaye, Djomga and Titabé villages within the Sahel region. **Table 2** provides an overview of the household socio-demographic characteristics in terms of gender, education level, ethnic groups and religion. In this survey all respondents were household heads and the median value distributed by sex shows that 93.98% were headed by men and 6.02% by women. The majority of respondents (91.73%) were illiterate while 6.77% and 1.50% have reached primary and secondary school respectively.

In fact, the sampled respondents' education level remains very low. However, the education level is very important in the development of adaptation strategies to extremes climate events challenges in the region. Two main ethnic groups were identified in the sample and the most important group was “Peulh” representing around 66.92% of the respondents followed by “Bellah” (33.08%). The religious affiliation was homogenous in the surveyed area, with Islam (97.74%) found as the most dominant religion in the Sahel of Burkina Faso followed

by Christianity (2.26%).

Table 2: Socio-Demographic Characteristics

Characteristic	Sample (N=133)	
	Frequency	Percentage (%)
Gender		
Female	8	6.02
Male	122	93.98
Education level		
Illiterate	122	91.73
Primary school	9	6.77
Secondary school	2	1.5
Ethnic groups		
Peulh	89	66.92
Bella	44	33.08
Religion		
Christian	3	2.26
Muslim	130	97.74

Table 3 shows that the overall mean age for the household head was 50 years old ranged between 20 and 97 years old with a significant difference between respondents. In addition, the average number of people per household was 12 which suggested that most of the families were larger sized in the study area. According to [2], a family with a big number of members can be an extra pressure on smallholder farmer's with limited resources and this can put household in high vulnerable to climatic and environmental hazards.

3.2 Livelihood Sources

The results from individual households' survey show that their livelihoods were mostly from climate sensitive

sectors, highly exposed to slow-onset stressors and drought events in all of the villages surveyed. Agro-pastoralism was an integrated farming system aiming to capitalize on the complementarity between crop and livestock productions in order to diversify and increase farmers' livelihoods and resilience to climate stress. While agro-pastoralists depend mainly on extensive breeding for rural small farmer's livelihoods, they also were greatly engaged in crop production for food security. About 60% percent of the respondents practice crop production, and are involved in various types of breeding (**Figure 3**).

Table 3: Household Head Age and Household Size

Characteristic	Observation (n)	Mean	Std. Dev.
Age	133	49.78195	11.96924
Household size	133	11.65414	6.595505

