ID: 278

Rangeland degradation, its perceived impacts and adaptive mechanisms by pastoralists and government in Tahoua State of Niger Republic

Moumouni Ousseini, Baba M, Soumane Idrissa, Inusa S.K, Keiba Dar, Idrissa Allassane

Bayero University, Kano (BUK), Centre of Dryland Agriculture (CDA), PMB: 3011. Garzo Road Kano Nigeria

Abstract

This study points out the drought characteristics and responses, pastoralists and Government as well as partners employed continuously to minimize the effect of recurrent drought events on the livelihood of herders in Tahoua region of Niger Republic. Multiple data sources, including socioeconomic activities interviews with 225 households, group discussions and informal interviews with pastoralists were used to gather the aspects of drought and adaptive mechanisms and coping practices. Standardized precipitation index derived from long-term rainfall data obtained from National Direction of Meteorological service distributed across the pastoral zone was used to appreciate different degrees of drought intensity between 1988 and 2018. Results revealed the alternance of near normal, wet and drought events with 77.4% prevalence of drought events. The socio-economic survey revealed that 97.3% and 95.6% of the respondents were male and of Tuareg tribe respectively. All respondents resided in the area for than 30 years and 86.7% never attended western education. The main occupations of 40.1, 37.8 and 20.9% of respondents were livestock rearing, crop farming, and agro pastoral activities respectively. Nomadic, Agro-pastoral and Transhumant were the dominant livestock production systems. The highlighted drivers of rangeland degradation were recurrent draught, rainfall deficit and rising in temperature, overgrazing, tree clearing and abusive fodder collection, frequent fire outbreak and endemic shortage biomass production. Rangeland degradation indicators based on pastoralists knowledge enumerated include decrease in tree density and firewood, in plants species and wildlife, frequent forage shortage and increase barren land and water ponds. These droughts negatively impacted the livelihoods of pastoralist. The impacts include reduction the productivity of animal, calving rate, milking frequency, increase susceptibly of animals to disease and mortalities, reduction in the price in the markets and conflicts over the resources utilization. To adapt or cope with climatic hazards, households used a variety of adaptive mechanisms and strategies. The strategies adopted vary according to the rate of forage and water deficit. In Normal year characterized by good availability of forage and water, pastoralists undergo intra-departmental mobility, strategic culling off weak and unproductive animals at time their prices on market are good to gather money for buying natural forages, crop residues, concentrate and satisfy family needs. In moderate years, Nomadic and transhumant (59.6%) carried out inter departmental mobility, supplemented their animal during the dry season (36.4%) coupled with strategic culling off and buying of forages. Mobility, buying of forage, supplementation, and strategic destocking strategies were respectively realized by 1.3%, 41.8%, 30.2% and 26.7% of the sample in high forage shortage. The actions conducted by government and partners to assist pastoralists were free vaccination of animals, Supply of concentrates at moderate price and activities such as Firewall construction, Soil and water conservation, and seed broadcasting in the form of cash for work, cash for food and cash transfer**.**

Keywords: *Pastoralist, Mobility, Strategy, Coping, Destocking, Drought*

Introduction

Niger Republic is a landlocked country located in the Sahel, an arid and semi-arid area having large grazing areas of about 60 million hectares (Dieter Geesing & Hassane Djibo, 2006). The population inhabiting the area depend mostly on extensive livestock farming (Gerber *et al.*, 2010). Pastoralism and agro-pastoralism being an important component of livelihood, are the main livestock production systems (Jeannette & Markos, 2012), procuring income for the rural population (Kaufmann *et al.*, 2019).

The livestock species raised are local breeds of cattle, small ruminants, camels and donkey, well adapted to the arid environment to sustain livelihood strategies (Martin *et al.*, 2016). The livestock farming systems are highly dependent on the exploitation of natural pastural resources (pasture, fodder, forest products and water), which are directly affected by climate variability and change (Djoudi *et al.*, 2011). Climate change and extreme temperature impacts severely livestock farming of the area (Rivera & Rosen 2012). It is well established that warming destabilizes precipitation patterns which consequently disturb the primary biomass production, filling of water reservoirs, while unpredictable increasing water availability impacts livestock productivity and influences animal mobility. (Valentine Debray; Adeline Derkimba & Katia Roesch, 2015). This phenomenon leads to overgrazing which together with the northward extension of agriculture because of high land demographic pressures and the adoption of sedentary lifestyles by pastoralists provoke rangeland degradation (Snorek, 2016). The rainfall pattern

and availability govern the spatial distribution and availability of pasture as water is essential to sustain the animal's productivity (Tiruneh & Tegene, 2018). Climatic factors (temperature and precipitation) and the frequency and prolonged droughts directly affected livestock yields due to their effects on feed availability, feed quality, weed, pest and disease incidence (Rivera & Rosen, 2012). In addition, successive years of extreme drought decimate herds and prevent their reconstitution (Rivera& Rosen, 2012). Rainfall variability, increased dryness and prolonged drought, with regional variability, are recurrent phenomena since the 1970 (Adamou, Rabani; Ibrahim, Boubacar; Bonkaney, Abdou Latif; Seyni, Abdoul Aziz & Idrissa, 2021). The seven major droughts occurred during 1910-1916, 1941-1945, 1968, 1971-1974, 1984, 1987,1989, 2004, 2009, 2011 and 2012 (Fewsnet, 2011) and have adversely impacted the agricultural and livestock production. The 2009-2010 severe drought reduced animal population by 24.04% (Abdou, Issa & Hassane, 2011).

Over many years, pastoralist have been able through inter-seasonal mobility to meet the demand of pasture and water essential to maintain the animals in good production level and preserve their livestock assets. However, the traditional pastoral coping strategies of preserving livelihood have been adversely affected by the global environmental changes (Linstädter *et al*., 2016). The most important changes are those related to increasingly scarce and unsecure forage resources.

In recent decades, rainfall deficits and recurrent fodder shortages resulting for drought combined with the high demographic pressure of pastoral land impacted livestock productions systems in Niger republic (Laouali *et al.*, 2018). Drought is a frequent phenomenon in the arid and semi-arid area, which farmers and livestock owner are dealing with over many centuries. Drought chock is one of the most slow-onset and devastating phenomena characterized by extreme moisture deficits that normally disrupt rural livelihoods.(Ndlovu, 2019). But its frequency and occurrence need adjustment of coping strategies. Coping signifies the room to adjust, ability to absorb, accommodate and recover from drought impacts (Smith *et al.* 2000; Thomas & Twyman 2005; Ndlovu, 2019).

Much research has focused on the importance and consequences of climate change and land-use change on forage availability during rainy season (Ferner *et al*., 2018; Guuroh *et al*., 2018) but little is known on the adaptive mechanism developed by herders during high frequency of drought conditions.

The present study therefore seeks to understand the pastoralists' perception of rangeland degradation, its causes and consequences. It also tries to identify the indigenous coping mechanisms developed as well as the resilient strategies utilized by governments and its partners to strengthen local strategies and to minimize recurrent forage shortages experienced by pastoralists.

Materials And Methods

The study will be conducted in the region of Tahoua, Republic of Niger which covers 113371 km^2 and is located between parallel 13°42'and latitude 18°30' N and meridians 3°53' and longitude 6°42' E. The State is divided into three agro-ecological zones : saharo-sahelien or pastoral zone covering the northern and center of the local government of Abalak with an average annual rainfall ranging from 150 to 300 mm in the north; Western dune and Eastern plain zone occupying the southern Abalak, Northern Keita and Illela, western Tahoua and north-Eastern Bouza local government receiving an annual rainfall of 300 to 350 mm and lastly the Ader- Doutchi-Maggia and Tarka Valley zone in the southern part of Tahoua State having and an average annual rainfall of 350 to 450 mm. The mean annual temperature is 30°C with a maximum of 47°C in April and a minimum of 15°C in December-January (Conseil Regional de Development 2016-2020).

Four types of vegetations are encountered in the zone and include the woody steppe composed mainly of epinous tree species; some palms and euphorbiaceous trees; shrubs steppe with some annual grass plants; herbaceous steppe with some vivacious grasses and absence of vegetation in extreme north of the state.

According to the results of the General Census of Agriculture and Livestock of 2007, three husbandry systems are practiced in the State: the sedentary or agropastoral system (52.11%), nomadic (31.07%) and transhumant system (16.82%). The animal population is mainly composed of cattle (2, 868,016), sheep (2,762,002), goats (3,220,409), camels (553,817), horses (30,689) and donkeys (484,217) (Ministère de l'Elevage et des Industries Animales, MEIA, 2018). Tahoua State has 11,021,214 million hectares of grazing land composed of 7,950,800 million hectares pastoral land located in the north, enclaves (35,023 ha) and fallow (3,035,391 ha) situated in the agricultural zone in the south (MEIA, 2018).

The main crops grown in the region include cereals (millet and sorghum) and leguminous crops (cowpea, groundnut, sesame, Bambara nuts). In the dry season crops (wheat, sweet potato, cowpea, sesame, onion, cabbage, carrot, pepper, tomatoes are cultivated in the valley and around Swamps and irrigated areas (Conseil Regional de Development, 2016-2020).

