CSFD
Les dossiers thématiques
Issue 9

PASTORALISM IN DRYLAND AREAS

A case study in sub-Saharan Africa

AGROPOLIS INTERNATIONAL

Comité Scientifique Français de la Désertification
French Scientific Committee on Desertification

Les dossiers thématiques du CSFD Issue 9

Managing Editor

Richard Escadafal
Chair of CSFD
Senior scientist, IRD *(Institut de Recherche pour le Développement)* at CESBIO *(Centre d'Études Spatiales de la Biosphère)*, Toulouse, France

Authors

- **Bernard Toutain,** *bernard.toutain@yahoo.fr*
Agropastoralist, ex-CIRAD (Agricultural Research for Development, France)
- **André Marty,** *marty.andre@free.fr*
Sociopastoralist, ex-IRAM *(Institut de recherches et d'applications des méthodes de développement*, France)
- **André Bourgeot,** *bourgeot@ehess.fr*
Anthropologist, CNRS *(Centre National de la Recherche Scientifique*, France)
- **Alexandre Ickowicz,** *alexandre.ickowicz@cirad.fr*
Livestock Scientist, CIRAD (Agricultural Research for Development, France)
- **Philippe Lhoste,** *lhosteph@orange.fr*
Livestock Scientist, ex-CIRAD (Agricultural Research for Development, France)

Contributors

- **Véronique Ancey,** Socioeconomist of Pastoralism Issues, CIRAD
- **Gérard Begni,** Senior Expert: Environment and Sustainable Development, CNES *(Centre national d'études spatiales,* France)
- **Ronald Bellefontaine,** Tropical Forester, CIRAD
- **Marc Bied-Charreton,** Agroeconomist and Geographer, Université de Versailles Saint-Quentin-en-Yvelines, France
- **Bernard Bonnet,** Livestock Scientist, IRAM
- **Jean-Paul Chassany,** Agroeconomist, ex-INRA (Institut National de la Recherche Agronomique, France)
- **Antoine Cornet,** Emeritus Ecologist, IRD
- **Céline Dutilly-Diane,** Livestock Production Economist, CIRAD
- **Michel Malagnoux,** Forester/Ecologist, ex-CIRAD
- **Abdrahmane Wane,** Economist of Pastoralism Issues, CIRAD

Scientific editing and iconography

Isabelle Amsallem, Agropolis Productions
info@agropolis-productions.fr

Design and production

Olivier Piau, Agropolis Productions

Translation

David Manley

Photography credits

Bernard Bonnet (IRAM), **Diana Rechner** (INDIGO Image Library, IRD), **Ibra Touré** (CIRAD), **Gérard De Wispelaere** (ex-CIRAD), as well as the authors of the pictures shown in this report.

Printed by Les Petites Affiches (Montpellier, France)
Copyright registration à parution • **ISSN:** 1772-6964
1500 copies (also available in French)

une réalisation agropolis productions

French Scientific Committee on Desertification

The creation in 1997 of the French Scientific Committee on Desertification (CSFD) has met two concerns of the Ministries in charge of the United Nations Convention to Combat Desertification. First, CSFD is striving to involve the French scientific community specialized on issues concerning desertification, land degradation, and development of arid, semiarid and subhumid areas, in generating knowledge as well as guiding and advising policymakers and stakeholders associated in this combat. Its other aim is to strengthen the position of this French community within the global context. In order to meet such expectations, CSFD aims to be a driving force regarding analysis and assessment, prediction and monitoring, information and promotion. Within French delegations, CSFD also takes part in the various statutory meetings of organs of the United Nations Convention to Combat Desertification: Conference of the Parties (CoP), Committee on Science and Technology (CST) and the Committee for the Review of the Implementation of the Convention. It also participates in meetings of European and international scope. It puts forward recommendations on the development of drylands in relation with civil society and the media, while cooperating with the DeserNet International (DNI) network.

CSFD includes a score of members and a President, who are appointed *intuitu personae* by the Ministry for Higher Education and Research, and come from various specialities of the main relevant institutions and universities. CSFD is managed and hosted by the Agropolis International Association that represents, in the French city of Montpellier and Languedoc-Roussillon region, a large scientific community specialised in agriculture, food and environment of tropical and Mediterranean countries. The Committee acts as an independent advisory organ with no decision-making powers or legal status. Its operating budget is financed by contributions from the French Ministries of Foreign Affairs and of Ecology, Sustainable Development and Energy, as well as the French Development Agency. CSFD members participate voluntarily in its activities, as a contribution from the Ministry for Higher Education and Research.

More about CSFD:
www.csf-desertification.org

Editing, production and distribution of *Les dossiers thématiques du CSFD* are fully supported by this Committee through the backing of relative French Ministries and the French Development Agency (AFD).

Les dossiers thématiques du CSFD may be downloaded from the Committee website: www.csf-desertification.org

For reference: Toutain B., Marty A., Bourgeot A., Ickowicz A. & Lhoste P., 2012. Pastoralism in dryland areas. A case study in sub-Saharan Africa. *Les dossiers thématiques du CSFD.* N°9. January 2013. CSFD/Agropolis International, Montpellier, France. 60 p.

Foreword

Mankind is now confronted with an issue of worldwide concern, i.e. desertification, which is both a natural phenomenon and a process induced by human activities. Our planet and natural ecosystems have never been so degraded by our presence. Long considered as a local problem, desertification is now a global issue of concern to all of us, including scientists, decision makers, citizens from both developed and developing countries. Within this setting, it is urgent to boost the awareness of civil society to convince it to get involved. People must first be given the elements necessary to better understand the desertification phenomenon and the concerns. Everyone should have access to relevant scientific knowledge in a readily understandable language and format.

Within this scope, the French Scientific Committee on Desertification (CSFD) has decided to launch a series entitled *Les dossiers thématiques du CSFD,* which is designed to provide sound scientific information on desertification, its implications and stakes. This series is intended for policy makers and advisers from developed and developing countries, in addition to the general public and scientific journalists involved in development and the environment. It also aims at providing teachers, trainers and trainees with additional information on various associated disciplinary fields. Lastly, it endeavours to help disseminate knowledge on the combat against desertification, land degradation, and poverty to stakeholders such as representatives of professional, nongovernmental, and international solidarity organisations.