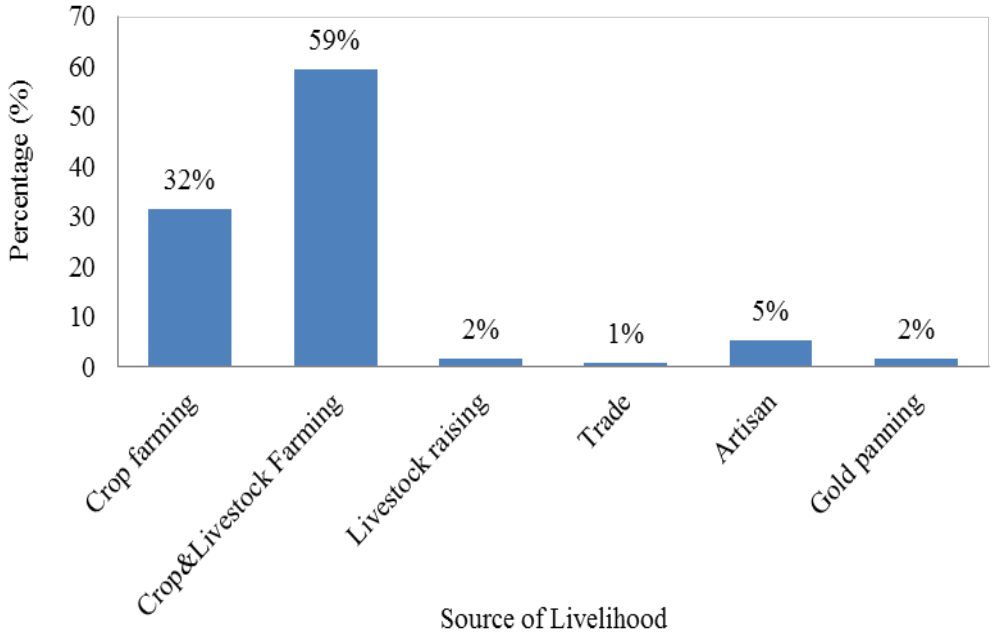

Figure 3: Main Sources of Livelihood within Sahel Region, Northern Burkina Faso

Household's livelihoods are mainly based on crop and livestock farming. In the Seno province, crop cultivation and livestock together represent 73.3% of the respondents' occupancy, while 17.8% of respondents were artisans (**Figure 4**). In Oudalan province, the majority of the respondents were smallholder farmer with 64.3% for crop and 31% for livestock. The proportions of the respondents for crop (41.3%) and livestock (45.7%) farming were almost balanced in Yagha province and about 13% of household heads were artisans. It appeared in these three provinces second income generating activities such as trade, gold panning for this local community at the small scale.

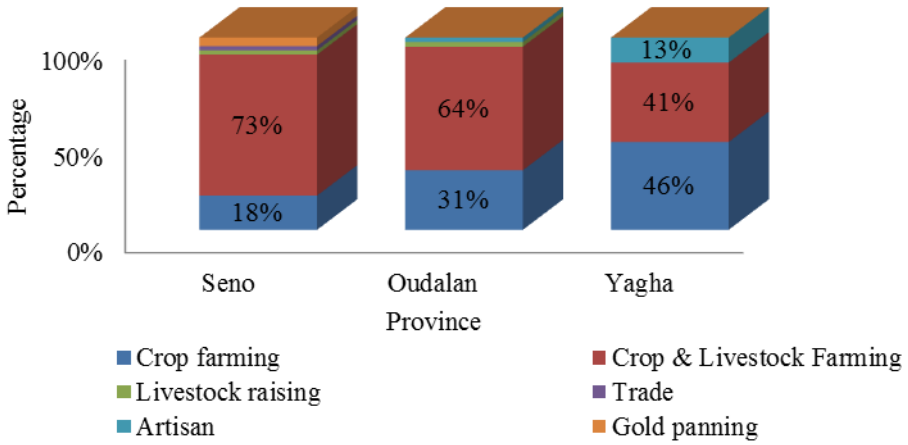

Figure 4: Main Livelihood Sources within Provinces in Sahel, Northern Burkina Faso

The Focus Group Discussions (FGDs) are in perfect agreement with the individual surveys results. The FGDs were organized with the communities in each village surveyed with the entire group, and then separate discussions were held with men, women, youth, and elder following a series of questions and exchanges. It comes out clearly in the survey that crop farming and livestock are main sources of livelihood for households in all these communities. However, the interview with young people and women has shown some little discrepancy. As an illustration at Sambonay, the main sources of livelihood for youths are gold panning and trade of cattle, goat and sheep, while for women, their livelihood is from the sale of livestock products such as milk. Women are also involved in the trade of gold that provides them an additional source of income, particularly in the dry season. In Bagawa, the main sources of household livelihoods are crop farming and livestock. At Titabé, the majority of the youth are artisans

3.3 Farming Practices

Crop and land

Crop production is the main activity of people living in the Sahel area of Burkina Faso. Based on household heads responses, the main staple crops in the region are millet, sorghum, and maize (**Figure 5**). Most of Sahel rural households appear engaged in subsistence agriculture dominated by small farmland between two and three hectares (**Table 4**)

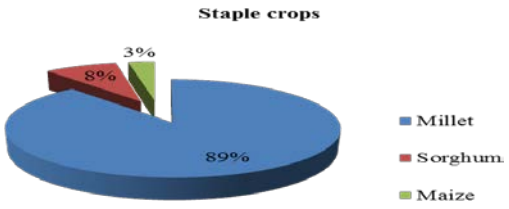

Figure 5: Staple Crops in the Sahel Region of Burkina Faso

Table 4: Farming Land in the Sahel Region of Burkina Faso

N = 133 Land (ha)	Sum	Mean	Std. Deviation
Land cultivated in 2013	370.55	2.7861	2.53094
Land cultivated last 10 years	429.85	3.2320	8.51035

The vast majority of households have possession of land from heritage (74%) for various uses. **Table 5** summarized the household land and farm status, and perception in the past 10 years regarding on their agricultural production. It was noted from that lands are essentially used for agricultural, livestock, and fallow. The decrease in production is due to the low precipitation, its variability, and the infertility of land, for the one hand, and the pockets of drought and pests attack (locust, birds) have caused production losses, on the other hand.

