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Risk management strategies among Fulani pastoralists in the Diffa region of Niger: from adaptation to resilience

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Abstract
Located in the far east of Niger, the Diffa region is an area with an essentially pastoral vocation.However, in recent decades, livestock farming has been subject to various natural and anthropogenic constraints.These constraints are all risk factors that hinder the smooth running of pastoral activity.To understand the strategies developed by breeders in the face of these risks, survey work was conducted with 147 households of Fulani breeders using a systemic approach. Analysis of the results reveals that faced with these risks, breeders develop ex-ante a set of means and mechanisms enabling them to protect themselves while awaiting the removal of uncertainty about the future.The reaction is also made ex-post when the shock has already occurred. These strategies are based on two requirements.That of ensuring the daily survival and social reproduction of the households in the group to which they belong on the one hand and, on the other hand, guaranteeing the sustainability and prosperity of their herd which constitutes the main means of production.

Keywords: *Adaptation, Pastoral breeding, Peul breeders, Risk management, Resilience, Vulnerability, Diffa.*

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I. Introduction

In the Sahel, pastoral farming is one of the most important animal production systems from an economic, social and environmental point of view. On the economic level, it contributes significantly to the formation of the Gross Domestic Products (GDP) of the Sahelian States. In Niger, in fact, this contribution is around 11% and livestock farming, practiced by more than 90% of the Nigerien population. It was, until recently before oil exploitation, the country's second export post after uranium (INS, 2010). It represents the main source of income for both agricultural and pastoral households. Also, through its products, livestock plays a decisive role in food and nutrition in both rural and urban areas, particularly in the Diffa region. In this region, 95% of the population practice livestock farming as their main or secondary economic activity after agriculture, with a herd of more than three million head of animals, i.e. 10% of the national herd (République du Niger, 2008). More than an economic activity, pastoral farming is also a way of life or even "a system of life" (Duteurtre and Faye, 2009) which ensures the pastoral household its social reproduction as well as its place in the community to which it belongs. Nevertheless, for more than two decades, this activity remains subject to various covariant shocks that weigh heavily on all pastoral and agro-pastoral production systems in this region.

Agricultural activity is especially favored by the presence of permanent watercourses, in particular the Komadougou River and Lake Chad, which are conducive to irrigated and/or flood-recession crops.Rainfed crops, which are very random, are observed in the extreme south of the region. However, in recent decades, the region has faced a climatic deterioration characterized by high rainfall variability (the regional annual average rarely exceeds 250 mm) and a phenomenon of desertification which compromises the restoration of the vegetation cover as well as of pastoral rangelandsand exponential extension of fields to the detriment of pastoral areas (Laouali, 2014). Thus, we are witnessing a reduction in the carrying capacity of pastoral rangelands, difficulty in accessing pastoral resources, a drop in livestock productivity and an exacerbation of conflicts between actors. This weighs on all pastoral and agro-pastoral production systems in the region.

This article aims to identify and analyze the strategies developed by Fulani herders in this region in the face of these risks and uncertainties. Dercon (2001) defines risks "as unforeseeable events likely to degrade living conditions. The unpredictable is related to the occurrence, timing and magnitude of the negative event." For Toutain (2001) risk is nothing other than "the more or less foreseeable eventuality or the probability of a danger". After presenting the study area, the methodology used for data collection will be described. Then, the obtained results will be presented and discussed. Thus, changes in the physical and natural environment will be

analyzed as well as for the production systems in place, particularly on the size, composition and structure of the herds. Then, the main risk management strategies (productive and food) of pastoral households will be identified and analyzed.

1. Material and method

1.1. Presentation of the study area.

Located between a Sahelian agro-pastoral zone in the South and a Saharan zone in the North, the Diffa region is a pastoral strip par excellence in Niger (Figure 1). The region covers an area of 156,906 km^2. It presents a relief made of plains and dune plateaus characterized by lacustrine and alluvial formations in its southern part and wind formations in the North. Thus, most of the population is concentrated in the southern strip of the region (Laouali, 2018).