These *Dossiers* are devoted to different themes such as global public goods, remote sensing, wind erosion, agroecology, pastoralism, etc, in order to take stock of current knowledge on these various subjects. The goal is also to outline debates around new ideas and concepts, including controversial issues; to expound widely used methodologies and results derived from a number of projects; and lastly to supply operational and academic references, addresses and useful websites.

These *Dossiers* are to be broadly circulated, especially within the countries most affected by desertification, by email, through our website, and in print. Your feedback and suggestions will be much appreciated! Editing, production and distribution of *Les dossiers thématiques du CSFD* are fully supported by this Committee thanks to the support of relevant French Ministries and AFD (French Development Agency). The opinions expressed in these reports are endorsed by the Committee.

Richard Escadafal
Chair of CSFD
Senior scientist, IRD
Centre d'Études Spatiales de la Biosphère

Preamble

I am highly grateful to CSFD for devoting this 9th *Dossier* to the topic of pastoralism in sub-Saharan Africa and for inviting me to preface it.

This short booklet clearly highlights the complexity of pastoral systems in a simple straightforward and unaffected way—the term 'complex systems' is actually not even mentioned once! However, with abundant details and illustrations, pastoralism is shown to encompass soil, vegetation, animals, humans, precipitation, runoff, water infiltration, complementary phenological features of herbaceous plant species, annuals and perennials, shrubs and trees, knowledge, social relationships and cultural values of human societies. This is not a marginal issue—pastoral societies occur worldwide, in sub-Saharan Africa, of course, but also on many other continents.

This pastoral world has, albeit not without difficulty, eluded the streamlined optimum model that has been promoted throughout the world within the framework of agricultural modernization in Europe or the Green Revolution in developing countries. This model—whose fundamental assumption is the uniformization and stabilization of production conditions—has almost universally fostered development based on the genetic improvement of animals and plants, accompanied by essential nutrient inputs (livestock feed or fertilizer), disease and pest control products. This model is in stark contrast with pastoralism, which is actually based on diversity, mobility, adapting and responding to events. The buzzwords are heterogeneity and dynamics! Achieving optimal results is not the overall aim—pastoralism involves trade-offs, biases and cunning that are used to come up with satisfactory solutions.

The question is not to determine, as the authors suggest, whether "pastoralism is ecologically viable or not"! Pastoralism is not an academic discipline and the problem is not to rank it within any discipline, i.e. ecology. Nevertheless, we researchers will only be able to understand this phenomenon by studying it through a diversity of approaches, including an ecological one.

It is necessary to focus on:
- dynamics (seasons, multiannual cycles);
- interactions (between humans and environments, between humans and animals, between animals, between animals and plants, between plants when they are subjected to grazing);
- diversity (of animal and plant species and physiological stages);
- temporal aspects (animal growth rates, plant restoration cycles, human activity patterns).

Spatiotemporal mobility is one of the key concepts concerning life in such dryland areas under irregular climatic conditions. Maps—which have long been based on assessments and interpretations geared towards the rationalization of the use of such areas, and on indexes such as the carrying capacity, etc.—are unable to account for the temporal factors! This is critical because, as clearly outlined by the authors, rangelands are often imbalanced, and this aspect cannot be assessed on the basis of static measurements. A third dimension is needed to account for the diversity induced by spatial heterogeneity and temporal changes, under the aegis of dynamic knowledge, which always enhances the handing down, learning, testing and appropriation of innovations.

'Traditional' practices are constantly, and slowly but surely, being adjusted to cope with unforeseen or exogenous factors because in order to last—as in all social or biological processes—it is necessary to change, transform, adapt, but also to know how to resist by inventing new things and creating the conditions required to achieve what might seem impossible! These are good lessons to be learnt from pastoral societies, which are based on the mobility of people, livestock and knowledge, and are focused more on resistance than resilience since their situations are never socially neutral. These situations are marked by power relationships between individuals, social groups, colonial or national administrations, NGOs, national and international institutions, etc. Pastoral communities are often marginalized—being regularly ranked as poor according to international criteria, while also generally paying the price for agricultural and development policies—rather than being the focus of favourable public policies. The authors of this *Dossier* nevertheless suggest several potential changes that could be made in these policies so as to make them less disadvantageous. Moreover, the pastoral communities may be forced to bear the consequences of international discussions aimed at promoting a decrease in meat production and consumption, at least by people in industrialized countries. These initiatives specifically target ruminants—as if they were only reared for meat production!

It would of course be of interest to review the nutritional balance of our fellow citizens, as well as the ecological, energy, social and ethical costs of some methods for producing meat from both ruminant and nonruminant animals—the latter have a better reputation in international reports, despite the fact that they could be more criticized from social and ethical standpoints! Note that both small and large ruminants are able to graze habitats where crops cannot be grown due to problems of slope, elevation or irregular rainfall. Herbivores can wander about on their own when seeking plants upon which to feed—which are made up of materials generated from solar energy—and which in turn they transform into energy for labour for cultivation and movements, into meat, milk, fiber, etc. Some 'ecological preachers' should look closer at these extraordinary ruminant transformers and be more respectful of human communities which have symbiotically developed throughout the world alongside these animals, especially in desert, mountain and wetland regions. In short, these areas are considered to be too harsh for human activities and are marginalized by development models based on the control and stability of cropping and livestock production conditions, and thus on the settlement of farming activities. Pastoral societies deserve better than the derogatory treatment they often get because they are a constant reminder that it is possible to stand up against the 'forces of progress' and that other value systems can turn out to be just as sustainable, or even more so, than those that are based on proven scientific evidence.

This report shows that science is also focused on such situations with the aim of knowing* and gaining insight into them, while helping concerned social groups in their contemporary transformations. In turn, it shows how this is beneficial for scientific disciplines and academic approaches—to focus on such systems, to test their own certainties and thus generate new knowledge, questions and new avenues for research, which could be fruitful in terms of their potential applications and the cognitive advances that they facilitate.

In particular, research is required to reach beyond the definition or categorization of poverty, which has never enabled a single 'poor person' to rise above his/her situation. It is essential to focus more on processes that make some people more vulnerable than others to economic or climatic (or other) risks and which generate inequalities leading to poverty, i.e. inequalities with respect to access to land, resources, markets, education and health services. These are just a few examples of areas in which pastoral societies encounter difficulties—especially when the structuring nature of mobility, a fundamental feature, is denied: mobility essential for feeding herds and people, as well as for social relationships between scattered groups. Factors that force these people deeper into poverty could be controlled by reversing the perverse pathways leading to increased inequality and vulnerability.

