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Perceptions, Impacts of Climate Change and Adaptation Practices Among Four Socio-professional Groups in Western Burkina Faso

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Summary

The main objective of this study is to identify the perceptions, impacts and practices of four socio professional groups at the western part of Burkina Faso. Specifically, it aims to list the key events of the last thirty years ; to characterize the perceptions of producers ; to identify the main adaptation practices. For this purpose, interviews were conducted in ten villages. The interview investigation focused on the objectives of the study. The interviews involved 180 producers, including 82 farmers, 37 livestock breeders, 31 market gardeners, 30 agricultural therapists and 64 sellers of agroforestry products. The data collected on significant events were processed with ArcGIS 10.3. The statistical processing of the data was done with R software version 4.1.3 (2022-03-10) ; perceptions were subjected to the Chi-square test of homogeneity to assess the variations in of responses using the chisq test function. The severity indices of Smith *and his colleagues* (2001) were calculated for each shock perceived by the producers. The results indicate five main events : the disruption of precipitation over 36.7% of the study period ; temperature (23.33%) ; biodiversity decline (20%) ; upsurges of violent winds (16.67%) and parasitic invasions (13.33%).

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For the perceptions, seven main ones were identified, the most severe characterized by low severity indices are rainfall disturbances (1.00) ; Seasonal disturbances (1.23) ; Parasitic attacks (1.47). A inventory of 31 adaptation practices corresponding to 35 impacts in the five socio-professional groups was established. These endogenous and modern practices require technical support for producers.

Keywords: Climate change ; Socio-professional group ; Perceptions ; Impact ; Adaptation.

1. Introduction

Sub-Saharan African countries and the Sahelian zones are most vulnerable to climate change and the phenomenon do not seem to stop [1,2]. An extreme temperature event that occurred once every 10 years in the 1990s, will now be observed four times every 10 years with +1.5°C of warming and 9 to 10 times with +4°C of warming [3]. Climate change poses a serious threat to the viability of households, especially rural ones. Ecosystems are increasingly being undermined by the adverse effects of climate change. Droughts impact soil quality and reduce agro-silvopastoral production [4,5]. In Burkina Faso, the National Adaptation Program of Action (PANA) to climate variability and change identified three most vulnerable provinces according to the sectors most impacted and the corresponding adaptation practices [6]. Numerous studies have examined farmers' perceptions and adaptations to climate change [7,8]. However each locality remains specific, taking into account socio-economic factors and anthropic actions on natural resources. Investigations on climate change are incomplete when all the socio-professional sectors and the different climatic zones are not covered. Most of the investigations did not take this aspect into account. Local populations are in risk of food insecurity and increasing poverty because of their low capacity to adapt to climate change. Studies combining the climate change aspects, perception, environmental impacts and endogenous adaptation strategies are required in different areas of the country for a good understanding of how rural communities in these areas are coping with the adverse consequences of climate variability and change. The hypotheses are that the actors in these sectors perceive climate change in terms of the impacts, the adaptation strategies developed are linked to their sectors. That is why, meaningful actions must be taken in a locality in the field of climate change taking into account the main socio-professional groups. Thus, the main objective of this work is to identify perceptions, impacts and adaptation practices of farmers, livestock breeders, market gardeners and traditional practitioners in the Houet province. The specific objectives are to characterize the main climatic events of the last 30 years ; to identify farmers' perceptions of climate change according to socio-professional groups ; to characterize effective and efficient adaptation practices.

2. Materials and Methods

2.1. Study site

The study was conducted in ten villages (Leguema, Farakoba, Dinderesso, Nasso, Samagan, Banakeledaga, Matourkou, Dafinso, Logofourousso and Pala) in the Houet province at the High Basin Region, wertern Burkina Faso (Figure 1). This province is located in the southern Sudanian phytogeographic sector of Burkina Faso [9] with the geographic coordinates of 11°19'60"N latitude and 4°14'60"W longitude. All of these villages are

located within 25 km radius of Bobo-Dioulasso city, the economic capital and second largest city in the country. The populations of these villages are composed mainly by indigenous people of Bobo ethnicity and migrants of Mossi ethnicity, Peulh and others. The main activities are : agriculture, livestock, exploitation of forest and wildlife resources forestry eco-tourism, handicrafts and small-scale commerce. Bobo Dioulasso city, where these villages are located, is the second most populated commune of the country with 983,552 inhabitants [10].