Table 5: Land and Crop Cultivation in the Sahel of Burkina Faso

Land and Farm	N = 133	
	Freq.	Percent
Access to land		
Heritage	98	73.68
Purchase	15	11.28
Loan	16	12.03
Other	4	3.01
Crop production purpose		
Sale	1	0.75
Household consumption	131	98.50
Sale and auto consumption	1	0.75
Crop production compared to last 10 years		
Increased	36	27.1
Remain the same	13	9.8
Decreased	78	58.6
Don't know	6	4.5

Livestock

In the study, surveyed households have an average of 8 cows, 12 goats and 6 sheep, 10 chickens and 1 pig (**Table 6**). The main purpose of livestock farming in Sahel is primarily for sale. However, it is also used occasionally for domestic consumption, and animal traction and ceremonial purposes such as weddings and baptisms. About an average income of 354,000 CFA (708 USD) per household is estimated to derive from the sale of their livestock in the past 12 months [17].

Table 6: Summary Statistics of Herd Size in the Sahel of Burkina Faso

Variable	Mean	Std. Dev.
Cattle	7.977	13.853
Goat	11.556	22.665
Sheep	6.007	9.3253
Pig	0.052	0.6069
Poultry	10.120	14.765

3.4 Household's Major Constraints

A number of studies have underscored the importance of farmers' perceptions of climate change in choosing to adapt [4]. Change in rainfall patterns over the last 20 years has obviously caused long drought spells in the Sahel at the northern region of Burkina Faso. Drought was a critical environmental factor which initiates water stress in crops and a major constraint on plant growth and livestock productivity perceived by 67.67% of respondents surveyed in this area (**Table 7**).

Table 7: Major Constraints on Household Livelihood

Major Constraints	(N = 133)		
	Freq.	Percent (%)	Cum.
Drought	90	67.67	67.67
Desertification	10	7.52	75.19
Flood	4	3.01	78.20
Soil Fertility	7	5.26	83.46
Erosion	3	2.26	85.71
Diseases	19	14.29	100.00

3.5 Household Vulnerability to Drought

Drought stresses represent the most limiting factors for agricultural productivity because of their detrimental effects on plant growth and livestock. It affects people ability, increase the incidences of the weather events [13]. From the focus group discussions it emerged that most households at risk are those who are involved more in crops and livestock farming with a huge number of herds. It was mentioned that agro-pastoralist households that reside in the region's arid and semi-arid zone are one of the groups strongly affected by droughts [9].

The FGD showed that households with their activities based solely on livestock are at high risk of vulnerability. It was also noted that the category of farmers who neglect the application of best agricultural practices such as mineral fertilizers, and water and soil conservation or livestock destocking may be more affected by drought and any change in rainfall pattern. From the viewpoint of the communities, they all are vulnerable, and women group believed to be the most exposed since men always abandon the house for migration.

Analysis from women perspectives indicated that this vulnerability affects to the same degree all gender, but each category plays a different role in mitigating the impacts of climate stressors. Some of the roles played by young people are to look for other sources of income, and they often migrate to gold panning sites, and some men go in transhumance, and women stay in the house to take care of the children. Yet the discussion with young people revealed that the most vulnerable households of the changes in precipitation and extreme drought are also elderly families with lower income levels for the simple reason of limited capabilities of movement when compared to young men. A large number of household heads think that men are the most affected. This could be justified by the fact that Fulani women are not involved in agricultural activities.

Crops and Livestock: The household perception about the drought effects on their livelihoods in the last ten years has been confirmed by qualitative variables from the focus group. According to the different groups, the late onset, early cessation and scarcity of rainfall have been factors that affect at a different level crop (staple crops) and livestock (milk, eggs, etc.) with a negative effect on the food prices.

The negative impact of drought spells in the household economy has been reflected on several sectors. According to the individual survey, 63.91% and 39.10% of household heads indicated a severe effect of drought on crops and livestock respectively (**Figure 6**). The negative impacts have direct consequences on the decline in yields and productivity, thereby resulting in a grain deficit and recurring famine. This has also caused nutritional needs deficiency of animals, and their maintenance.

Food prices: Analytical results from the study revealed that the long drought spells have negatively affected household economics.

The effect on food prices was felt by the households as very severe. However, 90.98% of the household heads were negatively affected by an increase in food prices due to drought. Basically, the rarity of food commodities and products drive up the food prices, and this is mostly due to the farming low yield and productivity is driven by a decrease in rainfall amounts, and unevenly variability. More recent study has emphasized risk related to drought and the importance of smallholder farmer’s perceptions in process of decision makers to motivate adaptation decisions [5].