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

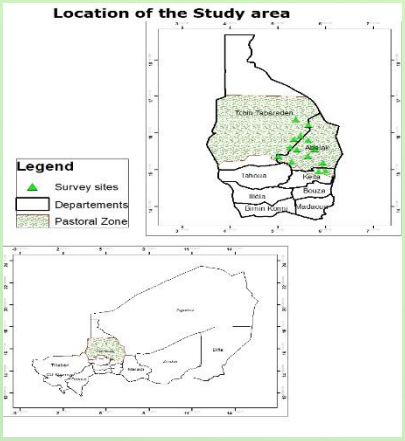

Figure 1. Map of Tahoua Region Showing Department, Pastoral Zone and Survey localities

The research surveyed 225 household distributed in 7 communes located in three main departments across the pastoral zone of Tahoua. Questionnaires were administered and collected from 225-household selected across the pastoral area. This gave the study a response rate of 100 percent. According to Amin (2005), if the response rate is greater or equal to 70 percent, the data can be analyzed. The methodology for determining the pastoralist's perception of the rangeland degradation, its impacts and coping strategies includes a survey and a drought analysis using meteorological chronological data series. The survey methodologies include a series of steps which are:

Step1: Construction of a sampling frame: the sampling frame is made from the national repertoire of localities (Renaloc) of the last general census of habitat and population of 2012 (Renaloc Institut National de la Statitistics INS, 2012). Since our target is the pastoral and agro-pastoral households, the primary units were constituted respectively by the water points (PE) and the encampments (CPT) where these populations are concentrated. The methodological approach to get this population include two exclusion criteria which are: (i) Exclusion of localities such as agglomerations, administrative villages, temporary settlement of crop farmers and (ii) exclusion of localities whose household size is less than 15 households.

Step 2: Determination of households to be interviewed**.** A systematic random sampling technique is used to select 225 households for interview using the probability proportional to size formula developed by Katori (2004) as follow:

$$n = \frac{Z^2 * P * Q * N}{e^2(N-1) + Z^2 * P * Q}$$

where n is the sample size, Z is the desired Z (1.96) value giving the desired degree of confidence, p 95% is an estimate of the population, Q is 1-p and e is the absolute size of the error in estimating p that we will be willing to permit and N the of households.

In this study the p value of 0.5 because a proportion of 0.5 is statistically adequate. The study used 95% level of confidence. Therefore, P-value z value is 1.96 (two tailed) and with an allowable error of 0.05 that is e = 5%.

Step 3: Fifteen (15) localities were sampled proportionally to the size in the first degree and the second degree in each locality of the households were randomly selected. The challenge is to be able to spatially represent the sample.

Step4: A structured questionnaire of four sections is prepared. Section A captured socioeconomic information of the respondents and the livestock species kept while sections B, C and D gathered information on the impact of rangeland degradation and perceptions of pastoralists regarding rangeland resources degradation; the adaptive strategies of the stakeholders and efforts by government in alleviating the effects of drought on the livelihood of animal owners in order to make them more resilient.The questionnaire include both open-ended and closed ended questions. The open-ended questions gave the respondents opportunity for self-expression, experiences and opinions. Section D, is addressed to the regional permanent secretary of the national team of early warning systems and the animal husbandry director of Tahoua.

Step 5: Five trained enumerators were selected to assist in the administration of the questionnaires. The selection is based on their knowledge of livestock management, local languages and experience in conducting this type of survey. The investigators were selected from the livestock workers at village and local government levels involved in the survey.

The survey is conducted during the month of February to March before the transhumance starts their downward movement to the south for the exploitation of crops residues.

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

Long-Term Observed Precipitation Data

The rainfall data used in the present study were obtained from the National Directorate of meteorology of Niamey. Ninety-nine (99) rainfall gauge stations distributed over the study zone and having available long-term and continuous record of rainfall data for the period under study were used. The precipitation datasets include observations over 15 decades from 1988-2018 and are considered enough to respond to the criteria of 30 years minimum continuous data required for a valid climate statistical analysis (World Meteorological Organization 2009). The Standardized Precipitation Index (SPI) was developed McKee, Doesken, and Kleist in 1993 for estimating wet or dry condition based on precipitation variables. The SPI has been used widely over the world (Australia (Abawi *et al*., 2003), Mexico (Giddings *et al.,* 2005), Kenya's Huho & Mugalavai 2010, Opiyo *et al.,* 2015), India by (Subash & Ram Mohan 2011) to examine drought severity. The SPI calculation is followed by its classification base of the standard classification accepted worldwide.

Data Analysis

After the survey, the households gathered information were coded, verified, corrected and processed using SPSS and Microsoft Excel 2013. Inconsistencies detected were corrected after verification with the investigators or in the field. Once the data have been cleared, they were first documented in Excel and transferred to SPSS software for analysis using descriptive statistics. Regarding the Drought analysis, the Standardized Precipitation Index (SPI) was to analyses the wetness and drought condition of study area over the last thirty years. The SPI were calculated using the total annual rainfall recorded by 99 stations during the 5 months (May to September) corresponding to the length of the rainy season for the period extending from 1988(May-September) to 2018 (May-September). Negative values are considered to represent Dry period and positive values a wet periods while 0 value is considered as normal year.

The SPI is computed by dividing the difference between normalized seasonal precipitation and its long-term seasonal mean by the standard deviation as follows:

$$SPI = \frac{Xij - Xim}{\sigma}$$

where $\boldsymbol{\sigma}$ is the standard deviation, x_{ij} is seasonal precipitation at the ith synoptic station, x_{im} is long term seasonal mean precipitation. Meteorological drought was said to have occurred when the SPI value was negative and ended when the value became positive. Droughts were categorized as mild when the SPI value ranged from 0 to -0.99; moderate with a value from -1.0 to -1.49; severe when the value ranged from -1.5 to -1.99; and extreme when the value ranged from -2.00 and below. The near normal mean precipitation is when SPI was zero (0 to 0.99, the moderately wet ranged from 1 to 1.49, the severely wet with values from 1.5 to 1.99 and the extremely wet ranged from 2 and above.

Results

Socio-Demographic Characteristics Of Respondents

The results presented in Table 1 showed that the age of the respondents range from 40 to 85 years and above. The average respondent age was 57.2 ± 7.2 years. Sixty-seven per cent of them were in the 52-62 age category while 15.1% belonged to the 63-73 age category. On the other hand, 14.7% were aged 41-51 years and 4% were aged 85-95 years. The categories with the least number of respondents were that of those aged 74 -84 years and 40 years with respectively 1 and 2% of the respondents. The findings revealed that the sampled population is suitable to recall the events observed that might cause the change in the rangeland and to give the coping strategies adopted to tackle or minimize the effects on the livelihood and the wellbeing of the animals. Secondly, the study also showed that elders were found to be family heads and owning properties in the pastoral community, as most of them push to maintain family livelihood, since those that would support them could have been away on Government service and education.

The results presented in Table 1 unveiled that, 97.3 percent of the respondents were male while 2.7 percent were females, meaning there was more household headed by male respondent than female respondents. The dominance of male respondents are generally the household heads as they represent families 'and own properties such as domestic animals of the family compared to their female counterparts. The difference in property ownership may be attributed to culture in African tradition settings where the household head can stand the right of all goods held by the family. However, with increased civilization and women emancipation women are becoming property owners, especially the educated, politicians, businesswomen and in divorced women family.

The findings show that most (99.1%) of the respondents were married. On the other hand, 0.4% of the respondents stated that they were divorced, and lastly, 0.4% were bachelor. Information gathered during the focus group discussions and key informants reveals that marriage is a highly cultural activity in the study area. Every adult

male and female is expected to get married and have his or her own children. Marriage at an early age for girls was very common and any girl who had attained the age of 18 years was expected to get married unless she is attending school in a society were 100% of the pastoralist respondents were Islam practiced by 100%. Of the entire sample of 225 household interviewed across the study area, about 95.6% were of the Tuareg tribe, while the Fulani and Hausa tribes represented only 2.7% and 1.8% respectively of the sample size as indicated in Table 3. The entire 100% of respondents had been residing at their current homesteads for more than 30 years. The household having a size of 6 to 10 members constitute 50.7% of the household surveyed, followed by those of less the 5 members representing 28% while household with the largest was the least with 21.3%. It was also observed that majority (86.7%) of the respondents had never attended training school. The result shows that a small proportion (13.3%) of the respondents are of the Quranic school background.

Table 1. Socio-demographic characteristics

Variables	Frequency	Percentage	Mean	S.D
Sex				
Male	220	97.8		
Female	5	2.2		
Age (years)				
≤ 40	2	0.9		
41-51	33	14.7		
52-62	151	67.1	57.2	7.2
63-73	34	15.1		
74-84	1	0.4		
85-95	4	1.8		
Total family Member				
≤ 5	63	28		
6 to 10	114	50,7		
>10	48	21,3		
Marital status				
Bachelor	1	0.4		
Divorced	1	0.4		
Maried monoganous	201	89.3		
Maried Polygamous	22	9.8		
Religion				
Islamic	225	100		
Education				
Illetracy	195	86,7		
Islamic study	30	13,3		
Ethnic group				
Touareg	215	95.6		
Haoussa	4	1.8		
Fulani	6	2.7		

Source: Field Survey, 2020

The information in Table 2, established the occupation of the local community members in Tahoua State pastoral, 40.1 percent of the respondents are livestock keepers while 37.8 percent are those engaged in farming and livestock rearing as means of earning a living in the area. 20.9 percent of the respondents were involved in farming activities and those in trading activities represented nearly 1 percent of the respondents. Pastoralism as occupation became predominant in the community because, culturally, animals are properties considered as livelihood assets which every pastoral family should possess. Another plausible reason of possessing the animals is that families have the ability to sell livestock in response to numerous shocks and stresses as a key resilience capacity.