I will end by mentioning the resource issue—and those who asked me to prepare this preamble are fully aware that this has been a pet concern of mine in recent years. The resources do not exist as such! They are generated by the use that is made of certain environmental elements by human groups. I refer to the 'functional integrity' concept outlined by P. Thompson and discussed by the authors in this *Dossier*. What may be a resource for a certain group at one time may not be at another time or for another group. Forest uses and resources, for instance, thus vary and are variable depending on the time period, techniques and the needs of societies, etc. The same applies to systems formed by pastoralists, their animals and the rangelands they utilize. The resources of these systems also have immaterial yet essential aspects, such as herd management know-how, rangeland access and grazing rights, herd movement rights, etc., which are the main resource of pastoralism.

Bernard Hubert

Research Director at the French *Institut National de la Recherche Agronomique* (INRA)

Director of Studies at the *École des hautes études en sciences sociales* (EHESS)

President of Agropolis International, Montpellier, France

* as highlighted by Ovid's *maxim Ignoti nulla cupido* ("there is no desire for what is unknown").

▲ Transhumant herder leading his dromedary camels to grazing lands. Northern Senegal.
© B. Toutain

Table of Contents

Pastoralism and desertification– a controversial issue

© A. Ickowicz

▲ Aridification in the Sahel. A herd benefitting from the shade of a tree, Kanem, Chad.

DESERTIFICATION—LAND DEGRADATION IN DRYLAND AREAS

The United Nations considers that desertification is "the greatest environmental challenge of our time" and warns that, unless political decisions are made to combat this phenomenon, over 50 million people could migrate out of their homelands over the next decade (UN, 2007). In arid, semiarid and subhumid regions*, the term 'desertification' refers to the degradation of land quality and productivity. During this period of rapid human population growth, especially in Africa, the ecosystem crisis that it represents is compounded by the fact that potential farming areas cannot be infinitely extended, they are subject to degradation and even coveted by international powers.

Desertification is defined by the United Nations Convention to Combat Desertification (UNCCD) as "land degradation in arid, semiarid and dry subhumid areas resulting from various factors, including climatic variations and human activities."

Desertification is a major current environmental issue and a concern for human societies, while also mobilizing policymakers in many concerned countries. The international community began dealing with the desertification problem in 1977 following the recurrent droughts occurring in the Sahel. An international conference was held in Nairobi in 1977 and a programme was set up to combat the phenomenon.

Due to the persistence of the phenomenon and its serious impacts, this topic took on a new political dimension during the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. Chapter 12.0 of Agenda 21 adopted during this conference concerned the management of fragile dryland ecosystems and the prevention of drought effects. Decision 12.4 stipulated that an international treaty on desertification should be drawn up. A text was written following intergovernmental negotiations and then the UNCCD, which was signed in Paris in 1994, entered into force in 1996.

* For West Africa: arid means annual rainfall of under 200 mm; semiarid from 200 or 250 mm to 500 or 550 mm; subhumid from 550 to 1 200 mm over a 6–8 month period.

> FOCUS | Regarding land degradation and desertification...

From a geographical standpoint, a **desert** is an uninhabited arid area. **Desertification** is the progression towards this state involving, according to the suffix *–fication,* the action of humans. The desertification concept applied in this *Dossier* is based on the assumption that it is an evolutionary process, while also allocating some responsibility to human activities. This underlines the impact of human societies on the environment but also the effects of this degradation on societies, where land degradation encompasses both ecosystems and living organisms.

In tropical Africa, a link is almost always noted between a population increase and desertification*, whereas in temperate Europe, 'desertification' is interpreted in the sense of "the disappearance of all human activity in a gradually deserted (by inhabitants) region" *(Dictionnaire Robert).*

The term 'desertization' was used in the 1960s for steppeland in North Africa (Le Houérou, 1968) pertaining to this evolution towards desert facies. Steppelands in the northern Sahara show severe degradation signs, leading to land denudation or oversimplification of the plant community. Overgrazing by herds and land clearing for cultivation worsen the impact of climatic aridification in these areas and it is feared that a recovery is no longer possible at these stages. However, the term 'desertization' was not used thereafter by the scientific community, at least in reference to tropical countries.

It is hard to find reliable statistics on the extent and degree of desertification in the Sahel. An global satellite remote sensing assessment in 1986 indicated that 18% of the overall area in dryland African regions south of the Sahara was degraded (Dregne, 1986). However, field surveys often suggest that these figures are exaggerated.

Drought is a soil moisture deficit situation in which human, animal and plant water needs can no longer be fulfilled. Drought is mentioned when this water deficit is unusual for the climate in the area and when it lasts long enough to be damaging. Drought differs from **aridity**, which is due to low mean rainfall or a scarcity of natural available water resources.

▲ Camels standing beside sand dunes in the Air region. Niger.

P. Blanchon © IRD

Is desertification synonymous with 'desert encroachment'?

The desert has a specific meaning and features for both geographers and ecologists. The climate is hyperarid and typical species live in this environment. A desert cannot be further desertified, but, conversely, a living environment could seemingly become a desert. What is the actual situation? The discussion hereafter applies only to Sahelian Africa south of the Sahara where it has been noted, on a temporal scale of the last few decades (around half a century overall), that the ecological boundaries between the Sahel and the Sahara have apparently not substantially varied. The geographical distribution of Saharan species has not expanded (except for the Saharan perennial grass *Panicum turgidum,* whose distribution range has extended into the Sahelian region by seeds being carried by cattle in their fur), and that of Sahelian species adapted to arid conditions has basically remained unchanged. These plants are good indicators of environmental conditions, especially rainfall patterns. Moreover, remote sensing surveys have highlighted the variability in plant cover according to the rainfall patterns, but without any extension of the Sahara (Tucker *et al.*, 1991). Recent studies have even indicated an improvement in the vegetation cover in some regions south of the Sahara, in pastoral areas, and also indicate a sharp and large-scale increase in plant biomass between 1982 and 2003 (Herrmann *et al.,* 2005). We therefore cannot talk about desert encroachment in this part of the world. However, advancing mobile sand dunes and silting may be observed in some regions, especially in Mauritania. Their cause is complex but the phenomenon cannot be equated with desert encroachment.

For further information on this topic, see:
Mainguet, 1995; Mainguet & Dumay, 2006; Berte, 2010.

* Even though the expression 'more people, less erosion' holds true in some agricultural regions (Tiffen *et al*,.1994; Boyd & Slaymaker, 2000).