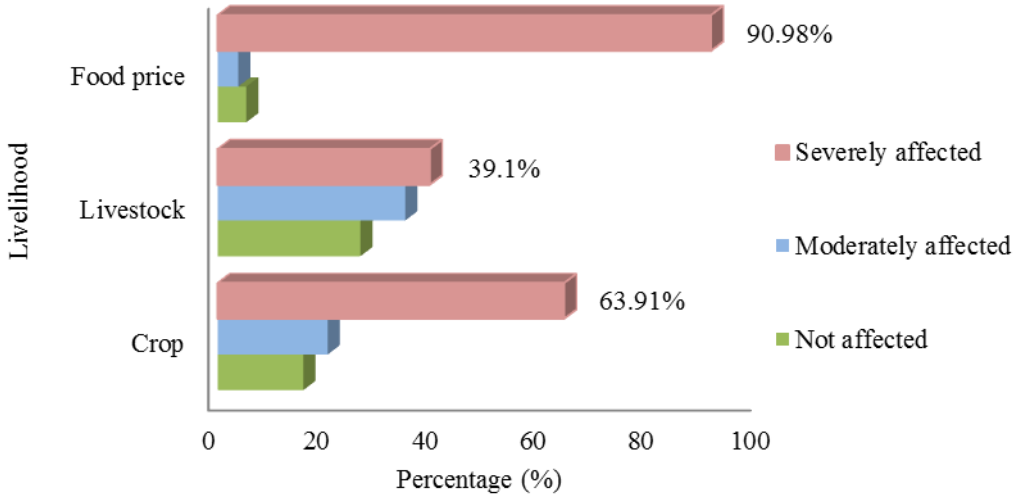

Figure 6: Negative Effects of Drought on Farmers' Livelihoods in Sahel Region, Northern Part of Burkina Faso

3.6 Adaptive Measures

Crop Farming Practices Adopted

There are many adaptive strategies options for the households to cope with threats posed by climate change such as increasing system resilience, diversification, and risk management [17]. **Figure 7a** indicates that household heads modified their overall production system in 2013 compared to last ten years to adapt to the shock of change in rainfall causing long drought spells, adopting:

- To attend training on SWC technics (50.38%);
- To use improved seeds (48.87%);
- To apply mulching (33.8%) and fallow (24.8%) practices;
- To have access to weather information (18.8%);
- To use compost (15.8%) and groundwater (11.3%);

Livestock Farming Practices Adopted

A majority of households in the Sahel area pursue a number of adaptation strategies to adapt to the adverse impacts of drought. From the focus group discussion, it appeared that the pastoralists are smoothly shifting from livestock to crops or from cattle to small ruminants i.e. raising goats.

In this area, there are now more people raising goats, and according to them, goats can resist better to rainwater shortage, and climate vagaries. The individual survey has revealed that the pastoralists in this area did not adopt new practices to cope with the vagaries of drought compared to last ten (**Figure 7b**).