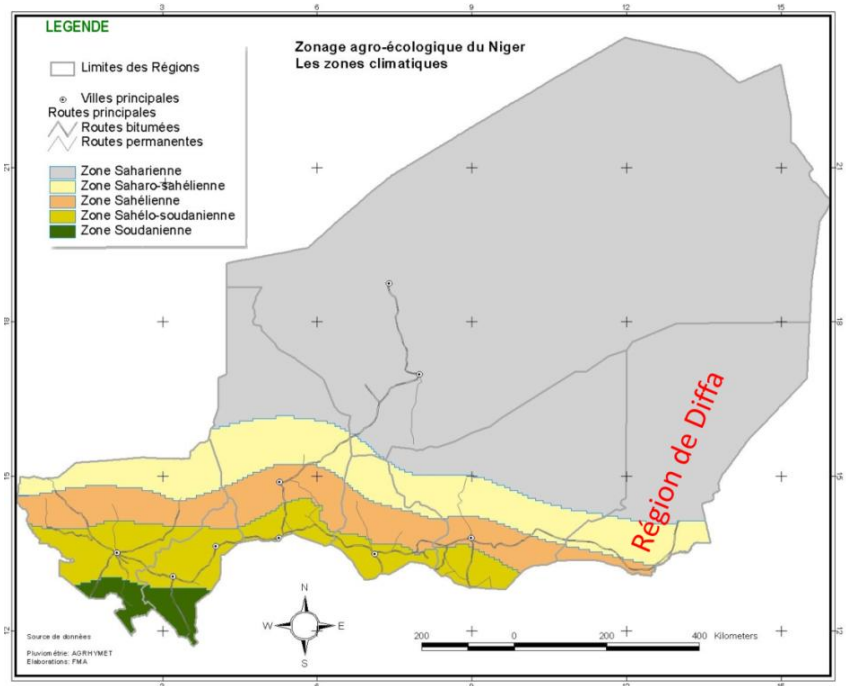

Figure 1. Agro-ecological zoning of Niger

Source : CIPSDR, 2004

The climate is of the Saharo-Sahelian type. The annual rainfall extends from July to September, rarely June. The amounts of precipitation vary on average, from about 340 mm of precipitation per year for 36 days of rain in the South (Mainé Soroa department) to 178 mm of precipitation per year for 28 days of rain in the North, department of N'Guigmi (INS, 2010). This makes Diffa one of the pastoral regions par excellence in Niger. This climate is characterized by an increasingly constant succession of dry periods (Figure 2).

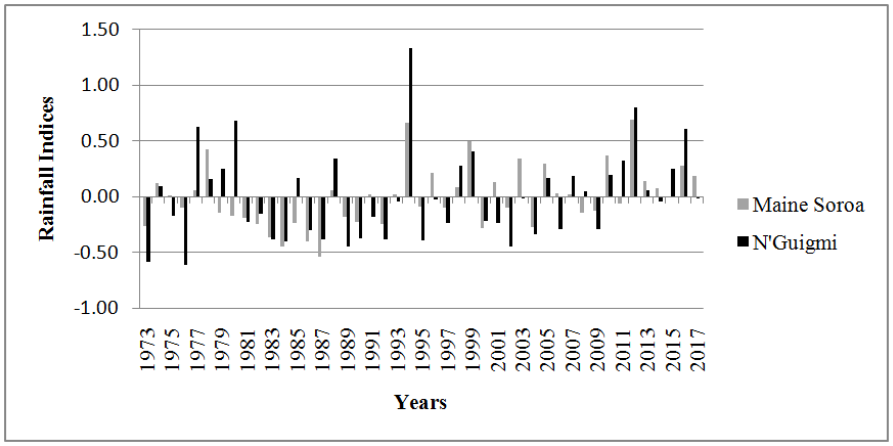

Figure 2. Rainfall variation in the Diffa region from 1973 to 2018

Source: National Department of Meteorology database

This climatic variability generates recurrent shocks, particularly in terms of pastoral resources leading to significant fodder deficits (Figure 3). These deficits become more and more structural for an extensive farming system.