PASTORALISM—THE FORERUNNER OF DESERTIFICATION?

There are three main human factors that cause desertification (MEA, 2005):

❶ overuse of farmland and water resources to feed a rapidly growing population

❷ overharvesting of natural vegetation (excessive gathering, deforestation, etc.) and its destruction by land clearing

❸ overgrazing of vegetation by herds, thus reducing rangeland production and natural reproduction of many forage trees.

The present *Dossier* is focused on this third factor—the role of livestock farming—and is limited to one large region in the world where **pastoralism*** is still one of the main economic activities, i.e. dryland tropical West and Central Africa. In pastoral areas of this broad subregion, cattle are often blamed as being the main factor responsible for environmental degradation. Is this criticism warranted? This *Dossier* provides some answers.

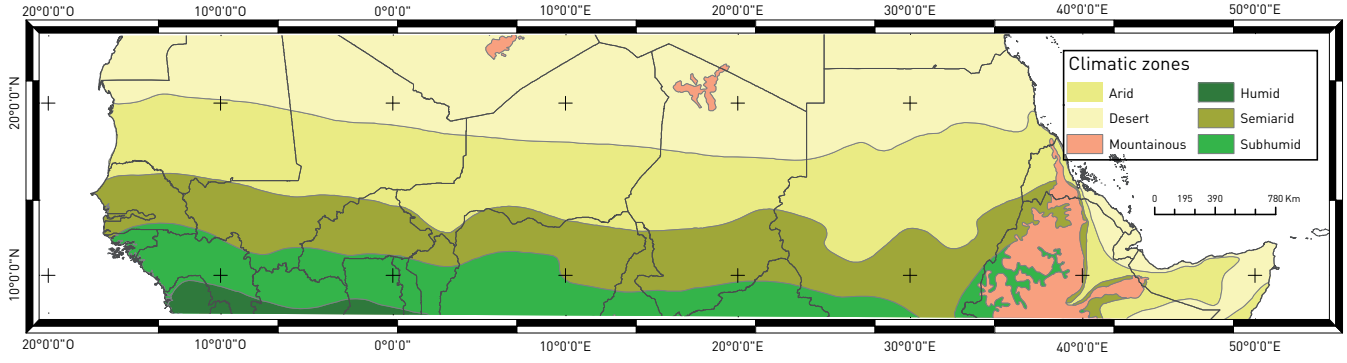
A review of the different types of pastoralism in the world highlights a surprisingly broad range of different pastoral environments, from pre-Arctic regions to tropics, mountains to plains, arid lands to swamps *(see for example Faye, 2008)*. The socioeconomic settings are also highly varied. However, some features are comparable in the social and familial organization, in the techniques applied, in the relationship of humans with animals and of societies with other social groups.

A LONG EVOLUTION SINCE ANCIENT TIMES

As early as Neolithic times, African populations specialized in pastoral livestock farming, as illustrated in some wall frescoes in the Sahara (Tassili). These **pastoralists** reigned over huge grassland areas, even though they were unsuitable for settled farming because of the harshness of the environment and scarcity of water. At the same time, to supplement their diversified diets and gain access to other staples, herders practiced hunting and gathering while also developing trade with other farming people. The climate changed in the Sahara and in and in sub-Saharan Africa. Livestock farmers were forced to move to find habitats suitable for their activity, while each time tailoring their lifestyle and production to the prevailing conditions.

Over the last century, the incredible increase in the global population also affected pastoral environments. The dramatic political, economic and social transformations that this generated everywhere were compounded, in the pastoral setting, by other substantial changes, in addition to the impact of climate change, especially the increase in pressure on natural and anthropogenic environments. These changes did not alter the progress of pastoralism and its extension into many regions worldwide. Although pastoralists seem to be going through the same moves as pastoralists have since ancient times, the **pastoral livestock-farming system** has been constantly evolving—nowadays herding knowledge is passed on from generation to generation, but pastoralists apply and tailor it to the prevailing situation in order to be able to quickly take advantage of opportunities that arise and cope with the constraints encountered. It is a survival strategy.

*Terms defined in the glossary (page 59) are highlighted in blue in the text.



▲ Climatic zoning of dry regions in sub-Saharan Africa between Senegal and Somalia.

I. Touré © CIRAD-PPZS

Sahelian countries in West Africa: Mauritania, Senegal, Mali, Burkina Faso, Niger, Nigeria • Sahelian countries in Central Africa: Chad, Cameroon
Source: FAO

M-N. Favier © IRD

▲ Rock paintings in the Akakus region. Libya.

> FOCUS | A few figures...

The estimates are from various national (State statistics) and international (Food and Agriculture Organization of the United Nations, FAO) sources concerning the livestock-farming and pastoralism sector. However, data on herds in West and Central Africa are not precise and are often underestimated.

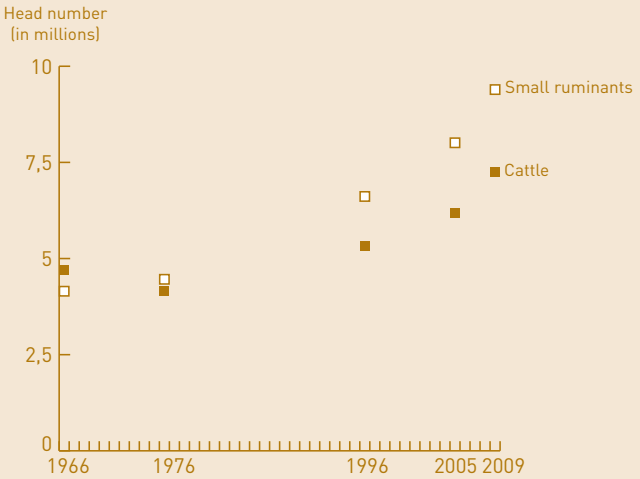
Just in the 15 countries of the Economic Community of West African States (ECOWAS), i.e. all countries between Cameroon and Senegal (but excluding Mauritania, Chad and the Central African Republic, where pastoral farming is widely practiced), the pastoral area, strictly speaking, covers 25% of the territory (Ly *et al.,* 2010). In the 1990s, pastoralism provided a living for 16% of the 35 million inhabitants in Sahelian countries alone (Bonfiglioli & Watson, 1992).