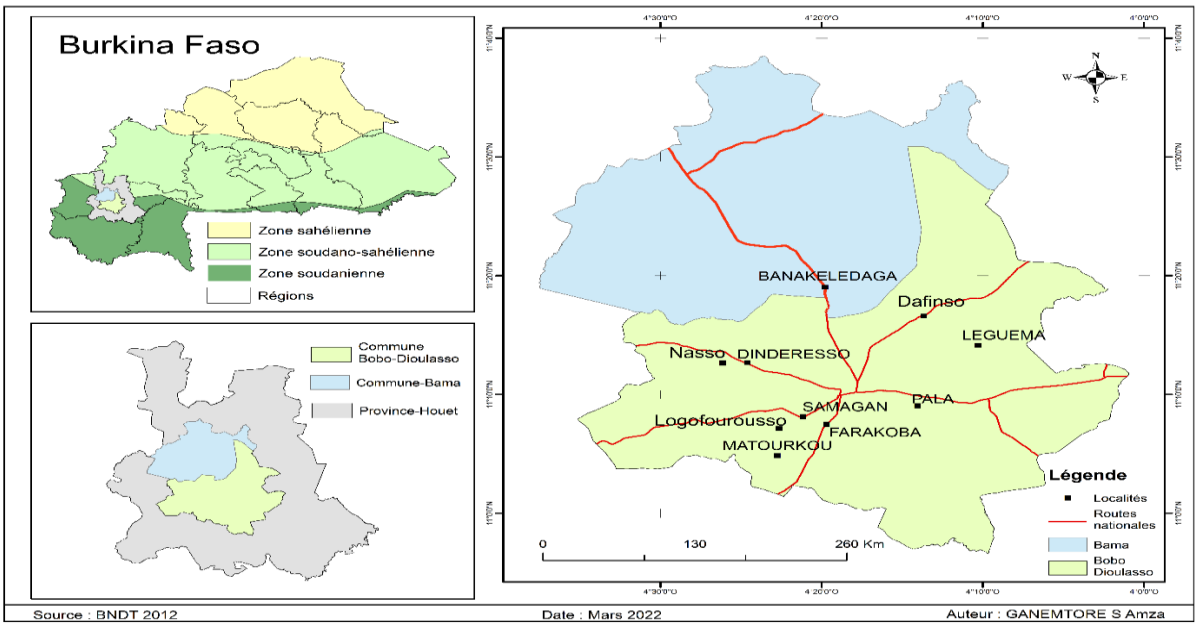

Figure 1: Location of study villages

Houet province is marked by two main seasons, a wet season that extends from April to October and a dry season that extends from November to March. The average annual temperatures vary between 24°C (minimum) and 31°C (maximum). The High Basins region is one of the most rainy regions of the country with an average rainfall of 1142.91 mm over a ten-year period (Figure 2). We note the existence of shrub savannahs, wooded savannahs, open forests, gallery forests and riparian formations [9,11]. The soils of the region are tropical ferruginous type with acidic pH = 5.5 to 6.5 and texture sandy-silty to sandy-clay sandy clay with active leaching of nutrients. They have a good concentration of exchangeable bases and a low phosphorus content [12,13].

2.2. Data Collection

Individual interviews were conducted with producers in the ten villages. These villages were chosen based on accessibility, the presence of the four main socio-professional groups such as farmers, herders, traditional healers and market gardeners. Another criterion is the location of these villages around the city of Bobo-Dioulasso. In the north, we have Dafinso and Banakeledaga ; in the west, Nasso and Dinderesso ; in the south, Matourkou and Farakoba ; at the east Pala and Leguema ; and at the southwest Samagan and Logofourousso. The total size of the sample surveyed was 180 producers, divided into 45% farmers, 21% herders, 16% market gardeners and 16% traditional herders.