Nomadic, Agro-pastoral and transhumance were the main husbandry systems practiced in the area. The nomadic system is characterized by an unpredictable constant moving all year round of the herders and their flocks in search of pasture and water within the same region. The nomadic system represents 23.6% of the sampled interviewed. The agropastoral system is another form of livestock production highly dominant in the area and account for 64.9% of the sample. This system is characterized by a relatively low mobility of animals. The animals, therefore, relay on extensive exploitation of forage resources, and are supplemented with crop residues. Another important feature of this system is the higher exploitation rate of livestock compared to the pastoral system namely nomadic and transhumant. The transhumance system, which constitutes nearly 12% of the respondents is characterized by a cyclic seasonal movement of the animals in search of feed and water and concern all livestock species. Depending

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

of the mobility amplitude, two main types of movement can be distinguished. The lack of pasture and water forced the herders to move downward from the Northern to the Southern Agricole and agropastoral zone where natural pasture and crop residues are available. The second type of shifting is the Northern-South/East/Ouest movement of animals motivated by the lack of quantitative as well as qualitative forage from the pastoral zone. The animals therefore move to the agricultural zone and sometime may reach neighboring countries such as Nigeria, le Mali, le Burkina Faso, Chad and even Cameroun.

The livestock species reared are cattle, sheep, goat, camels, donkey and horses. Depending on the herd size estimated in Tropical Livestock Unit (TLU), the livestock owners are classified into big, medium and small representing respectively 68.4%, 20.4%, and 11.11%. The average herd size estimated is 102.24, 43.37 and 3.96 TLU respectively for the big, medium and small herders. The animal feeding relay on the pastoral resources composed of essentially of pasture (herbaceous plants species, shrubs, trees and crop residues) and water (ponds, lakes and wells). 100% of the respondents stated the rangeland provide numerous services, which include forage for feeding, watering of animal, firewood, construction materials, fruits gathering and revenue from the selling of forage, firewood, charcoal and fruits.

Table 2. Socio-economic Characteristic of Pastoralists

Variables	Frequency	Percentage	Mean	S.D
Main activity				
Animal Husbandry	91	40,4		
Crop production	47	20,9		
Trading	2	0,9		
Animal Husbandry and agriculture	85	37,8		
Breeding System				
Agropastoral	146	64.9		
Nomadic	53	23.6		
Transhumance	26	11.6		
Type of breeder				
Big breeder	25	11.1		
Medium breeder	46	20.4		
Small breeder	154	68.4		
Herd size in TLU				
Big breeder	2556	49.70	102.24	52.37
Medium breeder	1995	38.80	43.37	31.91
Small breeder	594	11.50	3.96	5.7
Feeding system				
Natural Pasture	15	6.7		
Natural Pasture and supplementation	210	93.3		

Source: Field Survey, 2020

Characterization Of Drought

In an arid and semiarid area like Niger Country, drought is the most important agricultural risk with high probability and severity affecting crop and livestock production. The analysis revealed that from 1988 to 2018, the area experienced both, near normal, wet and drought condition as indicated (Table 3). From 1988 to 2018, 48% of the year are extremely dry with drought severity ranged from -4.2 to -2.1. Near normal rainfall condition which is about 4% of the year, occurred in 1988, 1994, 2006 and 2009 with drought severity ranged from 0 to 0,1. However, in 1998, the area registered a moderate rainfall condition followed by severe wetness condition in 1999 and 2012. The remaining years were drought conditions with a prevalence of 77.4%. The occurrence of the extremely wet condition represented 6.5%, moderately wet condition 3.2%, near normal condition 12.9%, extremely dry condition 41.9%, severely dry 19.4%, moderately dry 12.9% and mild dry 3.2%.

Causes Of Rangeland Degradation As Perceived By Pastoralists.

The Table 4 gives the summary of the causes the respondents perceived as being the causes of rangeland degradation**.** There are many interacting variables and processes that contributed to degradation of rangelands. 99.1% of the respondent indicated that the rangeland of Tahoua is degraded. Pastoralists argue that forages are the most valuable feed resources for livestock particularly ruminants' animal. Pastures highly available before are becoming less and less frequent. Many causes responsible for rangeland degradation listed in Table 4 can be grouped into to two broad categories the climatic and anthropogenic factors according to pastoralists. All the respondents mentioned a decrease in the rangeland potential to produce pasture as a result of climate change and variability.

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

Table 3. Meteorological Drought Severity in Tahoua Pastoral Zone from 1988 to 2018

Years	Annual rainfall Total (mm)	Standard deviation (σ)	Drought severity index (SPI)	Drought category
1988	360,53	35,77	0	Near normal
1989	258,84	112,14	-2,8	Extremely dry
1990	243,85	123,35	-3,3	Extremely dry
1991	287,12	95,5	-2,1	Extremely dry
1992	293,44	80,45	-1,9	Severely dry
1993	238,36	125,39	-3,4	Extremely dry
1994	364,55	68,55	0,1	Near normal
1995	221,06	152,95	-3,9	Extremely dry
1996	273,04	101,89	-2,4	Extremely dry
1997	209,08	162,36	-4,2	Extremely dry
1998	397,98	75,88	1	Moderately wet
1999	473,16	125,84	3,1	Extremely wet
2000	235,75	133,11	-3,5	Extremely dry
2001	259,29	116,74	-2,8	Extremely dry
2002	297,64	80,44	-1,8	Extremely dry
2003	278,66	99,5	-2,3	Extremely dry
2004	320,81	54,47	-1,1	Moderately dry
2005	314,3	68,88	-1,3	Moderately dry
2006	359,97	50,09	0	Near normal
2007	288,96	83,13	-2	Extremely dry
2008	332,57	57,34	-0,8	Moderately dry
2009	364,56	38,13	0,1	Near normal
2010	301,89	81,66	-1,6	Severely dry
2011	275,67	91,86	-2,4	Extremely dry
2012	450,55	114,84	2,5	Extremely wet
2013	307,05	63,51	-1,5	Extremely dry
2014	292,51	75,51	-1,9	Severely dry
2015	308,72	63,84	-1,4	Moderately dry
2016	290,81	76,83	-1,9	Severely dry
2017	286,54	76,57	-2,1	Extremely dry
2018	318,61	54,17	-1,2	Moderately dry

Forage shortages were very common now a days and were reported by 94.2% of the sample studied. Beside the climate variables, anthropogenetic facture such as overgrazing, trees clearing to make firewood and charcoal to earn revenue during drought period, and pasture fire outbreak consuming large quantity of plants and trees are cited as part of the causes of rangeland degradation by 4%, 3.6%, and 37.3% respectively. After enumerating the perceived causes of rangeland degradation, the pastoralists listed base on their knowledge and experience the signs or indices of rangeland deterioration. 94.2% of the sample population observed an increase in the frequencies of forage shortage. The tendency of forage deficit frequencies seems to be more common compared to before. Decrease in trees density, distances of getting firewood, and annual burning frequency of pasture fire outbreaks consuming important quantities of already scarce pasture resulted in increased barren land, have been cited among the endogenous indicators of rangelands degradation assessment by 89.8%, 89.3%, 8%, and 92.4% of the respondents respectively. The trees and shrub species that disappeared based on the declaration of pastoralists include *Acacia sieberiana, Acacia seyal,Acacia laeta, Ziziphus mauritiana, Maerua crassifolia, Balanites aegyptiaca, Bauhinia rufescens, Sclerocarya birrea, Acacia Senegal, Capparis decidua , Tamarindicus indica, Acacia radiana , Acacia tortilis, acacia ehrenbergiana, Boscia senegalensis and Acacia Macrotyla.*

Sixty-nine (69.3%) of the respondent further observed the disappearance of wildlife animals present resulting from the destruction and disappearance of dense trees occasioned. Also 72.9% of the respondents admitted to having noticed a reduction in the diversity of some plant species in the semi-arid area. The herbaceous species that disappeared are *Cenchrus biflorus, Cymbopogon schoenanthus Citrillus colocynthus, Tragus ramosa Cassia obstifolia Chrozophora brochiara Chrysopogon aucheri, Andropogon ganayanus and Blepharis linarifolia.*

Ninety-two (92.4%) percent of the pastoralists confirmed that the decrease in the drinking water sources as an indicator of rangeland as result of in the quantity of rainfall in the area. finally high mortality loss due lack of forage and water year was among the indices of rangeland deterioration and quoted by 100% of the respondents. The most prevalent disease in the pastoral zone cited by pastoralist Bovine Pleuropneumonia, Sheep pox, Pasteurellosis, Donkey Strangles and Rift valley disease. Their frequency and percentage occurrence importance are presented in Figure 2.