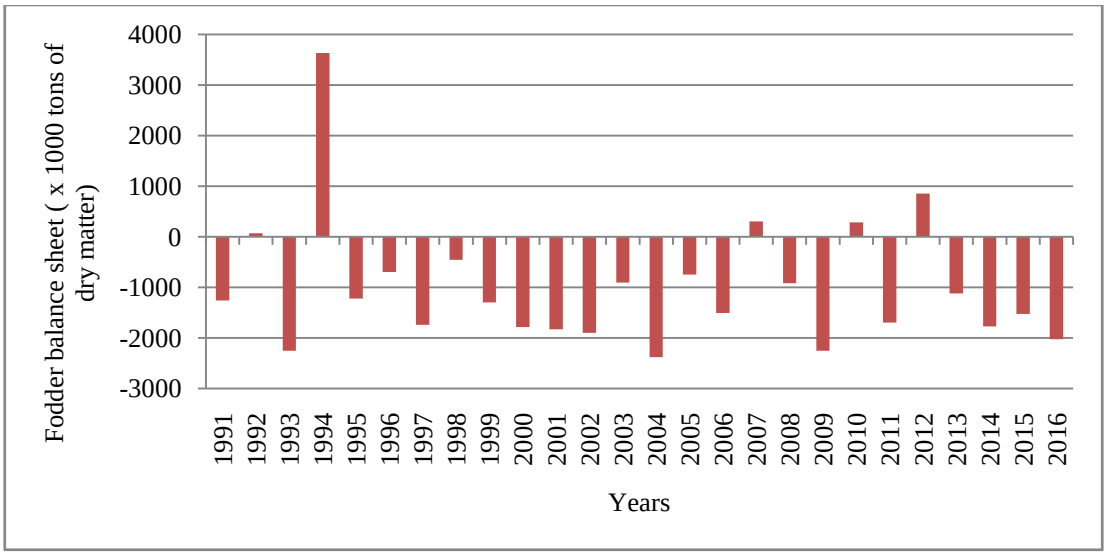

Figure 3. Evolution of the fodder balance in the Diffa region from 1991 to 2013.
Source: Annual reports of the Regional Livestock Department of Diffa.

The years with a fodder deficit are consecutive to the years of rainfall deficit that the region has experienced (in a normal year the average annual rainfall is around 250 to 300 mm in the southern band and 250 to 150 mm in the north) in particular and Niger in general.

1.2. Methodology

The methodology adopted is based on a so-called systemic approach, considering livestock farming as "a set of techniques and practices implemented by a community to exploit, in a given space, plant resources by animals, under conditions compatible with its objectives as well as the constraints of the environment" (LHOSTE P., 1984).

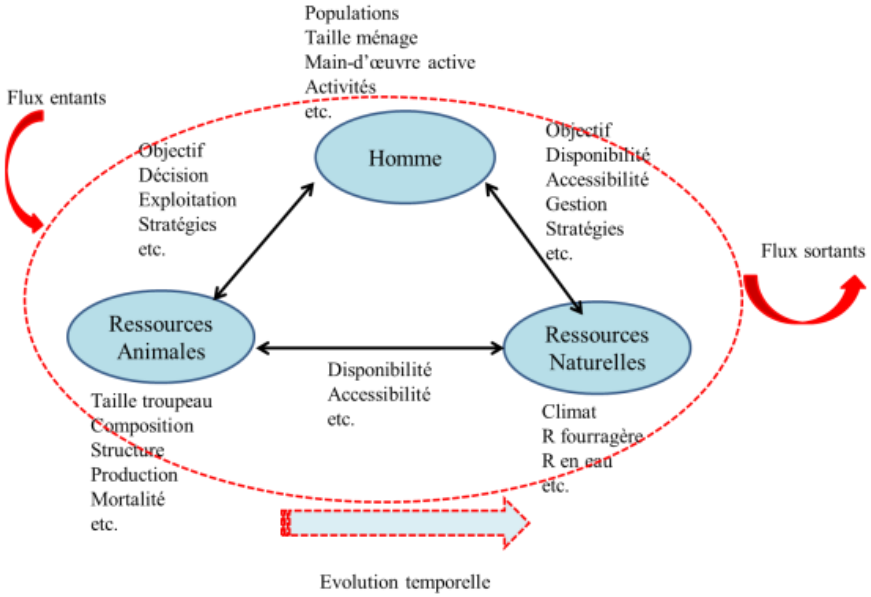

Figure 4. Systemic approach for analyzing the dynamics of the livestock system. Source: Laouali, 2014.

In addition, the "Land-Use and Land-Cover Change (LULCC)" approach (LAMBIN et al., 2000; LAMBIN et al., 2001; LAMBIN et al., 2007; PRAKASAM C., 2010) was used for the study of land use dynamics based on satellite images from 1990 and 2010.

1.2.1. Agro-ecological zoning

In order to take into account the existing agro-ecological variability and the mobility of breeders in time and space, the study environment was subdivided into three agro-ecological zones:

- Zone of pastoral basins (ZPB): Included between the isohyet 150 to 250 mm per year, it corresponds to the Saharo-Sahelian strip (north of the Diffa region). Livestock is the main economic activity of the population in the area.
- Komodougou zone (KZ): Located in the south, along the KomadougouYobéRiver over a length of 150 km. It receives 250 to 300 mm of precipitation per year. Agriculture (irrigated and/or flood recession) is the main economic activity of the population. It is a retreat area for herders in the dry season.
- Lake Chad Zone (LCZ): Located at the extreme east of the region in the Lake Chad Basin. It receives 250 to 300 mm of precipitation per year and agriculture (especially during the recession) represents the main economic activity of the population of the area. It is an area of retreat par excellence for breeders.

1.2.2. Sampling and statistical analysis

A total of 150 households were randomly sampled at the rate of 50 per agro-ecological zone. The choice of households is made in such a way that we have 75 households with sedentary breeding and 75 households with mobile breeding. The database was built with Excel spreadsheet. Data processing was done using Minitab 16 software.