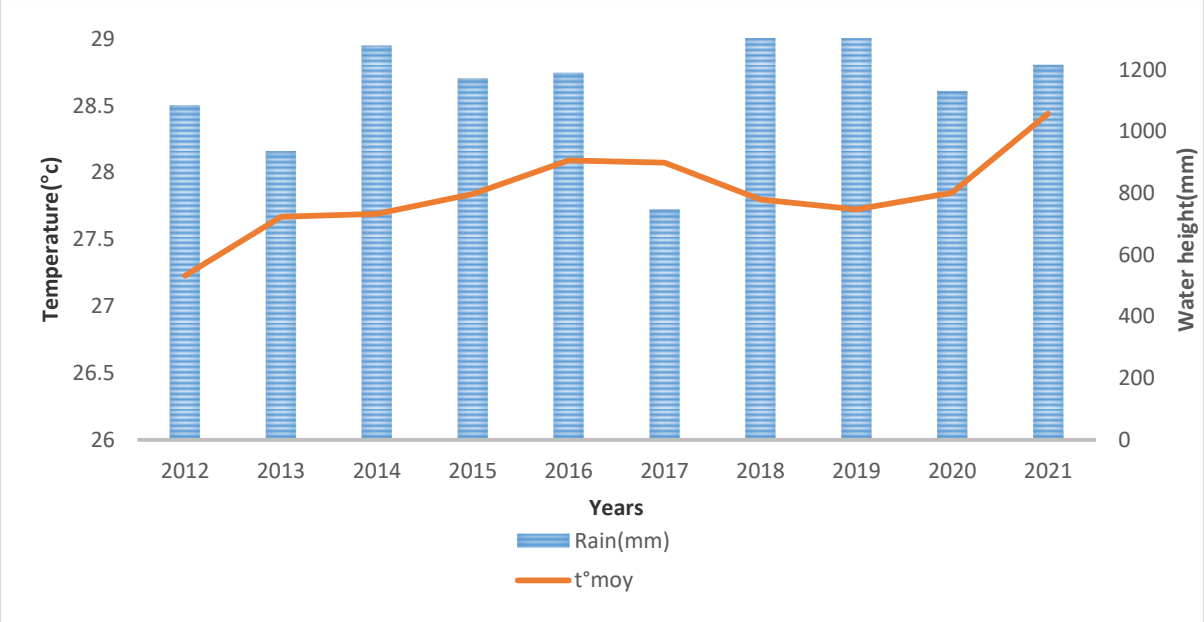

Figure 2: Average rainfall and average temperature of the High Basins region.

Source : Direction of Aviation and Meteorology 2022.

It should be noted that farmers include managers of agroforestry parks and nurserymen. The questionnaire focused on periods of the main events that have marked the environment in which the producers live the impacts experienced by each socio-professional group and their adaptation strategies.

2.3. Data processing

Climate change milestone data were mapped using ArcGIS 10.3 software. Perceptions of climate change by socio-professional groups data were first subjected to the Shapiro test to verify their normality. Then the Chi-square test of homogeneity was performed for the variation in responses using the chisq.test function of the RVAideMemoire package [14]. The significance level was 5%. The differences observed between the variables are assessed according to the following cases : $p \geq 0.05$: differences are not significant ; $p < 0.05$: differences are significant ; $0.001 < p < 0.05$: differences are highly significant ; $p \leq 0.001$: differences are very highly significant. The statistical processing data was done with R software version 4.1.3. The Severity indices according to [15] were calculated to characterize perceptions identified by the four socio-professional classes. The severity (S) characterizes the intensity of the climate shock/event experienced by the local populations. In other words it is the measure of the harm experienced by each shock. It is calculated by applying the following formula : $Sj=1+[(r-1)/(n-1)]$. (1)

Sj=severity index ; r=rank of the threat by order of the participants ; n=total number of threats listed by participants. The severity value is between 1 and 2, $1 \leq S \leq 2$. A low value of S reflects a high severity while a high value of S indicates a low severity of the evil experienced.

In addition, in each socio-professional group, the impact retained for this study is the major impact recognized

by at least 55% of the producers in the group and which is related to the seven perceptions. Thus, seven major impacts were selected for each group.

3. Results

3.1. Key Events

The examination of the Figure 3 reveals the following main events experienced in the last thirty years related in descending order of importance :

-Precipitation disruptions : these covered 11 years or 36.7% of the study period. These disturbances were perceived through high and low rainfall, of irregularities and poor distribution of rainfall, flooding, high frequency of weather events of meteorological events ;

-to the disturbances of temperatures during 23, 33% of the period of study : they were manifested during the hot days and nights, cold nights and days. During these years, the cold periods were sometimes prolonged. Producers noted rapid drying up of land and water retention ;

-the regression of biodiversity over 20% of the period studied : this is one of the main facts indirectly linked to the climate, but strongly felt by the producers who noted strong plant and animal mortality as well as species extinction ;

-to frequent and violent winds during 16.67% of the last 30 years : these winds with increased frequency nowadays are loaded with aerosols polluting the environment and causing numerous health problems ;

-parasitic attacks on 13.33% of the investigation period : they are summarized in proliferation of insects and parasites damage on the crops, animals, plant animal pathologies and the use of pesticides.