For all of the following Sahelian countries—Mauritania, Senegal, Mali, Burkina Faso, Niger and Chad—FAO statistics indicate the following overall livestock numbers in 2009:

- cattle: 39.7 million head
- sheep: 45.8 million
- goats: 52.4 million
- camels: 5.7 million

Out of this population, a high proportion is strictly pastoral, while the rest is mainly agropastoral, therefore partially pastoral, with a small share being periurban.

The Sahelian stock is increasing, even though a downturn occurred during the severe droughts of 1972 and 1973.



▲ Livestock herd patterns in Chad from 1966 to 2009
(figure on page 29 shows the geographical distribution).

Sources:
1966, 1996: *Ministère de l'Agriculture et de la Production animale,* Chad
1976: *Direction de l'Élevage,* Chad
2005: Wane, 2006 from FAOSTAT 2005
2009: FAOSTAT, 2011

© B. Toutain

▲ A herd of small ruminants at a watering point, Ferlo, Senegalese Sahel.

PASTORALISM TODAY AND TOMORROW

This *Dossier* aims to address some questions that livestock-farming and environmental policymakers are currently asking:

- Does pastoralism—a very extensive economic activity—have a future?
- How will pastoralism fare in the development of Sahelian countries whereas, in parallel, most global increases in livestock production are the result of the development of intensive livestock production?
- Is the development of pastoral livestock farming in line with resource conservation objectives and current environmental concerns of societies?
- What political and technical decisions should be taken to ensure that pastoral farmers will be able to sustainably maintain the services that pastoralism provides human societies and the environment?
- How can pastoral activities be oriented and supported to enable pastoral farmers to improve their living conditions?

The pastoral reality gradually reveals its complexity when viewed from a scientific standpoint using specialized tools. To come up with potential avenues to be explored, it is necessary to take an in-depth look at two areas, i.e. pastoral livestock-farming systems and the degradation of pastoral areas. Understanding the recent historical evolution and underlying dynamics, especially social links that support pastoralism, will help clarify the options open for legal and political intervention.

The first part of this *Dossier* presents sub-Saharan pastoral livestock-farming systems, their motivations, history, specific features and difficulties, along with the benefits they offer people in concerned countries.

The second part is focused on interactions between pastoralism and natural resources, especially the environmental impacts, while striving to differentiate the real responsibilities associated with extensive livestock-farming activities from other causes of degradation.

The third part takes a critical look at the measures taken or to be taken to ensure the sustainability of pastoralism and, for this, to strengthen pastoral viability by encouraging the participation of development policymakers, civil society, researchers and international supporters.

The authors of this *Dossier* hope that readers will be able to develop their own opinions on the relevance for States to maintain, defend and support pastoralism. The aim is also to clarify the terms used in discussions on links between pastoralism and desertification, which is still a controversial issue. They also want to shed light on possible ways for pastoralism to ensure efficient management of fodder resources that are sparse, dispersed over large areas, often hard to reach and subject to climatic variations.

▼ Zebu cattle farming, Senegal.
A young shepherd and his zebu herd.

J.-J. Lemasson © IRD

Pastoralism in sub-Saharan Africa

SPECIFIC FEATURES OF LIVESTOCK-FARMING TECHNIQUES IN DRYLAND REGIONS

Very substantial mean interannual variability in plant biomass production may be noted in dryland regions, i.e. potentially over 60% in 1 year per decade, whereas it is 2- to 3-fold lower in subhumid and humid regions. In these dryland regions, the local rainfall spatial distribution is also highly varied. Livestock farmers, because of the resulting uncertainty concerning the availability of fodder resources, are obliged to adopt specific livestock-farming techniques to preserve their production capital, i.e. cattle and ecosystems. **Pastoralism** hinges on the marked capacity of livestock farmers to make effective use of spontaneous fodder resources scattered in heterogenous environments.

The survival of livestock and the viability of **pastoral societies** in these restrictive environments are dependent on technical management strategies, based mainly on:

- the choice and combination of different herbivorous species
- the use of various fodder resources: herbaceous plants, supplemented by forage supplied by trees and shrubs
- the herd mobility, sometimes accompanied by the pastoralist's family.

Adapted livestock species and breeds

Domesticated herbivorous livestock reared on **rangelands** have acquired a genetic potential that is especially well adapted to their grazing environment and to this type of livestock farming. This ensures the **resilience** and sustainability of **pastoral livestock-farming systems**. Livestock farmers form their herds on the basis of four major combined qualities (Lhoste, 2007):

- Species diversity: depending on the environments grazed, the resources and aims of the **pastoralists**, pastoral herds consist of cattle, small ruminants (goats and sheep), camels and sometimes a few horses, donkeys or hybrids.

- Adaptation to the environment: this is mainly adaptation to heat, aridity and long-distance movements (camels are highly adapted in this respect). It also includes the capacity to withstand periods of feed shortages and long periods between watering, even though this is only possible to the detriment of their body mass (e.g. animals use part of the energy obtained by feeding just to move).

- Hardiness, i.e. the capacity to withstand environmental variations and harsh conditions (e.g. poor feed quality or exposure to certain diseases or pests): this hardiness is the result of a long selection process in adaptation to such environments. However, this goes hand-in-hand with the low individual production performances (fecundity, milk production, carcass conformation), offset by the number of reared animals.

- Versatility: most of the reared species provide many services, such as generating high-protein foods (milk, meat), fertilizer and energy (carrying, transport, water pumping, animal traction).

Combined herbivorous species

Livestock farmers rear one livestock species or combine several. In this latter case, the farmer is able to take fuller and more balanced advantage of the available environmental resources as each species taps a slightly different feeding niche. The farmer diversifies the products and services provided by the herd. This enhances the pastoralist's capacity to adapt to a range of different environmental and social conditions.

The herd composition may also change over time. Many livestock farmers whose herds were decimated by the droughts have opted to rebuild them with small ruminants—this was a marked trend in the 1980s. With the return of more humid climatic conditions, herd compositions gradually shifted in favour of cattle (or camels in arid regions), which are more lucrative, culturally entrenched and prestigious.