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

Table 4. Perception of causes and indicators of rangeland degradation of Pastoralists

Causes of range land degradation Variables	Yes (number and % of responses)	No (number and % of responses)
Rangeland dégradation	223 (99.1%)	2 (0.9%)
Causes of range degradation		
Drought	208 (92.4%)	-
Rainfall	190 (84.4%)	35(15.6%)
Température	190 (84.4%)	35(15.6%)
Overgrazing	9(4%)	-
Tree clearing /fodder collection	8 (3.6%)	
Decrease biomass production	225 (100%)	-
Pasture Fire outbreaks	84 (37.3%)	141(62.7%)
Degradation indicators	Yes (number and % of responses)	No (number and % of responses)
Frequent forage shortage	212 (94.2%)	13(5.8%)
Decrease in trees population	202 (89.8%)	23 (10.2%)
Decrease in plants species	164 (72.9%)	61(27.1%)
Decrease in firewood	201(89.3%)	24(10.7%)
Decrease in wildlife animals	156(69.3%)	69(30.7%)
Decrease drinking water sources	208(92.4%)	17(7.6%)
More bare soil/less trees	208(92.4%)	17(7.6%)
Frequent burning of pasture	18(8%)	208(92%)
High loss of animals		

Source : Field Survey, 2020

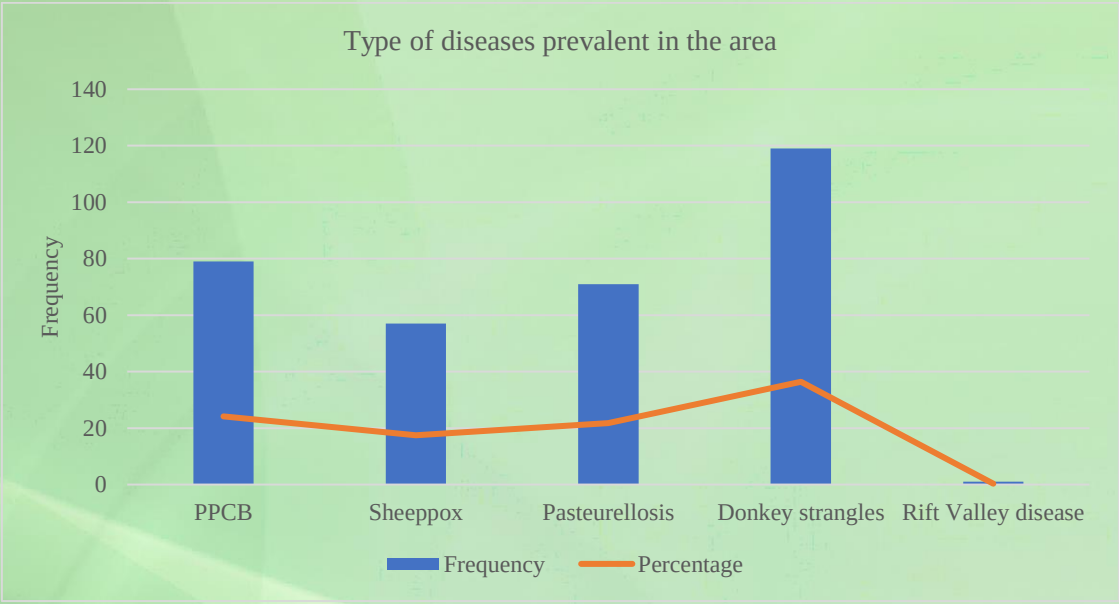

Figure 2. Prevalent Diseases as Indicators of Rangeland Degradation

Impacts Of Rangeland Degradation As Percieved By Pastoralists

The respondents were asked to cite the main causes and impacts of rangeland degradation on their means of livelihood. The impacts cited are presented in Table 5. It can be seen clearly that 84% of the respondents observed a decrease in the production and availability of pasture to animals especially during long dry period the last 30 years as a result of frequent drought due to climate change and variability coupled with rising in temperature in the area. Reduced livestock assets or numbers and productivity of animals were also noticed. Mortality of animals was reported by all the respondents while the reduction in livestock productivity 'meat and milk), and reproductive parameters such as calving rate and milking frequency, reduction in number of milking were respectively cited by 75.6%, 72.9 and 99.6% of the respondents. Impacts like competition over resources, conflicts and reduction in the body score condition or reduction in the economic value of animals as a result of forage scarcity were also mentioned by 71.6% 16%, 68.4% of the respondents respectively.

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

Table 5. Impact of Rangeland as Perceived by Pastoralists

Variables	Yes (number and % of responses)	No (number and % of responses)
Degradation of rangeland	204(90.7%)	21 (9.3%)
Decrease in biomass production	189(84%)	36(16%)
Decrease of productivity	176(78.58%)	48(21.3%)
Reduction in calving	164(72.9%)	61(21.7%)
Reduced milking frequency	164(72.9%)	61(27.1)
Reduction in milking number	224(99.6%)	1(0.4%)
Increased susceptibility to disease diseases	194(86.2 %)	31 (13.8%)
Mortality of animals	225 (100%)	-
Increase compétition over resource	161 (71.6%)	64(28.4%)
Conflits on ressource utilisation	36 (16%)	189(84%)
Decrease body score condition/low prix	154 (68.4%)	71(31.6%)

Source : Field Survey, 2020

Strategies Adopted By Pastoralists To Overcome Frequent Pasture Shortage

Pastoralists have been dealing with drought and related consequences for many years in the arid-and semi-arid areas. The strategies developed to minimize or to become more resilient depend on the severity of the shock. The strategies adopted in normal, moderate shortage and important forage shortage were highlighted in Table 6.

Normal year**:** Mobility is already a habit and is practiced all years but the amplitude being the most important feature of differentiation. During normal year, the nomadic and transhumant pastoralists undertook their habitual movements in the search of forage and drinking water to maintain their livestock in a good nutritional and health condition to guarantee the production of meat and milk to their family. Their movement began generally between October to December depending on the availability of pasture and water. The nomadic generally moved to North Abalak, Tchintabaraden and Tassara while the transhumant moved in the agropastoral area of Madaoua Department bordering Nigeria.

Since the last severe drought of 2010, pastoralist discovered that agropastoral herder animals receiving crops residues and other concentrate like cotton seedcake, cereal brans were able to cross the long dry season and recorded less mortality. As a result, 60% of the respondents affirmed supplementing their animals particularly the lactating while 1.3% and 6.7% were involved in the collection and buying of forages particularly natural pastoral, crops residues and concentrated feed from farmers and markets. The strategic culling or selling off weak and unproductive animals are carried out to gather money. The selling generally occurred during months of September to October at crop harvesting time and served to buy natural forages, crop residues and, concentrate as well as feed for the family need.

Moderate Pasture Shortage: As stated above, Nomadic and pastoralist in such years, undertook their habitual inter departmental (Madaoua, Tchintabaraden, Tillia) or regional (Ingall) mobility in as early as possible toward end of September. The downward movement in the south is governed by the free liberation of crop farmers to avoid conflict. Beside mobility, Supplementation, Strategic culling off and buying of forages are also carried by 59.6%, 36.4% and 4% of the respondents respectively (Table 6). The supplemental feeds are feed produced both locally and coming from abroad. Based on the utilization, the supplemental feed may be grouped into national, abroad and combination of the two types by 43.1%, 31.1%, and 25.8% of the respondents respectively.

The main type of concentrate feed used in the supplementation includes agro-industrial by products such as millet bran, wheat bran, cotton seed and cotton seedcake. 60% of the respondent declared using only cereal bran as supplemental feed while, 32.4% and 7.6% used cotton seedcake/cereal brand and cotton seedcake and cotton seed. The feeds were bought from different sources. The herders procured the feeds form different buying sources (Figure 6). Depending on the sources, 42.7% of the respondents bought from markets, 24.4% from the animal husbandry services, 23.6% got the concentrate from markets and animal husbandry services while 9.3% are obtaining the feeds from markets, animal husbandry services and concentrate boutique of the villages. The regional network of prevention and disaster management retained that to facilitate a quick access of pastoralist to concentrate feed, the far placement should be 30km away from the herder's habitation. The findings revealed that 81.3% of respondent could procure concentrate less than 30km against 18.7% that were satisfied at above 30Km.

Years of High Forage Deficit: Years recording high forage shortage required the pastoralists to employ more coping strategies to minimize the effects. Common strategies to all situation like, mobility, buying of forage, supplementation, and strategic destocking were respectively realized by 1.3%, 41.8%, 30.2% and 26.7% of the sample population. The mobility however may go beyond the country, and they moved generally in Nigeria in the pasture lands of Sokoto State and sometime in Mali republic with movement starting from October to march. The duration does not exceed three months maximum and returned in July coinciding with the establishment of rainfall

meaning availability of water and pasture in the area. The severity of the situation forced the pastoralist to diversify their activities to reduce and increase their resilience. The diversified activities like trading, selling of firewood, fruits, pasture, vegetable farming, Migration, Social help, digging of new wells, and herd diversification are undertaken by 10.7%, 18.7%, 16%, 12.4%, 53.3%, 17.3%, and 48.3% respectively by respondents.

Table 6. Strategies Developed by Pastoralists

Variables	Frequency	Percentage
1.Normal situation (No forage deficit)		
supplementation (local feed)	135	60.0
Strategic culling off (strategic destocking)	72	32.0
Buying of fodder and storage	15	6.7
Fodder collection	3	1.3
3.Moderate forage shortage		
Supplementation (local and abroad concentrate)	134	59,6
Strategic calling	82	36,4
Buying of forage	9	4,0
3.Important forage shortage		
Supplementation (local and abroad concentrates)	94	41.8
Buying of forage	68	30,2
Strategic culling off (strategic destocking)	60	26.7
Mobility local /transboundary	3	1.3
4. Diversification of activities		
Trading	24	10.7
Selling of fruits, firewood, and forage collected	42	18.7
Cultivation of végétales	36	16.0
No diversification	95	42.2
Migration	28	12.4
Social help	120	53.3
Digging new wells for drinking animals	39	17.3
Herd diversification	109	48.4

Source : Field Survey, 2020

Role Of Government And Partner Agencies In Ensuring Pastoralists Resilience

The government and its partners help the pastoralists in their continuous coping strategies to overcome the recurrent forage shortages affecting their mean of livelihood and to become resilient. More attentions were given to herders since the last 2009-2010 severe drought during which nearly 25% of the livestock animal population perished. Avery years after the pasture evaluation, zones of good and high pasture production are determined, zones and herders at risk of vulnerability assessed and emergency program giving in details all actions that contribute to reinforce the resilience of pastoralists is elaborated. The actions of good year of pasture production, therefore, differs for those of deficit. The actions normally directed to herders include the following.