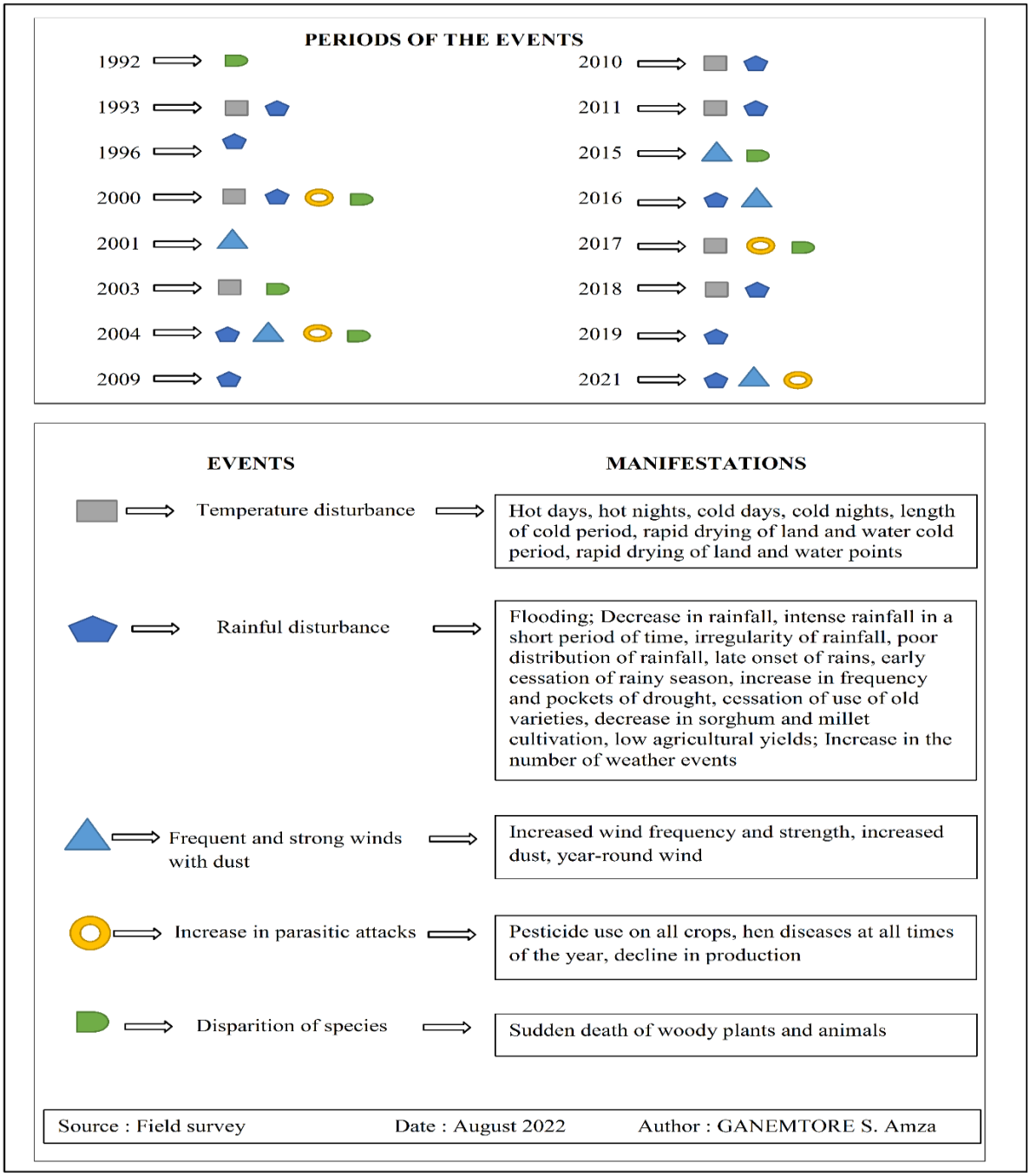

Figure 3: Events in the study site from 1992-2021

3.2. Perceptions of climate change by socio-professional groups

3.2.1. Perceptions by socio-professional groups

The results presented in Table 1 reveal that producers perceive climate change in different ways. Each stakeholder group is unanimous that climate change is perceptible through rainfall disturbances. While according to the socio-professional groups, perceptions are different through increases in temperatures, seasonal changes, increased pest attacks, increased wind speeds of violent winds, mortality of woody plants and the

frequency of climatic events. Indeed, the proportions of each group are different from each other.