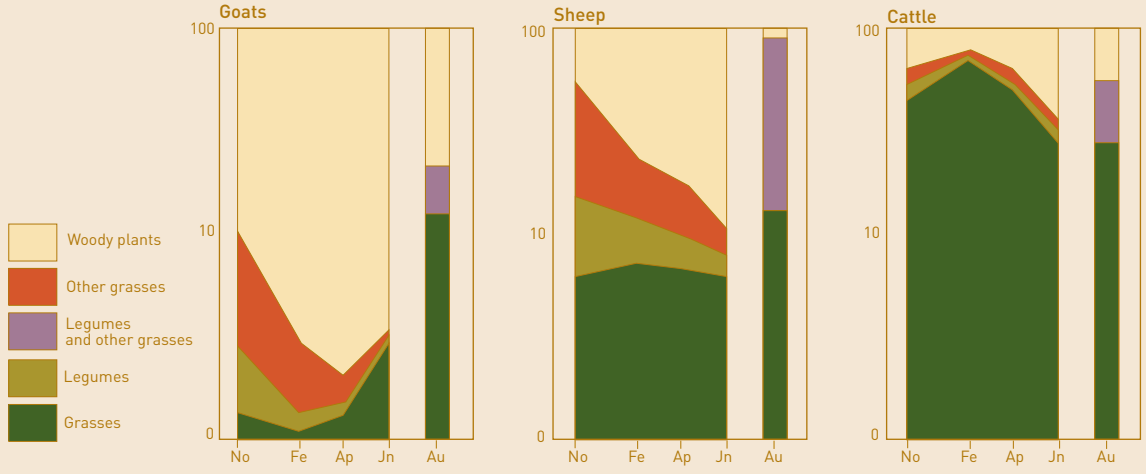
© A. Ickowicz

▲ Artificial ponds that serve as watering points during large-scale transhumances in the Sahel, eastern Chad.

> FOCUS | Cattle feeding preferences

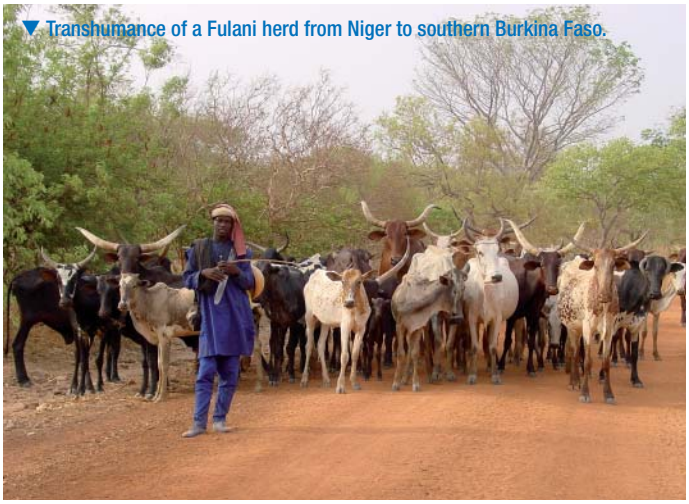
Cattle preferentially feed on grass, but supplement their diet by browsing on tree leaves (around 10%). An adult 250 kg cow requires a daily ration of 6–6.5 kg of dry grass (24–26 kg of green grass). Tree leaves account for almost half of a sheep's diet, but the capacity of these animals to very closely and intensively graze rangelands and then to regraze the same areas can degrade these lands. Goats preferentially browse on leaves (around 80%) and supplement their diet by grazing on grass.

Their ability to defoliate branches within their reach, right to the tips, as well as all young plants has given them a plant destroyer reputation. This reputation is well founded but highly exaggerated in Sahelian conditions. Camels are also preferential browsers but they can also sustain themselves by grazing on the tough grasses that grow in the Sahara.



▲ Comparison of rangeland feeding patterns of goats, sheep and cattle in the dry season and rainy season at Vindou Tiengoli (Senegal), 1982–83: from November to June (from the beginning to the end of the dry season), and August (middle of the rainy season).
(from Guerin *et al.*, 1988)

x-axis: month
y-axis: proportion in % (log scale)



▼ Transhumance of a Fulani herd from Niger to southern Burkina Faso.

© B. Toutain

▼ Herds returning via the Niger River Delta. Mali.

O. Barrière © IRD

A quest for better fodder

A pastoral landscape is a heterogenous environment—rangelands are complex patchworks of overlapping and more or less interdependent ecosystems, while also being subjected to different seasonal climatic conditions. Each unit in this patchwork (of highly variable surface area) nevertheless has grazing potential, providing fodder of different qualities depending on the type of vegetation cover and the season.

Each ruminant livestock species has a markedly different behaviour with respect to grazings, especially in the diet composition and depending on the season *(see figure p.13)*.

The daily quantity of feed ingested by a grazing animal depends on the height and mass of the available fodder. This intake level generally determines the performance of ruminant livestock. According to several studies, within a minimum biomass level (around 500 kg/ha of dry matter [DM]) or a mean grass height (around 5 cm), with variations depending on the type of vegetation, the animal can no longer offset a scarcity of resources by increasing its feeding activity without an excessive energy expenditure. Moreover, when the grass is high and the biomass substantial, intake may be hampered by a low fodder quality and an extended grazing time (when grass hard to graze) (Ickowicz & Mbaye, 2001). The pastoralist's task is thus to drive the herd to the best resources at that time, which must be done every day and according to the season. The main way a pastoralist, **stockman** or **shepherd** can orient the diet of his herd is based on herd rangeland management practices* (Diop *et al.*, 2010; Diop *et al.*, 2011).

▲ Goats browsing as high as possible on shrub leaves (here an acacia). Burkina Faso, Tenkodogo region.

© B. Toutain

Feeding livestock fodder that has been harvested elsewhere and transported (depending on available supplies: straw, hay) or supplement feeds (oilseed cakes, cottonseeds, cereals, etc.) is seldom practiced in sub-Saharan Africa, except on a small scale and with specific objectives: lactation of females that produce milk for the family, work animals, weak animals, fattening, or in research stations or on a few ranches**, etc.

The watering rate also differs according to the animal species, season and pastoralists' practices—it is usually daily in the dry season and can be much more spaced out during the rainy season because of the high moisture content in the fodder. In the dry season, some cattle herders only water their animals every 2 days (or even 3) when driving them to distant rangelands. Camels can survive without drinking for a week or even longer. The presence of some relatively moist plants, such as desert gourds *Citrullus colocynthis,* the crucifer *Schouwia thebaica* or the Chenopodiaceae species *Cornulaca monacantha,* reduces the water needs.

* On this topic in France, see the book edited by M. Meuret, 2010. *Un savoir-faire de bergers.* Éditions Quae, France.