The analysis of risk and uncertainty management strategies is based on the understanding of the concept of resilience. A system is thus said to be resilient when it succeeds not only in resisting and absorbing the shock in such a way as to maintain the existing by actively responding to disturbances (defensive attitude) but also in adapting, transforming, modifying or to break with what already exists following an offensive attitude (Lallau and Thibaut, 2009; Provitole, 2009). Studying the resilience of an individual, a household or a community therefore comes down, first of all, to understanding the strategic choices made by the latter in the face of his or her environment or the risks to which he or she is exposed but also to analyze the risk management strategies adopted to deal with them (Boureima et al., 2012; Lallau and Thibaut, 2009; Marc, 2009; Adger et al., 2003; Adger, 2000; Holling, 1986; Pimm, 1984).

II. Results

2.1. Changes in the physical and natural environment

The analysis of Table 1 indicates that 28% of the area considered was subject to the phenomenon of silting, which recorded an increase of more than 224% in 20 years. The pastoral and/or agro-pastoral basins and lowlands were the most threatened over the period considered.

Table I. Cumulative dynamics of land use units (1990 and 2010)

Yeras	1990		2010		Ecart 1990-2010	
Land coverunits	Superficies (ha)	Coverage rate (%)	Superficies (ha)	Coverage rate (%)	Superficies (ha)	% de 1990
Shrub steppe	303253,4	13,5	236501,8	10,5	-66751,6	-22
degradedshrub steppe	710755,3	31,6	687826,6	30,6	-22928,6	-3,2
Food crops and market gardening of flood recession	202799,9	9	243457,4	10,8	40657,6	20,1
Quite dense vegetation of the lake bed	137127,8	6,1	90209,8	4,0	-46918	-34,2
Very dense vegetation of the lake bed	8381,5	0,4	11074,1	0,5	2692,7	32,1
KomadougouYobe River	3593,6	0,2	3604,5	0,2	10,9	0,3
Pond	114,7	0,01	114,7	0,01	0	0,0
Agro-pastoral basins and bottomlands	16994,1	0,8	16387,7	0,7	-606,4	-3,6
Pastoral bottom	58914	2,6	50860,5	2,3	-8053,4	-13,7
Rainfedcropping	255525,6	11,4	259477,7	11,6	3952,1	1,6
Combined dune area	7005,3	0,3	9945,1	0,4	2939,8	42
Live dune area	194158	8,6	245477	10,9	51318,9	26,4
Sandy area	339389	15,1	365043,8	16,3	25654,9	7,6
Silting around basins and agropastoral lowlands	8025,6	0,4	26057	1,2	18031,3	224,7
TOTAL	2246037,8	100	2246037,8	100		

In addition, it is important to emphasize that the gradual withdrawal of Lake Chad from the territory of the region has favored the densification of the vegetation cover by the proliferation of *Prosopisjuliflora*. This species spontaneously invades the space abandoned by the waters of the lake. The analysis shows, in fact, a regression of the steppe (shrub and degraded shrub) of about 25% of its area between 1990 and 2010 and this, in favor of crops (rainfed, recession and/or irrigated) more precisely on the outskirts of Lake Chad and around the Komadougou River. Also, the various observations and analyzes have noted the degradation of pastoral routes

marked by the appearance of plant species of poor fodder quality, little or not palatable by animals, such as *Calotropisprocera*; *Sidacordifolia* or *Pergulariatomentosa*; etc.

2.2. Changes in herd size, composition and structure

Reading Table II indicates a significant difference between the size of the sedentary herd and that of the mobile herd. Indeed, the average of the sedentary herd is around 18.8 TLU, largely dominated by small ruminants against 25.6 TLU for the mobile herd, predominantly large ruminants (57.8%). On the other hand, there is no significant difference in terms of numbers between sedentary and mobile households; the average is between 11.6 and 12.4 people.

Table II. Average Fulbe household and herd sizes by livestock system

Rubric	Averagehousehold size (persons)	Herd size (TLU)	Proportion of cattle (%)
Sedentary	11,6[a]	18,8[b]	46,2
Mobile	12,4[a]	25,6[a]	57,8

Table III shows that with a ratio of less than 3 TLU per capita, both sedentary and mobile herds are below the pastoral viability threshold. Indeed, only 13.8% of sedentary herds are viable against 25% for mobile herds.