On the one hand, the analyses of variance (Cki2 test) show that the differences are not significant between socio-professional groups (P>0.05). Farmers, herders, traditional healers, market gardeners, and vendors were unanimous that the seven perceptions are real and important. On the other hand there are significant differences between the perceptions. This means that in the socio-professional groups the ranking order of the seven perceptions would not be the same. This is why :

-Among farmers : Disruption of rainfall >Disruption of seasons>Recrease in violent winds ;

-For the herders : Disruption of rainfall >Disruption of seasons> Increased temperatures ;

-for Traditional healers : Rainfall disruption >Seasonal disruption Seasonal changes>Recrease in violent winds ;

-market gardeners : Disruption of rainfall > Increase of violent winds easonal disturbances

Table 1: Perceptions of climate change by socio-professional groups

Group Perception	**Farmers**	**Breeders**	**Traditional healers**	**Vegetable farmers**	**Salesmen**	
Rainfall Disruption	**100**	**100**	**100**	**100**	100	χ^2 = 0, df = 4, P = 1
Temperature rises	79,64	89,77	64,1	80,65	80	χ^2 = 4.3383, df = 4, P = 0,36
seasons disruption	**91**,02	**90**,91	**94**,87	82,26	90	χ^2= 0.94994, df = 4, P = 0,92
Parasitic attacks increasing	74,25	81,82	66,67	80,65	85	χ^2= 2.736, df = 4, P = 0,60
High winds recurrence	**83**,83	**84**,09	**94**,87	**83**,87	82,5	χ^2= 1.2079, df = 4, P = 0,88
Woody plants mortality	56,29	48,86	66,67	69,35	51,25	χ^2= 5.7254, df = 4, P = 0,22
Climatic events frequency	67,07	64,77	87,18	72,58	60	χ^2= 6.2178, df = 4, P = 0,18
	χ^2= 16.352, df = 6, **P = 0,012**	χ^2= 17.946, df = 6, **P = 0,006**	χ^2= 22.943, df = 6, **P = 0,000**	χ^2= 7.0926, df = 6, **P = 0,31**	χ^2= 22.192, df = 6, **P = 0,001**	

3.2.2. The severity of the shocks experienced

The results presented in Table 2 specify the shocks experienced and their intensities. The disruptions in precipitation remain the most damaging factor overall to climate change. It is unanimously recognized by all professional groups as having the most important shock measure. While at the levels of temperature disruptions, it is mainly temperature increases that have threatened the survival of local populations the most.

For the producers, parasitic attacks are an obstacle to agriculture, livestock breeding, the availability of products used by traditional healers, the availability of products used by traditional healers and market garden production. This has repercussions on the agro-sylvo-pastoral products sold by the populations.

Table 2: Perceived event severity indices by socio professional groups

N^{O}	Event	Farmers	Breeders	Traditherapists	Vegetable farmers	Salesmen	Medium severity
01	Disruption of rainfall	1,00	1,00	1,00	1,00	1,00	**1,00**
02	Disruption of the seasons	1,17	1,17	1,17	1,33	1,33	**1,23**
03	Pest attacks	1,33	1,67	1,33	1,17	1,67	**1,43**
04	Recurrence of high winds	1,67	1,33	2,00	1,67	1,17	**1,57**
05	Temperature rises	1,67	1,67	1,67	1,67	1,67	**1,67**
06	Frequent climatic events	1,83	1,83	1,67	1,83	2,00	**1,83**
07	Mortality of woody species	2,00	2,00	1,83	2,00	1,83	**1,93**

3.3. Climate change impacts by socio-professional groups

The impacts presented in Table 3 are related to the seven perceptions. They can be grouped into the following main points :

- For farmers, the impacts are related to changes in activity schedules, poor plant development and health, and food insecurity ;

-For livestock breeders, it is a question of repercussions on the availability of fodder and water for the animals, health, animal mortality and the quality of production ;

-For traditional practitioners, the impacts are the rarefaction or even disappearance of medicinal species, resulting in the regression of medicinal species, hence the regression of the ligneous diversity. There is also a decline in the quality of PFNL used in the medicinal care and exploitation of immature fruits ;