** In North Africa, cereal subsidies have enabled pastoralists to provide complement feed for sheep grazing on steppelands. This has sharply boosted the herd growth rate, which is disproportionate with what would be possible when feeding on available grass, and ultimately causing intense degradation of the vegetation, thus worsening desertification. This practice is generally too expensive in sub-Saharan Africa where herds mainly consist of cows.

Vital herd mobility

Domesticated ruminants worldwide are able to digest quite rough vegetation because of the unique physiology of their several stomachs. They can thus graze various types of vegetation, even sparse or highly seasonal. When grass and shrubs are available, they browse the best plants and plant parts, and they also need regular (basically daily) access to water.

Spatiotemporal variability in natural resources can lead to one- to fourfold differences in fodder availability at given sites and between years (e.g. from 500 kg DM/ha to 2 t DM/ha at the same Sahelian site depending on the year). Sometimes the herd just has to travel 10–20 km to find a more (or less) better situation. This variability is more marked in semiarid than in subhumid areas. Cattle must therefore always be able to move to look for fodder where it is available. Note that wild herbivores also practice different forms of **transhumance** seeking the most accessible grazing resources.

In a single day, the distances travelled around a camp (small-scale mobility) vary substantially depending on the season and the availability of water and fodder resources. Seasonal mobility, especially transhumance, is a specific feature of pastoralism in response to seasonal variations in resource availability and quality, which may differ depending on regions. Pastoralists sometimes walk long distances (even hundreds of kilometres) alongside their herds every year. This flexible mobility strategy enables pastoralists to deal with the many events that may arise due to the hazards they encounter along the way.

This resource uncertainty and mobility goes hand-in-hand with collective access to rangelands. In harsh environmental situations, resources can thus be shared over vast areas when there are temporary local shortages—pastoralists thus have reciprocal access.

For pastoralists living in sparsely populated regions, this mobility also facilitates exchanges with other social groups: selling products, purchasing cereals in agricultural areas and other products for the family, exchanging services for fertilizer or transportation, social encounters, etc.

> FOCUS | Different types of pastoral mobility

There are different extents of mobility:

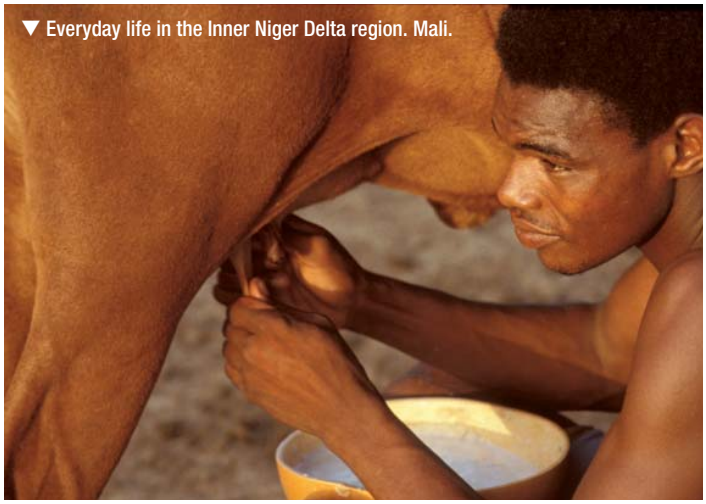
- In their daily movements, the herd disperses in the rangeland before grouping together for watering and spending the night in paddocks. The wandering range for cattle is around 10 km, or a maximum of 15 km (less for small ruminants).

- Transhumance, or the seasonal movement of livestock, involves a change in grazing region. The herd may travel up to 800 km from its home area during some transhumances (in eastern Chad, central-eastern Niger). For farmers that practice **nomadism**, the entire **lineage** wanders with the herd. Nomadism prevails in dryland regions, whereby families move around with their herds to take advantage of grazing opportunities and water supplies, but also sometimes to participate in markets and social networks.

The extent of herd mobility is never steadfast—it is flexible and fluctuates according to cyclical variables. From a mobility standpoint, like many other aspects, differences are never clearcut and there may be many variations within the same group (tribe, lineage, family group).

Often within the same region there is a broad range of different mobility systems that cooperate or compete for resource access. The main features of these mobility systems are as follows:

- the geographical distance of movements (from a few to several hundreds of kilometres, and even up to 1 000 km)
- the social scale of movements (shepherds alone or families)
- fixed points and links to local communities and land in the usual havens occupied during the hot dry season
- seasonal grazing on fodder plants and **salt cures**
- water resources, that must be accessible to be able to use rangelands outside of the rainy season period when surface water is readily available. Well access rights are negotiated between communities during the dry season
- markets, because they have a key role in generating income via sales of animals and milk and in providing access to staple cereals and other products for herding households
- social ties, which facilitate movements and dealing with the different problems encountered during transhumance.



▼ Everyday life in the Inner Niger Delta region. Mali.

O. Barrière © IRD

▼ A herd of Fulani zebus grazing in a millet field after harvest, Burkina Faso, Dori region.

© B. Toutain

MANY SPECIFIC GOODS AND SERVICES

Pastoral systems enable pastoral societies to live according to their traditional culture and lifestyle while also supplying commercial networks with products of high market value, especially high-protein foods such as milk and red meat. Hence, they contribute to feeding humans and supplying the substantial Sahelian export market to more populated coastal countries. Animals are also a source of energy (animal draught, potential use of dry dung as fuel) and fertilizer for crops (Lhoste, 1987).

A variety of products

Meat and milk are the main products from pastoral livestock farming; hides are also used:

- The meat production rate of a herd depends on several parameters: the female fertility rate, juvenile growth and mortality rate, and the adult mortality rate. In extensive farming systems, male cattle are often marketed at the age of 5 to 7 years old. The number of animals reared and the extent of area grazed offset the low levels of productivity per head. The per-hectare production rates of pastoral systems on collective rangelands are higher than those of ranching systems in USA or Australia (Breman & De Wit, 1983). Bille (*in* Daget & Godron, 1995) compared the per-hectare cattle production rate of 10 kg liveweight per year in the Borana region (East Africa) with that of 5 kg liveweight reported on ranches in northern Australia, where production costs are eightfold higher. On cattle markets, there is higher export demand for animals from pastoral areas than for heavier animals from agropastoral areas. This is the situation in Chad for animals exported to Nigeria.