Vaccination: Vaccination programs are carried out every year to protect and minimize mortality of animals. The vaccination is free and obligatory. All herders should vaccinate their animals against the prevailing diseases such as Contagious Bovine Pleuropneumonia, Small ruminant' Pleuropneumonia, Camel smallpox during the cold season where the conditions for vaccine conservation are conducive and before the herders start their downward transboundary mobility. Vaccination against Pasteurella's or Hemorrhagic Septicemia, Anthrax and smallpox diseases are more prevalent during the rainy season and animals are being vaccinated before the onset of the rainy season. From 2009 to 2018 the rate of vaccination of animal is ranging in between 36% to 70.35% all specie considered.

Fire Break Bands or Firewall Construction: Fire outbreak is recorded every year in the pastoral zone from September to December. When it occurs important quantity of biomass were lost and sometime even result with death of human beings. As indicated in figure 3, fire outbreak cases were recorded every year with a varying intensity. The causes reported of fire outbreak include Tea or cooking fire unintentionally left by transhumant or kids while some with unknown causes.

The quantity of forage lost every year during recurrent fire outbreak is reported in figure 4.

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

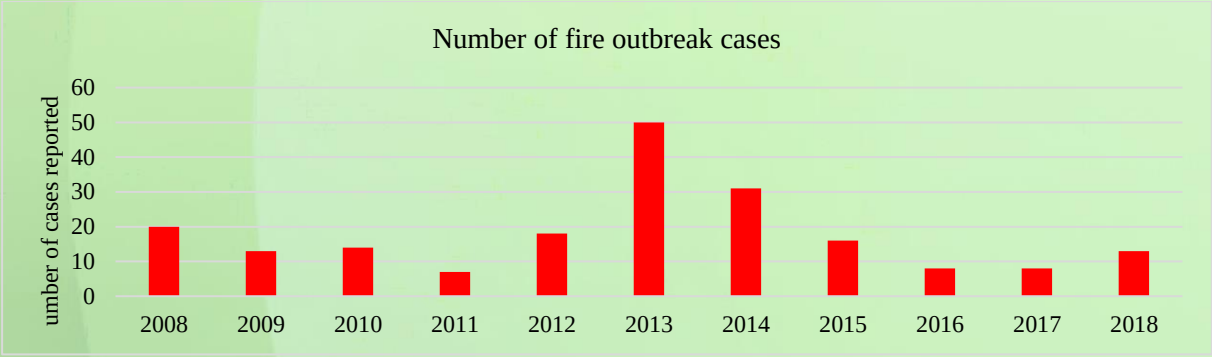

Figure 3. Number of Fire Outbreaks Cases

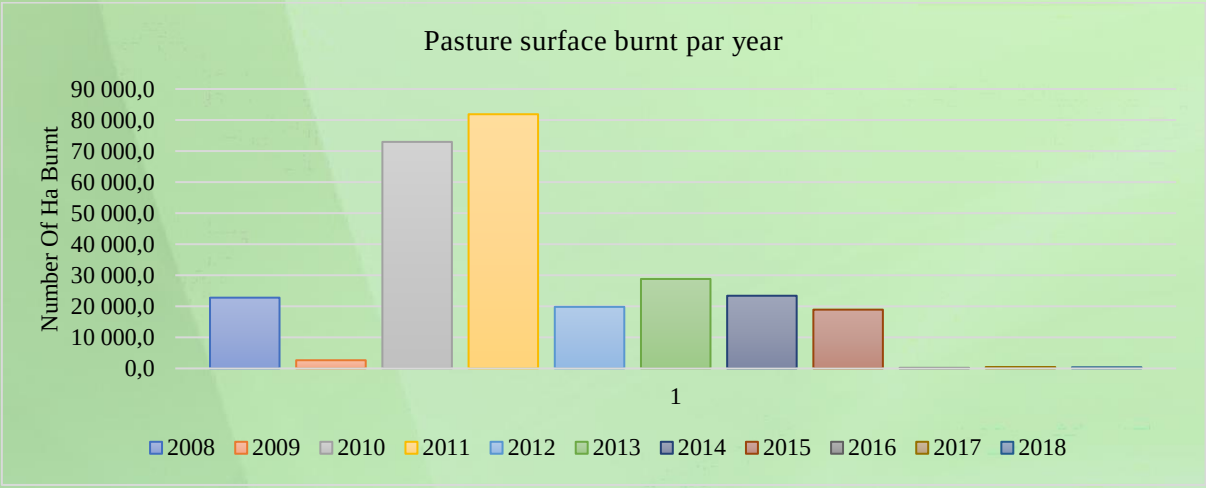

Figure 4. hectares of pasture burnt from 200-2018

Fire Breaks Band or Firewall Construction: Fire break band is an action carried out each year to protect good pasture production area and avoid loss of biomass fundamental to the survival of animals and consequently the mean of livelihood. The realization of these firebreak bands was realized just after the pasture evaluation and was undertaken jointly by the forestry services workers in conjunction with their counterpart of animal husbandry services. The manpower employed to realize these fire protected bands is composed essentially of the herders and in the form of cask for work or work for food to enable them to get food and or revenue to avoid selling of their animals. The number of number of kilometers realized vary on the level of area to be protected.

Table 7. Yearly Linear Kilometer Realized to Prevent Fire Outbreaks

Department	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Abalak	935	431		290	1765	4 614	2150	890	1 060	82	1058
Tahoua				1500	543	370	400	150	100		
Tassara					600	700	853	870	150	77	515
Tchintabaraden			1 500	1887	1955		418	320	683	161	520
Tillia	121	245			600	640	1050	448	150	310	167
Total pastoral zone (Kml)	1166	676		3677	5463	7 974	4871	2678	2 143	630	2260

Source: Field Survey, 2020, Kml: Linear kilometer

Soil and Water Conservation Measure and Seed Broadcasting: Like fire outbreak, every year the barren lands identified by the Directorate of Pastoral Development (DPD), are being treated by the realization of half-moon and other soil and water conservation technics with the financial support government and related projects. Seeds mostly the most appetite are broadcasted to recover and favor forage growth thereby improving the forage availability in the area. The treated areas are defended some years before allowing the animals to graze the pasture. Since the last drought and like realization of firebreak bands, the local manpowers were used to carry out the work and were remunerated in the form of Cash for work, for food or cash transfer. The total area broadcasted are presented in the Table 8.

Table 8. Hectares of Land Recovered Through Seed Broadcasting

Department	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Abalak		95	1000		1150	1150	1.732	107	380	40	592
Tassara						120	493	20	290.21	250	378.05
Tchintabaraden			400		2019	711	240	195	140	829	315
Tillia									64	375	
Total	743	1 510	7630.75	3 861	10840.3	7 686	3140		1880.7	4 630	4938.2

Source : Field Survey, 2020

Supply of Concentrate to Herder at Moderate Price: To support herders, government and partners provide every year's important quantity of concentrates feed to Animal husbandry services close to herders in order to facilitate both the availability and accessibility. The concentrate provided are composed mainly of wheat bran, cotton seedcake and in some case, cotton seed, and are sold to herder at a moderate price lower than the buying price and on the market. As indicated on Table 9, the concentrate is provided mostly by the government at the rate of 77%. However, there are some partners like Food and Agricultural Organization (FAO), Qatari Red crossed (CRQ), Action Contre la Faim (ACF), United State Agency for Aid and Development (USAID), Non-Governmental Organization (NGO) Concern, Adkoul, Masnat, Areva and Association for the re-dynamization of Breeding (AREN). FOA is providing 16% of the total quantity provided followed by CRQ and 1% for each of the NGO and association remaining.

Urgent Destockage and Social Help: Urgent culling off operations is carried out in urgency situation when animals are highly emaciated, and do not have a good price on markets. Government and partners targeted the distressed herders and buy their weak animals and the meat processed and distributed in prison and medical centers. The social help actions are directed to livestock owners that lost their animals. The kit is composed of four female and one Male of small ruminants either sheep or goat but goat is preferred because of their resilience to forage shortage, or donkey to enable herders to reconstitute their livestock assets. The donkey kit is directed mainly to herders that lost their draught animals to lift drinking water from deep wells t. Women and children are the most vulnerable in the pastoral area. Government and Partners help them through fattening operations where they were provided rams, feed materials, dewormers, intromin licking block and veterinary services during the operation. Chaffing machines were also provided in rural area to facilitate access and reduce size of crops residues and facilitate feed ingestion. The fattened animals are sold during religious feast to earn more profit.

Rangeland Management Actions: Marking of livestock routes and enclaves in the agropastoral and agricultural, are also effectuated to facilitate mobility of herders and their animals and to avoid their encroachment and conflict between farmers and herders. Also, Wells were dug in area with high forage density to enable the peasant herders to get access to pasture and feed their animals thereby contributing to reduce transboundary mobility. Livestock markets were also constructed along the routes to facilitate access to markets for the selling of animals and buying of goods and feed during their mobility. The total of all these operations and the different partners are presented in Table 10 since the last drought.

Table 9. Quantity of Concentrates Provided and Sold at Moderate Price

zYears	Government	FAO	CRQ	CONCERN /FIDUCAP	ACF	USAID	ONG ADKOUL	ONG MASNAT	AREVA	AREN	Total
2010	1653.8	200	70							41,85	1965.6
2011	935.6	500							230		1665.6
2012	2341.0										2341,0
2013	2251.0	1042.65	700			70	100	203,65			4367.3
2014	3320.0	565									3885.0
2015	2800.0										2800.0
2016	3125.0			64.12						38	3227.1
2017	2500.0	700									3200.0
2018	2450.0	203									2653.0
2019	9.9	1350			30	140				70	1599.9
Total	21386.1	4560.7	770	64.1	30	210	100	203.7	230.0	149.9	27704.4
Weight	77%	16%	3%	0%	0%	1%	0%	1%	1%	1%	100%

Source : Field Survey, 2020

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

Table 10. Cost of Operations in Thousands of USD.