-among herders, the impacts are the scarcity or even disappearance of medicinal species, hence the need for traditional practitioners, the impacts are the rarefaction or even disappearance of medicinal species, hence the regression of ligneous diversity. We also note a decrease in the quality of PFNL used in the care and the

exploitation of immature fruits has also declined ;

Table 3: Impacts of climate change on socio-professional groups

	Impacts according to socio-occupational categories				
Perceptions	**Farmers**	**Breeders**	**Traditherapists**	**Vegetable farmers**	**Salesmen**
Disruption of precipitation	Disruption of the agricultural calendar (96%)	Low forage availability (97,29%)	Rarity of medicinal species (93,33%)	Producer debt (100%)	Low availability of agro-sylvo-pastoral products (90,62%)
Temperature rises	Drying and yellowing of plants (90,24%)	High animal mortality (100%)	Decline in NTFP production (93,33%)	Reduced product diversity (food insecurity) (96,77%)	Rapid deterioration of sales revenues (100%)
Disruption of the seasons	Staggered seeding periods (97,56%)	Early drying of watering points (91,97%)	Decline in NTFP quality (93,33%)	Disruptions in the work schedule (96,77%)	Staggering of sales periods (96,87%)
Frequent climatic events	Food insecurity (98,78%)	Weight loss of animals (100%)	Fall of immature fruits (96,66%)	Frequent destruction of plants (96,77%)	Reduced sales frequency and quantity (92,18%)
Pest attacks	Proliferation of pest organisms (95,2%)	Animal diseases (97,29%)	Low availability of medicinal species (93,33%)	Poor quality of market garden produce (food insecurity) (100%)	Reduction of the number of clients (82,81%)
Recurrence of high winds	Frequent destruction of plants (93,90 %)	Increase in animal disease (97,29%)	Destruction of plants of all ages (96,66%)	Loss of production (100%)	Low availability and poor quality of products (98,43%)
Mortality of woody species	Progressive disappearance of biodiversity (77%)	Low availability of woody fodder (75,67%)	Progressive disappearance of biodiversity (100%)	Poverty of producers (100%)	Low availability of NTFPs (98,43%)

-In the case of market gardeners, there is an indebtedness of the producers and losses of production that result from the disruption of the calendar. The disruption of the work schedule and the influence of climate change factors perceived by the producers. The quality of market garden products is poor. The quality of market garden products is questioned ;

-For sellers of agroforestry products, climate change has repercussions on sales periods, which are often shifted, and the quality of the products. In fact, the repercussion common to all socio-professional groups is the shift in

work calendars. The impact of climate change on sales periods, which are often shifted, and on the quality of products is common to all socio-professional groups.

3.4. Climate change adaptation practices

Figure 4 presents 31 adaptation practices according to the impacts experienced by the socio professional groups.