Table III. Average possession of TLU per adult equivalent and per capita according to the farming system

Rubric	Average TLU	
	per adultequivalent	*per capita*
Sedentary	1,9	1,7
Mobile	2,3	2

Such a situation indicates that the households are in a vulnerable situation, the pastoral activity of the household's surveyed being, for the most part, determined by the size and composition of their herd. Random and seasonal nature of these resources significantly influences the conditions for feeding and watering livestock. Beyond that, it determines the nutritional status as well as the performance of the herd. Indeed, repeated droughts, leading to structural fodder deficits, are the main causes of the reduction in the size of herds, both sedentary and mobile. The interval between two successive years of drought is relatively short, exceeding 3 years compared to five years in the past, thus compromising the chance of the herds to recover. The fodder deficit leads to the undernourishment of animals which become very vulnerable to epizootics. This situation negatively influences livestock productivity, particularly in terms of fertility, animal weight gain, abortion, milk production, etc.

It thus appears, and in general, that the breeders surveyed no longer have large herds of cattle. Also, the herds are largely dominated by small ruminants with a preponderance of goats for the sedentary breeding system in particular. This reflects the impoverishment of the households surveyed. Herd is the productive base of pastoral and/or agro-pastoral households in the Diffa region.

To deal with these risks and uncertainties, Fulani herders in the Diffa region are developing, as much as possible, a set of strategies aimed at preventing covariant shocks (insufficient rainfall; insufficient pasture; prevalence of epizootics; etc.) or mitigate their effects and ensure the survival of the household and productive capital and beyond that make their system more resilient.

2.3. Adaptive strategies, risk management and uncertainties

This section aims to identify the main strategies constructed and developed by the households surveyed in the face of productive risks and food insecurity, particularly in relation to biophysical covariant shocks. And therefore, to analyze and evaluate the level of construction of the resilience of the households surveyed.

The analysis of the strategies deployed by Fulani herders in the Diffa region has made it possible to categorize them into two large complementary groups. The first group concerns all the strategies aimed, on the one hand, at preserving livestock capital from biophysical risks and uncertainties and, on the other hand, at mitigating the negative effects due to covariant shocks and ensuring the survival of the livestock reproductive nucleus of the herd. The second group concerns all the countermeasures developed by breeders to preserve and guarantee the food self-consumption of households thanks to products from their livestock capital.

2.3.1. Productive risk management strategies

Aware of the consequences linked to covariant natural risks, the breeders surveyed have developed appropriate mechanisms, depending on the case, to deal with them or even build their resilience. It is:

• The distribution of risks

Like other Sahelian regions, livestock farming in the Diffa region is both multifunctional and multispecific (small and large ruminants). As such, breeders seek to protect themselves and/or mitigate the shocks of drought by spreading the risks over several species in the event of a severe fodder deficit. The logic is to rationally exploit the pastures on the basis of the diversity of the diets and food behaviors of the species. In addition, the results of the research show that small ruminants, especially goats, are becoming increasingly important in the composition of herds among breeders in the region, because goats are more resistant to drought shocks than cattle. Also, in the event of a pastoral crisis, some herders divide their herd, when the size allows it, into two groups for transhumance. Thus each group follows a different mobility circuit in order to be able to best save the reproductive nucleus of the herd in the event of possible shocks on one or the other of the circuits.

• Loans of young females or *habbanaye*

Even if the extent of this practice tends to be reduced, especially for large ruminants (due to the fact that households do not have enough large ruminants to allow themselves to lend a few heads to others without acting on their own capacity productive), few breeders do not have *habbanaye* animals in their herd. Indeed, 68.5% of surveyed households have *habbanaye* animals in their herd. At the same time, 61.9 have lent in the form of *habbanaye*. It is a strategy with both economic and social scope for both the borrower and the lender. From an economic point of view, in fact, it allows the borrower to increase and/or reconstitute his productive assets thanks to the products of the births from which he would have benefited according to the clauses. For the lender, placing a certain number of animals in the form of *habbanaye* is part of a calculated risk management strategy. Because, in the event of significant or partial loss of livestock following natural or epizootic shocks, he can easily reconstitute the reproductive nucleus of his herd by repatriating some or all of the animals that he would have placed in *habbanaye* as well as by -stockings that are rightfully his. From a social point of view, the *habbanaye* makes it possible to strengthen the bonds of solidarity, friendship and/or fraternity between the borrower and the lender and, beyond that, between the two families or even between communities or tribes. It constitutes an important reciprocal social capital on which pastoral households build and develop their resilience following covariant and/or idiosyncratic shocks. In addition to the *habbanaye*, poor herders also resort to other social support mechanisms, including donations, zakat, etc. to increase their livestock capital.