Variables	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Vaccination	195	195	195	195	195	195	246	250	263	1 928
Animal feeds							2 346			2 346
Cold chaine Materials							152			152
Animal fattening							124	24		148
Kit Household					168		620	50	585	1 423
Bande pare-feu	97	448	715	27	580	203	67	130	52	2 320
Destockage	241									241
Cash for work	122									122
Dewormers, Intromin Block									60	60
Well cosntructed and rehabilitated					496		237		201	934
Livestcok market							124			124
Animal feed boutique							64		150	214
Chaffing machine							4		17	21
Vaccination Parcs							36			36
Seed broadcasting	134	276	935	273	420	207	141	141	150	2 678
intensive training AE and producers							15			15
Marking Corridors and enclaves							119			119
Total cost	788	919	1 845	495	1 859	605	4 296	596	1 479	12 882

Source : Field Survey, 2020

Discussion

The Standardized Precipitation Index results indicate that certain meteorological drought years observed by the respondents are identical with the historical records. Thus, the statistical frequency of drought episodes issued from SPI values can be used to obtain the overall drought characteristics in the study area over time. The SPI analysis shows that extreme drought events are the most common and the frequency has increased over the last 30 years, with 32.26% of drought occurrences falling in the two decades between 1988 and 2001 while 9.7 % occurs between 2004 and 2018. It seems clear from the data that extreme drought conditions are reducing in the study zone. However severe and moderate drought seems to be more prevalent during the last fifteen years (2004-2018). Drought is therefore prevalent in the area under study.

Extreme and severe drought conditions seriously negatively affect livelihood security of pastoralists in the Sahel zone and the pastoral zone. The occurrence of these droughts is generally associated with the El Niño Southern Oscillation (ENSO) phenomenon, which causes changes in the temperature and rainfall in Sub Saharian Africa associated with shifts in the Inter Tropical Convergence Zone position (Salau *et al*., 2016). Climate factors are influenced by anthropogenic impacts from land use changes, which affect vegetation cover, surface, soil moisture and rangeland degradation (Rivera & Rosen, 2012). The increasing severity and frequency of occurrence of droughts is an indication that the region is getting drier and this change is reflected in the observed changes in pastoral zone. The area thus is being monitored every year and many resilient activities are conducted by the pastoralist as well by the government and its partners to reduce the impact of these drought on the livelihood of pastoralist and thereby avoid loss of livestock as in the 2009-2010 pastoral crisis

Most of the household (50.7%) had 6-10 family members and (21.3%) had above 10 family members meaning household with more than 5 family represent 72% of the sample population. The high number per family members were considered as a source of security and ability to diversified household coping strategies with drought and related problems. It could be seen also as a source of labour for taking care of the household livestock asset considered as source of wealth and food security in emergency. The high family members recorded in this study is similar to the finding reported by Snorek, (2016) who observed that cultural groups like Touareg and Fulani generally have large families and are monogamous due to the matrimonial historical frameworks. The result however differs from the finding of (Jane *et al*., 2013) who reported in their study that most households (42.5%) had 4 to 6 family members and only (22.5%) had 7 to 9 family members. Pastoralists are monogamous and have low literacy. It is observed that 90.7% of the pastoralists had no level and 9.3% have a level Quranic education. This finding differ from the result of (Djalal Ardjoun Khalil1, Sing-yabe Sahoulba, Mahamat Ibrahim Souleymane & ., 2021) in their study of the impact of the security crises on the transhumant pastoral system in the Province of Lac, Department of Mamdi reported pastoralist where they observed that sample surveyed are polygamous at 99.3% but have low literary level .

Three main breeding systems is prevalent in the pastoral zone of Tahoua and include Nomadic, Transhumant and Agropastoral system. The Nomadic and transhumant system as pastoralist system based on mobility to search of

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

feed and water as a response of the harsh environmental condition characterized by frequent drought and climate variability. Natural pasture constitutes the principal feeding system with no or less supplementation. The Agro pastoral system rely on natural pasture but animal is supplemented with crops residues. The nomadic system represents 23.6%, to transhumant 11.6% while the agro pastoral system constitute 64.9. These results attest the finding of the General Census of Agriculture and Livestock where it was observed that the agro pastoral system constitute 66% of the animal husbandry system in Niger Republic. The results substantiate the finding of Fodé (2010) who confirmed that the majority of livestock in Niger (donkeys, sheep, goats, camels, and cattle) are owned by sedentary people. Like the breeding system, three types of breeders are encountered in the area. The small breed, the medium and large breeders. All the household can be affected by the rangeland degradation of shortage of feed but with a varying degree. Small breeder generally suffers more compared to the medium and big herders. This is because, the big herder has the capability to deploy resources to buy and provide their animals with water, forage and concentrate like wheat bran and cotton seedcake as reported by Abdou *et al.*, (2011. They further documented that during the last drought that hit the entire pastoral zone of Niger republic, the small household lost more than 90% of their animals compared to big herders that lost only 20% of their livestock asset. The big herders are organized in cooperative, used their political power to obtain large of concentrates from government services and also fences area of the pastoral zone to secure their animal during drought condition. Due to their high financial means, they used water tanks to move their animals far to exploit in the dry season area rich in natural pasture that could not be exploited because of watering difficulties. In the late dry season, animals lose weight and therefore animal price are reduced and, sometimes, they were forced to destock at very low price to avoid total loss. During the pastoral crise of 2010 as reported by Abdou *et al*, (2011), 29.59% of the total animal's lots was as results of urgent destocking.

Over 92.4% of the respondents reported that drought was the major constraint to the productivity of their livestock and agriculture. Drought years are characterized by lack of availability of pasture and water which may result in death of animals if any action was not taken before the urgency phase. During such period, the best strategic adoption consists of destocking weak animals to avoid complete loss from death in the alarm phase because in the urgency phase animal may have a poor body condition or loss weight because of starvation and therefore animal price is reduced. During the last 2009-2010 drought, the Departments of Abalak and Tchintabaraden, located in the study area recorded respectively 11.84 and 24.29% of their animal population (Abdou *et al,* 2011) due to lack of pasture and flood. Climate hazard like high intensity rainfall associated flood with can also cause mortality of animals particularly the most emaciated and weak animals. The observations of the pastoralists were confirmed by the rapid evaluation of the impact of the forage deficit of 2009-2010 conducted by Abdou *et al*, 2011 where they recoded 1.7% animal death of the animal population of the entire pastoral area attributed to these conditions. The lack of feed to animal particularly in the late the dry season is manifested by a loss in body condition, miscarriage, reduction in fecundity and decrease in the milk and meat production (Abdou et *al*., 2011). Drought also results in the intensive exploitation of scarce tree and pasture resources which. Lead to overexploitation of these resources through wood fuel collection and charcoal production are among the major causes of rangeland degradation in the study area. The respondents reported that water points as result of frequent drought have either dried up or supply was reduced over the past three decades. The reduction in water availability and drying up of water points are indicators of a hydrological drought. In such conditions result pastoralist have to move long distances to fetch drinking water to their animals and for domestic use. Reduction of the drinking frequency is very common and may varies from 2 to 1 or even 1 every 2 days depending on the deep of the wells. The high animal pressure exerted on natural pasture or overgrazing has been cited among the causes of the rangeland degradation by 4% of the respondents. They explained, the concentration of the herders around watering points such as along the sides of perennial lacks, led to overgrazing of the existing forage resources and explain the increase occurrence of barren land in the pastoral zone. This situation caused loss of pastures from the rangelands and is therefore a sign of pastoral land degradation resulting from overgrazing of animals over a long period. The palatable grass species that disappeared from the rangelands include *Cenchrus biflorus, Cymbopogon schoenanthus, Citrillus colocynthus, Aristida sieberiana, Tragus ramose, Cassia obstifolia, Chrozophora brochiara, Chrysopogon aucheri, Andropogon ganayanus, Cyperus conglomerates, and Blepharis linarifolia.*

Similar cases have also been observed by Dieter Geesing and Hassane Djibo, (2006), where they reported that the number of species in the pastoral zone has declined and the floristic composition of the herbaceous layer has been modified, very often to the detriment of perennial *grasses: Aristida sieberiana, Cymbopogon giganteus, Cymbopogon schoenanthus, Andropogon gayanus, Cyperus conglomerates* regressed considerably, even almost disappeared.

Another impact overgrazing is that palatable species are being replaced by the encroachment of the unpalatable ones. Almost all the respondents reported that rangeland degradation resulted for drought and climate change affect the productivity of their livestock. Temperature and rainfall being part of the climate change indicators, their variability such as increasing temperatures and decreasing rainfall are known to reduce yields particularly, feed production, species composition and feed quality of rangelands, and contribute to their degradation. The rainfall

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

pattern and distribution overtime and space governed the spatial distribution and availability of pasture and water in an area (Hidosa & Guyo, 2017). Extreme temperatures tend to reduce animal feed intake and lower feed conversion rates (Bai, *et al.,* 2019) while climate change on livestock effects on livestock production apart feed shortage, shortage of water, include reduced productivity, and decreased mature weight and/or longer time to reach mature weight in their order of importance. Lack of pasture can favor the parasite infestation and disease spread particularly when animals meet in an area rich in pasture and water which consequently may result in high mortality of animals.