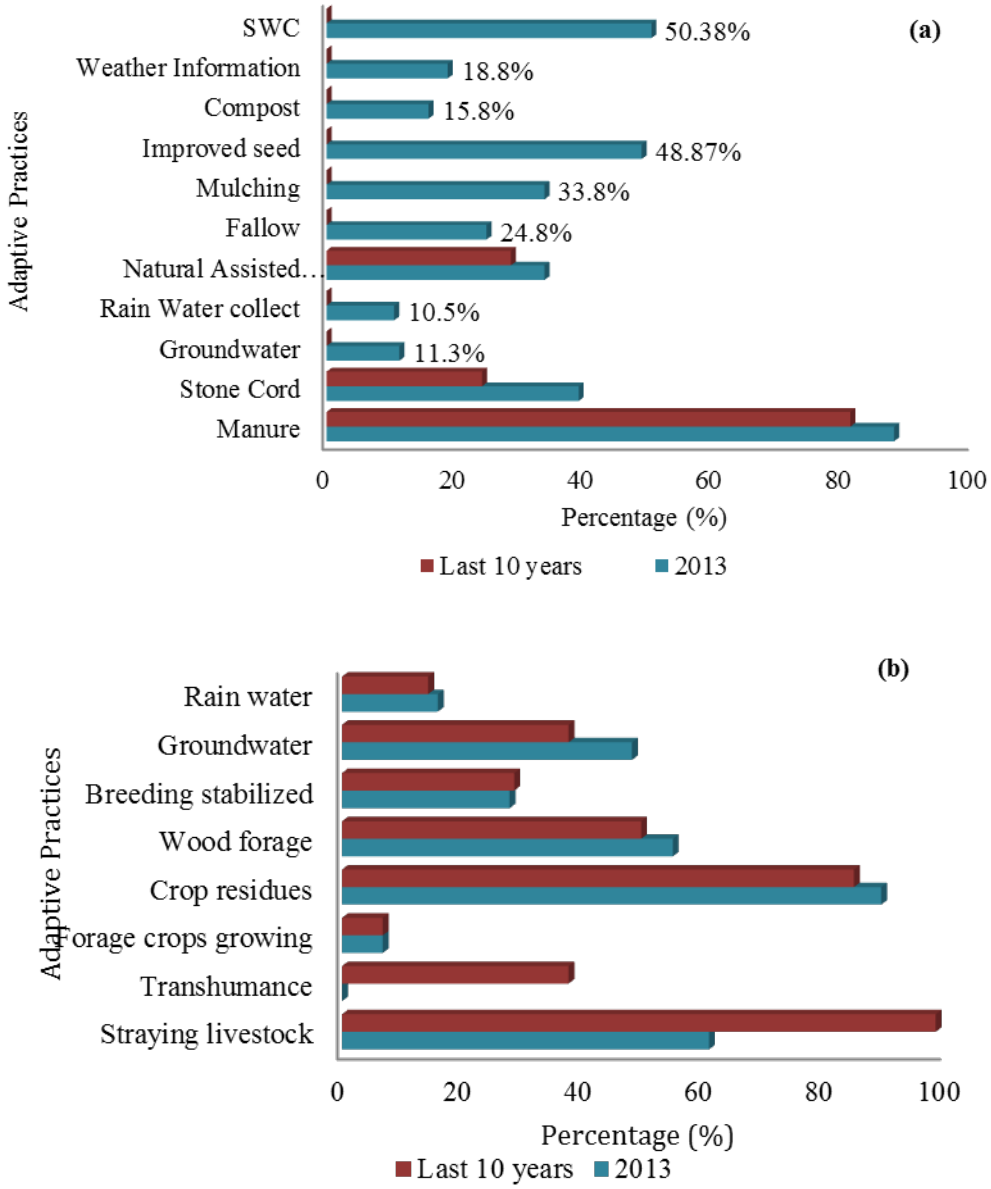

Figure 7: Adopted Measures in Crops production (a) and in Livestock System (b) in the Sahel Region, Northern Burkina Faso

4. Conclusion

Climatic conditions have undergone profound changes in the Sahel, and drought particularly affected local community livelihoods. It's appeared in the descriptive analysis that, drought was a major constraining weather stressor which have severely affected the majority of farmer's livelihoods in the study area. Negative impacts of drought on crops and livestock farming have direct consequences on food prices and cause a recurring famine for this rural community. Livelihood adaptation to drought is a continuous process built on the socio-economic circumstances and adaptive capacity of the local community. The results of this research pointed out, smallholder farmer low capacity to adapt long drought spells impact. In turn, they modified their overall crop production system toward some attempts with soil and water conservation techniques, use of drought tolerance

improved seeds or applying fallow farming practices. It also appeared that the pastoralists are smoothly shifting from livestock to crops or from cattle to small ruminants.

Climate disturbance, especially drought impact was very high and significant on the local community, they have no much adaptation options, and they existing practices have showed their limit. Further, the study suggests a supportive program or measure that will pack together best management of adaptation practices in the region as an integrated tool. Such tool if implemented toward capacity building and sound policy and institutional support framework, may likely be able to deliver suited interventions to mitigate drought impacts on livelihood. The study also recommended the following interventions measures as adaptations strategies:

- Promote agricultural water management best practices in the region and increase investment for rural water infrastructures development
- Support both crop and livestock farming system in the Sahel region
- Emphasizing on the thematic capacity building of local communities
- Support climate adaptation program for the most vulnerable people including women and youth
- Fill the information gap by supporting further research to understand relationships and interferences between climate variables and local communities' perception and characteristics in order to pave the way for robust actions in Sahel.

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