- Reconstitution by small ruminants:

Through this mechanism, breeders who have experienced the loss or reduction of their herd following natural or epizootic shocks are able to adjust and maintain themselves in the system. Thus, thanks to income from non-pastoral activities, more than 20% of respondents were able to buy, initially, small ruminants that they raised. And thanks to the income from the sale of the products of this breeding, they were able to gradually acquire large ruminants, reconstitute the herd and build their resilience.

• Complementarities and reciprocity of access to resources

Thanks to mobility, one of the five fundamental principles of pastoralism, the breeders of the Diffa region ensure the feeding and watering of their herds beyond their home territory, particularly in times of pastoral crises. However, access to pastures and water points located on the host sites is greatly facilitated by the level of social relations that the breeder would have woven with his hosts through, in particular, kinship ties, livestock loans, gifts, weddings, etc.

2.3.2. Food risk management strategies

Livestock are the main livelihood of pastoral households from which they derive most of their income and food. Thus, food security in pastoral areas is largely dependent on the ability of households to meet their daily food needs from the livestock they raise. Since the slaughter of animals for own consumption is rare or even occasional, milk associated with millet is the main consumer product in pastoral areas. The level of millet consumption depends on the ability of the herd to meet household milk needs. The more milk is available over time and in sufficient quantity, the less households have recourse to cereals. Consequently, the removal of the herd intended for sale to stock up on food on the markets is reduced to a strict minimum. Thus, survey households deploy various adaptive strategies to prevent and/or mitigate the effects of these shocks.

It's about the :

• Risk distribution and preservation of the reproductive and/or milk nucleus

To guard against the risks of food insecurity, pastoralists raise various animal species, thus spreading the risks over the resistance capacities specific to each species. Also, paramount importance is given to female individuals who represent more than two thirds of the herd, particularly in the age group of more than one year

for small ruminants or three years for large ruminants. This strategy allows the breeder to preserve the reproductive and/or dairy nucleus of his herd and therefore to be able to meet the daily food needs of the household.

• Mobilization of the social network

When the household has few or no lactating females, following covariant or idiosyncratic shocks, able to produce sufficient milk for its own consumption, it mobilizes its social network to ensure, as much as possible, its food security. . One of the strategies most applied by breeders is the loan of lactating females (or *dillaye*). This strategy consists in asking, from a relative or a friend, the loan of a cow (or camel) in lactation which can allow the borrowing household to have milk for its own consumption and this, for a well determined period. Any other product from this female during the loan period (new farrowing, for example), remains the property of the lender, unlike the *habbanaye* system.

- Transition to agro-pastoralism

The analysis of the research results reveals that the pastoral environment is marked by an influx of breeders towards agriculture characterized by sporadic installations of crops in areas normally reserved for breeding. Thus, the basins and other pastoral areas are colonized by fields in the rainy season, reflecting the growing propensity of pastoral households towards an agro-pastoral system. About 78.4% of mobiles are pastoralists-farmers. These are pastoralist households who practice agriculture as a secondary activity; 91.5% of sedentary people are farmer-breeders: These are agricultural households that combine livestock farming with agriculture as a secondary activity and 16.3% of the sample does not practice agriculture.

The sedentary people practice rainfed crops in the pastoral basins while the mobile people practice flood recession agriculture in the Lake Chad zone and/or rainfed when the first useful rains find them in their home land in the pastoral zone. Thus, part of the family takes care of herding while the other is assigned to agriculture. Agricultural activity allows households to have a certain quantity of cereals for self-consumption with levels of self-sufficiency varying from 1 to 3 months depending on the year. However, the self-supply of cereals, although insufficient to meet household food needs, nevertheless contributes to reducing the sale of livestock to obtain food products. In doing so, this food risk mitigation strategy contributes to improving the capacity for renewal and reconstitution of the herd. The box below gives the testimony of a head of household, in his fifties, motivating the transition to agropastoralism. And beyond that, this story reflects how this breeder was able to build and develop resilience in the face of drought shocks.

«….Before the drought that caused the so-called "El-bouhari[1]" famine, my brother and I had a herd of more than 150 head of cattle (not counting goats and sheep). But this drought was, for us, like most breeders, very dramatic. The animals died en masse to such an extent that in the end, we only had around thirty cows left. It must be said that we, at least, can consider ourselves lucky because many had lost all of their livestock. That said, as far as I am concerned, with a herd reduced to such a size, I had decided to leave my share in the hands of my brother to venture into agriculture. This is how I settled in a village located in the Lake Chad area on the Nigerian side. On the spot, I asked the Boulama (title of the village chief in the Kanuri language) for permission to access the land. This is how I was able to clear my field and start growing maize and cowpea. And with the income from the sale of surplus production, I bought sheep and/or goats that I sent to my brother for breeding. Thus, each time the small ruminants became numerous, I sold them to buy a cow. And so on until I was able to have enough large ruminants to take over the management of my herd myself without giving up farming. Currently I have three fields in Lake Chad on the Niger side where I continue to produce maize and cowpea. Except that I no longer sell agricultural products with a view to buying livestock in order to replenish my herd because I have enough. ThankGod ! »