There are varieties of coping strategies developed by herders to either become resilient or to minimize the effect recurrent forage shortages and to guarantee the sustainability and prosperity of their main means of production. In addition to the endogenous herder's strategies, herders are being accompanied by government and its related partners. The actions approved by government and partners in Niger republic since the heavy loss of animals registered during the 2009-2010 drought are based on the Livestock Emergency guidelines and Standard (LEGS). Before discussion, there is need to note that in LEGS, there are two type of catastrophes that may rise as result of climate change and include those happening suddenly and those having a slow evolution overtime. The sudden may include floods, outbreak of disease or fire outbreak while those of low evolution comment in the semi-arid zone are drought and insecurity. Each type of catastrophe has its own phases during which coping strategies should be brought to attenuate the effects and recovery from the catastrophe. The Sudden catastrophe because of its rapid occurrence has three phases and include immediate phase, short recovery and recovery. On the other hand, catastrophe evolving slowly like drought has four phases: alert phase, alarming phase, urgency phase and recovery phase with each having its own signs are described as follows:

Mobility is a one of the oldest well-known primary risk reduction strategies, particularly in times of drought employed by pastoralists exploiting rangelands and to deal with the recurrent feed and water scarcity in Sahelian countries. However, its amplitude varies according the agroecological zone, herder tribe, and the severity of forage deficit. Years of normal and moderate shortage, the herder mobility is more local within the same department, state or at most in another state, and movements are guided by the availability of pasture, water, market and veterinary facility along the routes. However, when the biomass deficit is important generally more than 50% of the animal needs, Herders carry out transboundary mobility in Nigeria, Mali, Benin and Burkina Faso irrespective of the insecurity, conflict with farmers or even herders they may face. These finding corroborate the observation of Abdou *et al.*, (2010 where they documented mobility of herders to Nigeria, Benin, Burkina Faso and Mali during the 2010-2011 severe drought. Another reason of mobility practices is to avoid loss of animals and preserve their asset. During the last 2009-2010 drought (Abdou *et al.*,2011) reported that the Department of Abalak and Tchintabaraden, located in the study area recorded respectively 11.84% and 24.29% loss of their animal population.

Supplementation with purchased concentrate feed particularly cereal bran and cotton seedcake is one of the resilience strategies of pastoralists. These concentrate feeds were purchased on markets or from animal husbandry services and provided to animals during night particularly the lactating animals to maintain the milk production for family need, especially towards the end of the long dry season where forage is scarce, and of low nutritive values. Based on the yearly pasture evaluation report highlighting the zone of good and bad pasture production of vulnerably zone at the probable pastoralist that may be affected by forage shortage, an emergency plan is elaborated by the ministry of animal husbandry. The plan will give the details activities that should be carried out to protect the livelihood of the pastoralists. The required concentrate to attenuate the shortage is determined. On this basis government and partners will accommodate to mutually buy and set the concentrates on the field close and on time to herders where were sold at moderate price. Also, during the alert phase, some pastoralists embarked on collection of hay and field residues to feed, get revenue, and to improve the productivity of livestock but the drawback of such practice is the acceleration of pastoral land degradation and loss of seed bank which later negatively impact the living conditions. These finding corroborate the results reported of Abdou *et al.*, (2011), and Snorek, (2016) who reported that during drought conditions many agro-pastoralists have made the selling of hay and field residues a prominent part of their livelihood, yet, the collection and sale of grasses is dichotomously a cause of the reduction of grassland and fodder.

Since the last drought during which many livestock species were lost, pastoralist learnt capacity-building initiatives from various non-governmental organizations and government agencies to embrace livestock off-take for long-term resilience to drought. The culling off of animals particularly the weak, old and unproductive ones at the alert phase or end the rainy season phase before drought crisis when they are of good heath, well fed and can be bought at a higher price at the alert phase is referred to strategic culling off, The practice will enable them to generate income to buy cereals for family use and feed for animal like hay, crop residues and concentrates to overcome forage shortages and to avoid losing their livestock assets. The intensive sale of animals or decapitalization of the herd adopted by pastoralists agree with the findings of that recent awareness and capacity-building initiatives from various nongovernmental organizations and government agencies led most of the pastoralists to embrace livestock off-take for long-term resilience to drought of Lauali, (2014,). The urgency decapitalization is carried out when

the drought condition enters the urgency situation characterized by the depletion of forage and high mortalities. It is carried out when the government declare that there is a pastoral crisis. As the declaration of pastoral crisis is announced, the rapid immediate response mechanism is activated, and all World Bank project were summed to supply 5% of their budget to intervene and settle the situation. Many activities are then conduction among which the urgency decapitalization of animals. Animals are bought from herder at predetermine prix to avoid high loss, slaughtered and the meat processed, which is later distributed to the needy.

Vaccination of livestock against the prevalent disease is a practice carried out by government and partners to improve the health of the animals. The activity is performed during the cold season before the animals start, the downward movement and at the onset of the rainy season, the vaccination is against the prevalent diseases such as Contagious Bovine Pleuropneumonia disease, small ruminant Pleuropneumonia and Pasturellosis and it is free mandatory and carried just after the rainy season to facilitate transhumance. This confirms the result of the General census of Agriculture and Livestock of 2007, where they observed in a survey of livestock productivity assessment that 31% of herders vaccinate their animals against the prevalent disease. Abdou *et al.*, (2011) noticed in the evaluation of the impact of the pastoral crisis of 2009-2010 in the 14 pastoral departments of Niger republic, that 42.31% of pastoralists vaccinate their animals.

Social help is common, and form of coping strategy employed by pastoralist. The strategy helps to contribute to the psychological and social well-being through restoring dignity and a degree of control to disaster-affected populations. Although the practice is carried by only 8% of the respondent, it enables the distressed herders to get a couple of animals that will provide them milk for years. The animals are kept for years to give offspring's which ultimately become its property, after which, the animals are returned back. The government also carry such operation to herders that loss all their animals. Every year distressed herder was identified and were given four female and 1 male particularly goat because of its ability to withstand drought and its high prolificacy. This practice has been reported and was applied by 87.5% of agro pastoralists in Nigeria as reported by (Godson-Ibeji *et al*., 2022).

Like, the creation of concentrate feed boutiques, vaccination, irrigation farming, marking of livestock passing corridors and, soil and water conservation technique and seed broadcasting are carried out through cash for works or cash for food operations is done to increase forage production and to minimize effect of drought crises.

Activities diversification is a major strategy employed by more than 50% of the respondents to thrive in a harsh environment and improve household resilience in drought periods. The diversification is an additional job to pastoralism, rather than to substitute for livestock production. The activities can be grouped into climate sensitive and no climatic sensitive activities.

The climatic sensitive activities include sale or trading of collected hay and field crop residues, firewood and charcoal activities, and wild fruits gathering and sale selling, vegetable farming. Despite these activities procure them revenue to improve the animal productivity and the family need, they are aware of their drawback. As explained during the interview, they accelerate the rangeland degradation though fastening of soil and water erosion and their related consequences. Most of these activities were carried out by pastoralist close to national road and big cities. Similar results have been reported by Opiyo *et al.*, (2015). Substance vegetable farming is a major widespread activity in Tahoua pastoral zone undertaken to reduce the sale of livestock to meet family needs. The activity apart from enabling them to earn revenues, contribute greatly to the family basket consumption. This practice is in line with finding of Snorek, (2016) who noticed many fences garden of vegetable farming across the pastoral zone. The non-climatic sensitive activities concern, migration social help, herd diversification, and drilling of boreholes or wells. Many boreholes and traditional wells are constructed every year by pastoralists, Governments and NGOs in high pasture producing. This will facilitate a better exploitation of natural pasture contribute to reduce the feed scarcity in the late dry season and to reduce drinking water issues.

The breed raised are well adapted to the harsh arid environment characterized by frequent forage shortage. However, Cattle and sheep are more sensitive compared to Goat and Camels. Herders discovered that the drought sensitive species died more than the non-sensitive species. Therefore, nowadays pastoralists have good preference for browsers (goats and camels), than grazers (cattle and sheep), due to changes in vegetation composition and water scarcity. They also notice that family embarked in diversification of herd composition and species have higher off-take and are therefore more resilient during drought events. This practice has been reported by (Little & Mcpeak, 2014), who reported that herd composition can be a strategic choice to manage household resilience in response to changing environmental conditions.

The actions undertaken by government and NGOs to improve the living conditions of the pastoralist, include provision of animal feed in quantity and quality, vaccination of animal against the prevailing diseases, improving animal's productivity, guarantee drinking water, marking of livestock routes and enclaves from encroachment, and social insertion of distressed pastoralist. Vaccination, soil and water conservation of barren land and seed broadcasting, social insertion, concentrate feed provision activities have already been discussed earlier. Animals fattening, creation of abattoirs and modern livestock markets, pasture cultivation, fire break bands making are activities conducted to improve the living conditions. Some of these activities are carried through cash money of

food for work to enable household to gain additional income and food and avoid loss of their asset through selling, while some facilitate the exchange of goods (markets) during mobility. The end results of these activities are to reduce livestock assets loss during drought or pastorals crisis and to minimize its effects.

Conclusion

The pastoralists clearly indicated that the rangeland is deteriorated due du recurrent drought, high livestock pressure on natural pasture, upward shift of crop farming in the protected pastoral zone as a result of high demographic pressure and pastoral crisis. The recurrent and prolonged drought coupled with the over-utilization of coping strategies affected the herbaceous and trees covers of the rangeland. The consequences include increase soil and water erosion due to increasing barren land frequency and change in pasture plants composition with replacement of highly palatable plants species by less palatable and undesirable drought tolerant species. These effects have changed their habits, practices and their socio-cultural values have been profoundly modified.