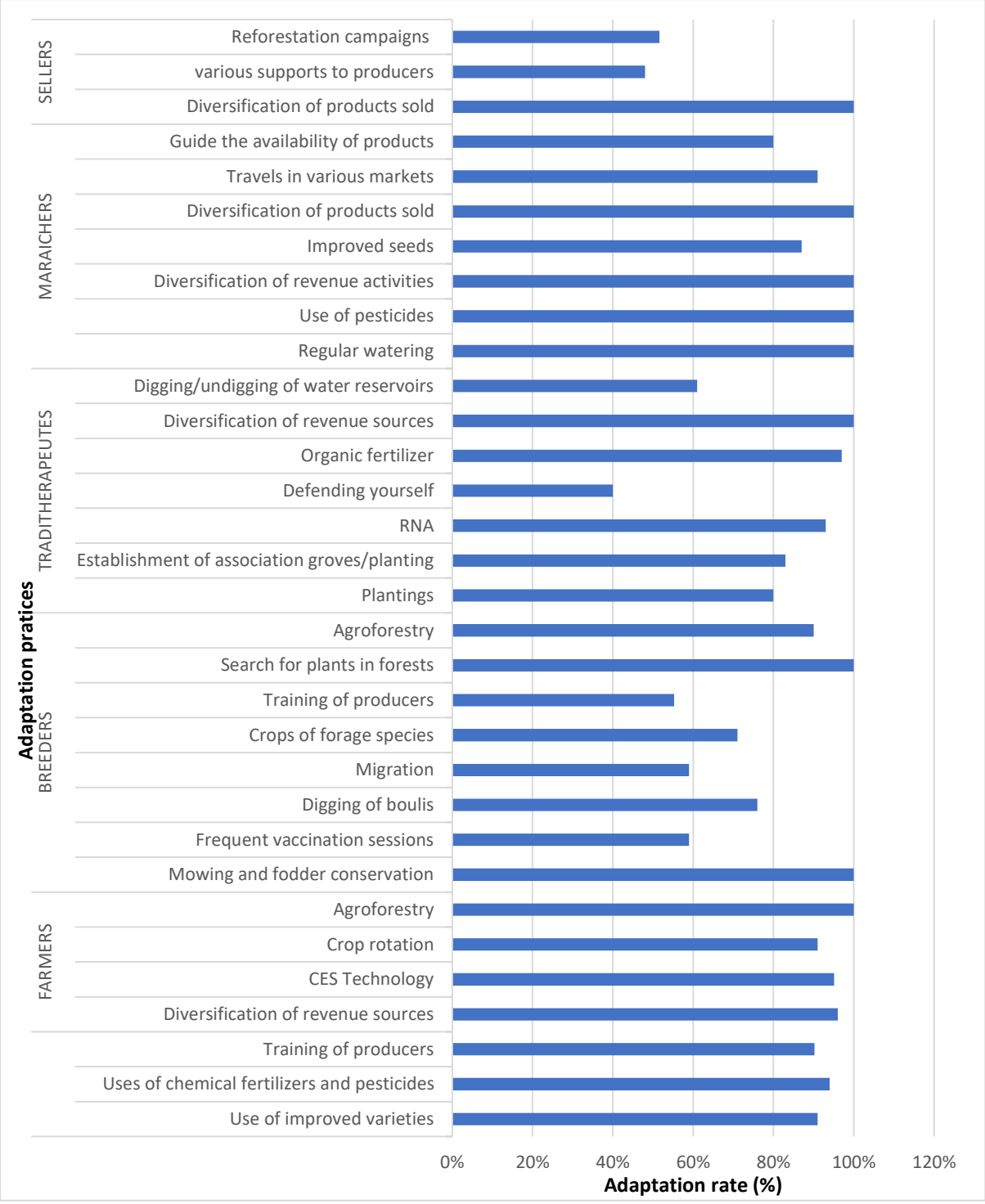

Figure 4: Climate change adaptation practices among socio professional groups

These practices consist in strengthening the initial practiced activities by producer or extending the activities to others that could be profitable. Thus, we note a diversification of activities among farmers (90%), market gardeners (100%) and agro-sylvo-pastoral products sellers (100%). Agroforestry, through its many practices is seen as a solution to the negative effects of climate change (Figure 5) in almost all occupational groups. Woody and herbaceous fodder species cultivation, reforestation with multipurpose species are done in agroforestry systems. Among the practices identified are those that aim to remedy water or rainfall problems : farmers use CES techniques (95%) and improved varieties (91%), while among herders, the adoption rate of boulis (Figure 6) is 76% and migration in search of water and fodder (Figure 7) is 59%. The market gardeners are also involved in the digging and desilting of water reservoirs. In addition to this, there are practices against soil degradation. The latter has an impact on agricultural production, the availability of fodder resources for food and animal health, woody biodiversity and agro-silvicultural products in general.

Figure 5: Agroforestry park to stop erosionPark

Figure 6: Bouli for livestock

Figure 7: Crop residues used as forage

4. Discussion

4.1. Events related to climate change and their intensities

The results of this work show that over the last thirty years (1992-2021) extreme events have marked the western part of Burkina Faso. Climate change is one of the explanatory factors of the phenomena experienced. Studies have shown that over the past 35 years, climate change had repercussions in the country's activities sectors. Indeed, the framework for analysis of climate services in Burkina Faso [16] reports that dry years 1991-1992, 1997-1998 and 2003-2004 were recorded in Burkina Faso but also wet years in 1988, 1992, 2006, 2007, 2010 with negative socio-economic impacts. Dreaded floods occurred in September 2009 and in 2020. The one of September 2009 was due to climate change, urbanization and sanitation. According to [17] increasing urbanization, the reduction of natural spaces lead to a strong concentration of stormwater and an increase in peak flows to be evacuated by the peak flows to be evacuated by the sewerage systems. This results in an increase in frequency and severity of flooding in urban areas ; climate change being the major cause of being the major cause of heavy rainfall. In 2020, floods covered 13 regions of Burkina Faso [18,19]. This is why the therefore the climatic parameters on which experts have focused in the development of the NAPA are rainfall, temperature, wind, sunshine, humidity evapotranspiration, the beginning, end and length of rains and their attendant risks which are droughts, floods, violent winds, disruption of seasonal cycles, heat waves, cold heat or cold waves [6]. Climate change is a reality that must be faced with the contribution of local populations who know how to perceive and predict it, in their own way.