• The practice of income-generating activities:

Alongside the agro-pastoral sector, this practice is another strategy for diversifying sources of income and food among the households surveyed. These include trade, crafts, guarding in urban centers, etc. Herding is essentially exercised by precarious Fulani who have temporarily settled in town while entrusting their livestock to the care of a friend or family member who has remained in the pastoral production system. The income from herding ensures the food supply of the household and beyond that, the surplus of this income is devoted to the gradual reconstitution of the herd.

[1]This clarification allows us to say that the breeder is talking about the drought of 1983-84. The impact of this drought has been accentuated, in part, by the closure of the Nigerian-Nigerian border decreed by the Head of State of Nigeria, General Mohamed Bouhari. As a result, imports, especially those of food products, had become rare, thus aggravating the food shortage. Hence the name of the famine "El-Bouhari" associated with this drought by ordinary Nigeriens, particularly in the regions of Maradi, Zinder and Diffa.

III. Discussion

The analysis of climatic dynamics combined with that of land use has made it possible to identify the occurrence of natural and anthropogenic contingencies that interact on the construction and/or evolution of the different physical and biophysical units of the Diffa region. . It is clear that in this region, pastoralism, as an extensive production system exploiting the natural environment (Toutain, 2001), is subject to various natural and anthropogenic constraints. These constraints constitute so many risk factors, both for the livestock and for the breeders, which hinder the smooth running of the pastoral activity. The high inter-seasonal variability of pastures (abundant, green and rich in the rainy season; rare, dry and poor in the dry season) has a significant effect on the food and nutritional balance of animals (weight gain in 3 to 4 months during the rainy season and drastic loss during the long dry season). Also, the irregularity of rainfall in time and space makes fodder production unpredictable both in terms of availability and the nutritional quality of fodder. This situation of unstable equilibrium affects the performance and productivity of livestock and is most often characterized by heavy livestock losses. Following the poor pastoral campaign of 2009-2010, livestock in the region recorded a loss by animal species estimated at 30% of the number of cattle; 20% for small ruminants; 1% for camels; 3% for donkeys and 4% for horses (DREIA, 2010).

The results of this study corroborate the work of Anderson and Monimart (2009) highlighting the phenomena of climate change in the Diffa region as well as the socio-economic upheavals that this engenders at the level of pastoral households, in particular on the size, composition and herd structure (Laouali et al., 2018; Laouali et al., 2014; Laouali et al., 2013). These results also highlight the vulnerability of the households surveyed, mainly pastoralists. Because the environment is characterized more and more by uncertainty which results in an acute perception of the risks, to paraphrase Ancey (2009), and an increased competition of the actors as for the access and the control of the pastoral resources. These risks can be categorized into two groups, united by a causal relationship, namely: productive risks and food insecurity risks. The former affect the productive assets of households, in particular through the loss of livestock due to climatic hazards, epizootics, etc. The latter affect the living conditions of households by deteriorating their food and nutritional balance. Indeed, the great droughts of the 1970s that the Sahel experienced with the subsequent crises (famines, decimated herds, disaster-stricken households, etc.) on all agricultural and pastoral production systems significantly affected Sahelian households. Since then, this phenomenon has become almost cyclical and climate crises have become more pressing, particularly in Niger. Studies and other research work have been undertaken on this subject in an attempt to analyze and understand the pastoral dynamics in the Sahelian strip as well as the risk management strategies initiated by both agricultural and pastoral households (Bernus, 1995; Josserand, 1994; Bourgeot, 1994; Thébaud, 1988; Anderson and Moninart, 2009).

Faced with these risks and given the vulnerability of the pastoral livestock system (Nori et al., 2008), Fulani herders in the Diffa region are developing a set of means and mechanisms enabling them to protect themselves while waiting for the uncertainty about the future: we talk about ex-ante strategy. The reaction also occurs ex-post when the shock has already occurred (Cantoni and Lallau, 2010). In other words, the strategy of the households surveyed is based on two requirements. That of ensuring their daily survival and social reproduction in the group to which they belong on the one hand and, on the other hand, of guaranteeing the sustainability and prosperity of their herd which constitutes the main means of production. Thus, analyzing the risk management strategies of households comes down to understanding their ability to adapt, resist and survive in the face of a critical situation. Because according to Raas (nd), the best management strategies aim above all to reduce risks in order to limit the probability of shocks. Added to this, are the sudden risk mitigation mechanisms to overcome negative effects. And finally, deploy risk adjustment strategies to ensure the survival and develop the resilience of the individual or the system in question.