The study highlighted that pastoralists of the pastoral zone undertake many different indigenous copying strategies to overcome these threats. They are also supported in their continuous efforts by the government and NGOs to make them more resilient and to minimize the effects of these recurrent and prolonged forage shortages resulting from drought. These adaptive mechanisms deployed by the government and partners include both development actions and non-development actions.

Continuous sensitizing on the need of anticipating responses since the alert phase of the drought occurrence is important to protect their assets and to minimize the effects. Also, early information system awareness on the of crisis, training and workshop of pastoral civile societies and educated representatives of pastoralists on the livestock emergency guidelines and standard are fundamental to enhance the indigenous knowledge of the pastoralists and to take the best decision making.

References

Abdou, Sala. Issa, Atte. and Hassane, Omarou. 2011. Evaluation rapide de l'impact de la crise pastorale 2009-2010 sur la décapitalisation du cheptel et sur les moyens de subsistance des populations pastorales et agro-pastorales du Niger.

Abawi, Y., S. Dutta and J. Ritchie. 2003. Potential use of climate forecasts in water resources management. In Science for drought: Proceedings of the National Drought Forum at Brisbane, Australia, ed. R. Stone and I. Patridge, 78–81

Rabani, A., Boubacar, I., Abdou Latif, B., Abdoul Aziz, S. and Mamoudou, I. 2021. Niger - Land, climate, energy, agriculture and development: A study in the Sudano-Sahel Initiative for Regional Development, Jobs, and Food Security.1-68.

Amin, A., E. 2005. Social Science Research, Conception, Methodology and Analysis. MAK University, printer, Kampala, Uganda. Amin, A., E. 2005. Social Science Research, Conception, Methodology and Analysis. MAK University, printer, Kampala, Uganda.

Bai, Y.; Deng, X.; Zhang, Y.; Wang, C.; Liu, Y. 2019.Does climate adaptation of vulnerable households to extreme events benefit livestock production? *J. Clean. Prod.*, 210, 358–365. [CrossRef]

Conseil Régional de Developpement. 2016. Plan de Développement Régional.2016-2020.

Dieter; Geesing and Hassane; Djibo. 2006. Country Pasture / Forage Resource Profiles / Afghanistan. *Fao*, 19.

Djalal Ardjoun Khalil1, Sing-yabe Sahoulba, Mahamat Ibrahim Souleymane, I. Y. 2021. Impact of the Security Crisis on the Transhumant Pastoral System in the Province of Lac , Department of Mamdi (Chad). *1*.

Djoudi, H., Brockhaus, M., Locatelli, B .2011. Once there was a lake: vulnerability to environmental changes in northern Mali. Reg Environ Change 13(3):493–508. Doi: 10.1007/s10113-011-0262-5.

Ferner, J., S. Schmidtlein, R.T. Guuroh, J. Lopatin, and A. Linstädter. 2018. Disentangling effects of climate and land-use change on West African drylands' forage supply. Global Environmental Change 53: 24–3.

FEWSNET, 2011. Niger Food Security Outlook Update (FEWSNET). USAID November 2012. Accessed online August 15 2013: www.fewsnet.net/niger.

Fode, C.M.S. 2010. Durabilité des systèmes pastoraux et dynamique de la strate herbacée des pâturages de la zone Sahélienne du Niger. Master's Thesis presented to the Faculty of Biological Sciences of Université des Sciences et Technologie Hoary Boumediene.

Gerber,P., Touré, I., Ickowicz, A., Garba I., Toutain, B. 2010. An information system on pastoralism in the Sahel , what are the challenges ? 2009, 1–32.

Giddings, L., M. Soto, B.M. Rutherford, and A. Maarouf. 2005. Standardized precipitation index for Mexico. Atmosfera 18(1): 33–56.

Godson-Ibeji et al. 2022. Effects of climate change on agro-pastoralists' economy and adaptation strategies used in Southeast, Nigeria. *MOJ Ecology & Environmental Sciences*, *7*(1): 18–22. https://doi.org/10.15406/mojes.2022.07.00242.

Guuroh, R.T., J.C. Ruppert, J. Ferner, K. Čanak, S. Schmidtlein, and A. Linstädter. 2018. Drivers of forage provision and erosion control in west African savannas - a macroecological perspective. Agriculture, Ecosystems & Environment 251: 257–267. https://doi.org/10.1016/j.agee.2017.09.017.

Hidosa, D.; Guyo, M. 2017.Climate change effects on livestock feed resources: A review. *Journal of Fisheries and Livestock Production* (5):259.

Huho, J.M., and E.M. Mugalavai. 2010. The effects of droughts on food security in Kenya. The International Journal of Climate Change Impacts Response 2(2): 61–72.

Jeannette van de Steeg and Markos Tibbo. 2012. Livestock and Climate Change in the Near East Region.

Jane, N., Mwangi, J. G. and Nkurumwa, A. O. 2013. *International Journal of Agricultural Extension*. *01*(01).

Kaufmann, B., C. Hülsebusch, and S. Krätli. 2019. Pastoral livestock systems. Encyclopedia of Food Security and Sustainability 3: 354–360.

Kotari, C.R. 2004. Research methodology. Methods and Techniques (2nd ED) New Delhi. New age International.

Laouali, A., Boubacar, Y. and Philippe, L. 2018. *Pastoral and agropastoral household economy in the region of Diffa (Niger): between poverty and vulnerability*. *38*(3), 6326–6335.

Laouali A. 2014. Contribution to the study of the dynamics of pastoral farming in Niger: the case of the Diffa region. (Doctoral thesis). University of Liège-Gembloux Agro-Bio Tech. 212 p.

Linstädter, A., A. Kuhn, C. Naumann, S. Rasch, A. Sandhage-Hofmann, W. Amelung, J. Jordaan, C.C. Du Preez, and M. Bollig. 2016. Assessing the resilience of a real-world social-ecological system: Lessons from a multi-disciplinary evaluation of a South African pastoral system. Ecology and Society 21: 35

Little, P. D.and Mcpeak, J. G. 2014. Resilience and pastoralism in Africa south of the Sahara. *IFPRI 2020 Policy Consultation & Conference: Building Resilience for Food & Nutrition Security*, *May*, 75–82.

Martin, R., A. Linstädter, K. Frank, and B. Müller. 2016. Livelihood security in face of drought – Assessing the vulnerability of pastoral households. Environmental Modelling & Software 75: 414–423. https://doi.org/10.1016/j.envsoft.2014.10.012.

Masike, S., Ulrich, P .2008. Vulnerability of traditional beef sector to drought and the challenges of climate change: The case of Kgatleng District, Botswana. J Geogr Reg Plan 1(1):12–18. http://www.academicjournals.org/JGRP.

McKee, T. B., N. J. Doesken, and J. Kleist, 1995: Drought monitoring with multiple time scales. Ninth Conference on Applied Climatology, American Meteorological Society, Jan15-20, 1995, Dallas TX, pp.233-236.

Ministère de l'Agriculture et de l'Elevage. 2018. Synthèse des résultats de la champagne pastorale 2017-2018.

Ndlovu, T. 2019. Coping with drought : Reflection of communal cattle farmers in Umzingwane district in Zimbabwe. 1–9.

Opiyo, F., Wasonga, O., Nyangito, M., and Schilling, J. 2015. Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya. *International Journal of Disaster Risk Science*, *6*(3), 295–309. https://doi.org/10.1007/s13753-015-0063-4

Ouédraogo, O., & Linstädter, A. 2021. *Resilience strategies of West African pastoralists in response to scarce forage resources*. *8*.

RENALOC. 2012. Répertoire National des Localités. Institut National de la Statistique.734

Rivera-Collazo**,** I**.** and Rosen, A. M. 2012. Climate change, adaptive cycles, and the persistence of foraging economies during the late Pleistocene/Holocene transition in the Levant. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(10), 3640–3645. https://doi.org/10.1073/pnas.1113931109

Salau, O. R., Fasuba, A., Aduloju, K. A., Adesakin, G. E., and Fatigun, A. T. 2016. *Effects of Changes in ENSO on Seasonal Mean Temperature and Rainfall in Nigeria*. *Figure 1*, 1–12. https://doi.org/10.3390/cli4010005.

Smith, B., Burton, I., Klein, R.J.T. and Wandel, J., 2000, 'An anatomy of adaptation to climate change and variability', Climatic Change 45(1), 223–251.

Snorek, J. (2016). Shrinking pasture, burgeoning herds: Divergent adaptation to climate change in Tahoua, Niger. https://www.tdx.cat/bitstream/handle/10803/400717/jusn1de1.
pdf?sequence=1&isAllowed=y

Subash N, Ram Mohan HS. 2011. Trend detection in rainfall and evaluation of standardized precipitation index as a drought assessment index for rice–wheat productivity over IGR in India. *International Journal of Climatology* 31: 1694-1709 doi: 10.1002/joc.2188.

Tiruneh, S., Tegene, F., 2018. Impacts of climate change on Livestock production and productivity and different adaptation strategies in Ethiopia. J. Appl. Adv. Res. 3 (3), 52–58.

Thomas, D.S.G. and Twyman, C. 2005. 'Equity and justice in climate change adaptation amongst natural resource-dependent societies', *Global Environmental Change* 15(2): 115–124. https://doi.org/10.1016/j.gloenvcha.2004.10.001

Thornton, P.K., van de Steeg, J., Notenbaert, A. and Herrero, M. 2009. The impacts of climate change on livestock and livestock systems in developing countries: a review of what we know and what we need to know. *Agricultural Systems*, 101: 113–127.

Valentine Debray; Adeline Derkimba and Katia Roesch. 2015. *Agroecological innovations in a context of climate change in Africa*.

World Meteorological Organization. 2009. Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation. Climate data and monitoring. WCDMP-No. 72.