4.2 Examination of the perceptions and impacts of climate change

Producers' perceptions of climate change through rainfall disruptions, temperature increases, seasonal temperature increases, seasonal disruptions, locust and pest invasions, increased wind and parasitic invasions, the resurgence of violent winds, the regression of wood diversity are all or some of these confirmed by previous work [8]. The social classes are unanimous in their perceptions of climate change, but the shocks experienced have very different intensities, which makes a special characteristic of a locality. The disruption of rainfall is more intense so that producers are surprised by short seasons, violent rains that deteriorate the quality of the crops, and soil by water erosion in place of fine rainfall lasts several hours [20,8,21]. Logically seasonal disruptions are a logical continuation of those of rainfall. This is why, they are recognized as the second most severe perception. But in some cases the precipitation disturbances may not be pronounced enough to change the season. That is why the producers distinguish them. Most of them have noticed the drop of the cereal yields. The sudden cessation of rainfall prevents the crops from completing their cycle. Similarly, the sequences of dryness during the grain filling phase affect significantly the yields [22,23]. Regarding to locust and parasitic attacks, the researches of [24] revealed that the risks of climate change in Houet province include these attacks. Comparative studies at the provinces of Tuy and Houet revealed strong farmer perceptions of high winds on plant resources at the Houet province [24]. Also producers note the severity of temperature increases compared to temperature. The analysis of impacts revealed that shifts in work schedules are common to the socio-professional sectors. It can also be noted that the problems related to water resources and temperatures can be seen as the root of the impacts cited. The non-availability of products and pathologies in the different sectors are

favored by water shortages. The impacts range from disruption of work to disruptions to production decreases and the impoverishment of producers [6]. Thus various adaptation strategies are adopted.

4.3. Adaptation to climate change in the sectors of activity

Climate change is a catalyzer for the deterioration of conditions and means of agroforestry production [5]. While it is possible that producers may perceive the same factor as a source of adverse effects of climate change, the impacts of this factor are different according to the sector of activity, as it is with the strategies for adaptation. Thus, in order to adapt to the negative effects of climate change, producers have many strategies and practices. The best known are the adoption of CES/DRS techniques, the irrigation, the possession of manure pits and varietal adaptation [25,8]. In each socio-professional group, it is imperative to identify adaptation practices and priority actions to be taken [6,26,27,28]. By analysing the different practices, it is possible to classify them into several themes according to the problem to be solved. We distinguish between practices those who aim to restore soil for agricultural, forestry and market gardening production and practices for solving problems related to water resources ; the decreases of plant and animal productivity. Rainfall disturbances are major cause of all negative effects that affect all agro-sylvo-pastoral production. Therefore, among the adaptation practices, we have the CES techniques, the digging of boulis and other water reservoirs, and the removal of sand from water points. From increasingly to cope with the shortened rainy seasons, improved varieties of millet, sorghum, maize and vegetable seeds are being adopted by producers, whereas they have been a long time neglected by producers and which are now a way to face the challenges of food insecurity and climate change [29, 30,31]. There are many endogenous practices that are more or less mastered by local populations and that are increasingly climate change [32]. On the other hand, the adoption of improved or modern practices requires trainings and supervision of the producer activities for the best quality of the practices in each locality. So it is necessary to identify the best practices. In each locality, it would be appropriate to studied replicability techniques by examining financial conditions for their implementation, as well as the sustainability and labor requirements.

5. Conclusion

The objective of this study was achieved by identifying perceptions, impacts and adaptation practices of farmers, herders, market gardeners, and sellers of agro-sylvo-pastoral products in Houet province. Socio-professional categories influence climate change perceptions, adoption and adaptation practices. The main strategies are CES techniques adoption, agroforestry, off-season crops, boulis construction, composting, and especially varietal adaptation. The profitability of a strategy can be measured by its effectiveness in adapting producers to climate change. There is a need to strengthen the adaptation and resilience capacities of agricultural producers in the study area through capacity building within farmers groups. In each locality, the work should aim to cover an exhaustive list of socio-occupational groups in other professional groups in order to identify effective adaptation practices among which we have the financial reach producers and to ensure technology transfer at the regional and national levels.

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