The strategies put in place by the breeders surveyed go from the distribution of risks, through the diversification of the animal species raised and the division of the herd, to the conversion to agropastoralism through the mobilization of social networks. And as Bode (2012) pointed out so well, in the face of all the adversities and multiple contingencies of the moment (climate hazards, anthropogenic and epizootic factors), breeders have been able, on the one hand, to preserve as best they can centuries-old pastoral practices and, on the other hand, to adapt them in order to resist and ensure their survival. To do otherwise would be synonymous with fatal condemnation both for the system and for the social reproduction of the group. Livestock is the main or even the only source of income and food for agropastoral and pastoral households in the Diffa region.

Over the years, the traditional mechanisms and strategies for managing food insecurity tend to show their limits in the face of the multifaceted and recurrent shocks experienced by the Diffa region. Indeed, to paraphrase Benoit M. (1977:218) these "old mechanisms are increasingly distorted by the dynamics of the global human and animal load". Thus, since the droughts of the 1980s, particularly that of 1983-84 which had decapitalized the Sahelian herd, breeders with few livestock became more and more numerous. This is the case in the Diffa region where animal loans and donations have been reduced to the strict minimum, thus accentuating the food vulnerability of poor households. To cope with this, many of them have tried to adapt

their production system to the variability and constraints of the environment by resorting to agriculture and therefore by diversifying their food sources. They thus move from strictly pastoral to agro-pastoral. For some, the practice of agriculture on the sidelines of pastoral activity is an alternative to cope with the reduction or even the gradual loss of their livestock due to the recurrent fodder deficit of recent decades. A similar strategy has been observed among Turkana herders, a community of Kenyan pastoralists (Cantoni and Lallau, 2010) who, in the face of climatic shocks, have been able to transform their production system to adapt it to the dynamics of the ecosystem and thus build their resilience.

For others, the cultivation of part of the rangeland, particularly in the area of pastoral basins, results from an attempt to territorialize the space allowing them to have a priority right of use over the pastoral resources in place that access to pastoral resources in the region is based on the principle of complementarity and reciprocity. Pastoral areas are more and more coveted by breeders, especially owners of large herds. This translates into regular conflicts with indigenous herders around pastoral routes and water points on the one hand, and with farmers on the other. All in all, and as Thébaud (1999) put it so well, household agropastoralism is part of a logic of "the constant search for a delicate balance between two activities that are theoretically complementary, but likely to compete" (Thébaud, 1999: 158). The farmer, who accumulates in livestock, contributes to the increase in the number of livestock in the area and the consequent need for fodder. On the other hand, by setting up fields on pastoral routes (in pastoral areas and/or in the bed of the lake), the breeder contributes to the restriction of pastures as well as the mobility of herds. Added to this is the extension of fields to pastoral enclaves and the elimination of fallow land by farmers, which compromises the availability of fodder for all livestock in the region.

In this dualism, a diversity of production systems is built "results of the integration or interweaving of a whole range of agricultural and pastoral behaviors" (Bonfiglioli, 1990). Pastoral farming is certainly changing, but it nevertheless remains one of the best means for "the most vulnerable not to sink into social and economic marginality" (Duteurtre and Faye, 2009). Traditional strategies essentially consist of ensuring the daily survival and social reproduction of households, on the one hand, and guaranteeing the survival of the herd, the main productive asset, on the other.

IV. Conclusion

The analysis has highlighted the extreme vulnerability of pastoral farming in the face of risks and uncertainties in a natural environment with an unstable equilibrium, as well as the interplay between actors to deal with them. Many pastoral households are unable to meet their economic and food needs, herd size has become too small and productivity low. They are thus in a situation of vulnerability to biophysical shocks. Faced with these constraints, breeders develop a set of strategies allowing them to protect themselves, resist or adapt or even build their resilience following the shock. In this regard, there is the growing shift of pastoral households towards a survival agropastoralism for some or opportunistic for others. However, these traditional strategies for managing biophysical risks and uncertainties cannot, at present, be sufficient on their own to ensure the resilience of pastoral households over the long term in the face of the recurrence of covariant shocks.

Added to this is the growing insecurity experienced by this region due to increased abuses by elements of the Boko Haram sect, which hinders the social and economic activities of the region. The repeated assaults of this sect in the Diffa region, precisely along the Komadougou River and in the bed of Lake Chad, constitute a major obstacle to the mobility of pastoralists and their herds. This is all the more critical as these spaces constitute fallback areas for herders in the dry season, but also transhumance corridors to Nigeria, Chad or even Cameroon.

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