- Cow milk production is limited on average to around 1 l/day (0.5–2 l) during the milking period. This low production is due to the hardiness of Sahelian breeds. Milk is also left for feeding the calves. In semiarid regions, only half of all females are lactating at once, which is related to the quite low average fertility rate (associated with the diet) of around 0.5 (one calf produced per 2 years). The age of the first parturition is more often 4–5 years old than 3 years old. Cows generally give birth to three to four calves in their lifetime.

- The hides and skins are generally managed by specific sectors.

These animal products are supplemented by the provision of many services:

- Field fertilizer: pastoralists make direct use of animal manure or trade it with farmers, thus enhancing the fertility of crop plots around villages or camps. Dung is produced by animals grazing in crop fields. Manure produced in night paddocks can be transported and spread in fields. This means that there is a net transfer of fertility from rangelands to cropping areas.

- Animal energy supplied in different forms (mounted, portage, transport, drawing water, animal draught) sometimes also represents a significant production for pastoral societies. Some pastoralists are specialized in providing transport services (**natron**, cereals, wood).

- A facilitator of social and economic relationships, e.g. the use of available labour, mechanism for exchange and transfer of goods and services, a means for social support or maintaining social networks.

- A savings instrument, which is better than banking products that are not very available in regions remote from cities—selling animals is a quick way to generate cash to purchase food or consumer products, monetized services).

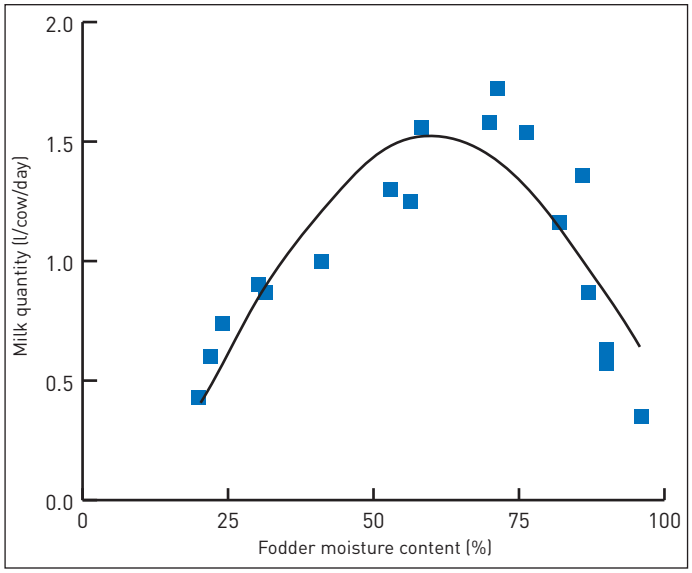
Herd numerical productivity

The herd offtake rate, or the number of livestock used by **herders** as offtake yearly, is a common indicator used to determine the productivity per animal number of a herd. However, the 'productivity yield in animal number' of the herd, which is calculated by also accounting for herd number variations (positive or negative numerical variations), is more representative of the actual situation. In Sahelian pastoral systems, the annual productivity yield in animal number of livestock ranges from 10 to 15% on average, but can vary markedly depending on the environmental conditions and the herder's competence.

Annual and interannual production variability

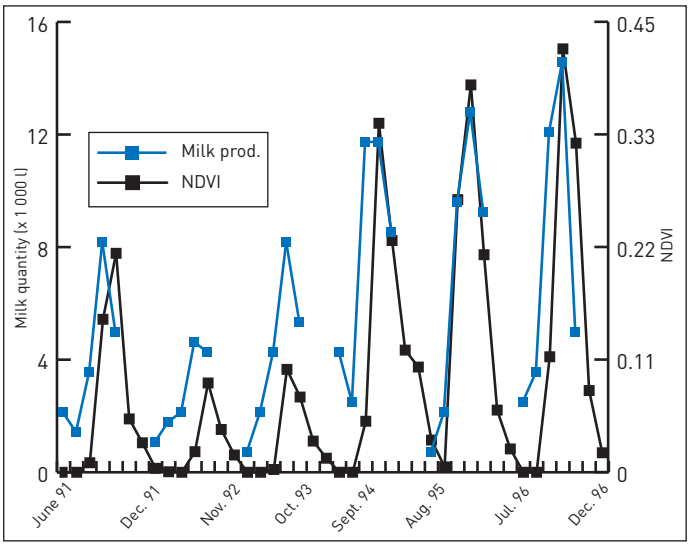
In sub-Saharan Africa, the fodder quality and abundance meet ruminant livestock feed needs during the rainy season and at the onset but not at the end of the dry season. This leads to substantial seasonal variations in livestock productivity. Milk production, which is highly correlated with feed intake, is a good indicator of the average fodder quality *(see adjacent figure)*.

There is also interannual variability, which depends on the annual rainfall pattern *(see figure below)*.



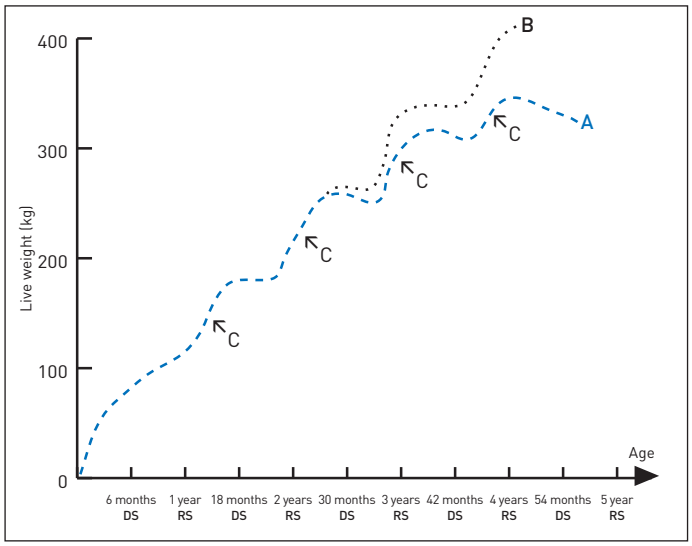
▲ Daily milk production of Sahelian cows according to the fodder moisture content. From Diop *et al.*, 2009.

The best grass for milk production is neither too moist (very young) nor too dry (end of growth cycle and straw).



▲ Seasonal and annual variations in mean milk production per cow in northern Senegal over 6 consecutive years relative to the normalized difference vegetation index (NDVI). From Diop *et al.*, 2009.

A high seasonal trend in Sahelian milk production may be noted, with a peak centred at the onset of the dry season and enormous differences between years depending on the level of grass production (assessed via the NDVI index).*



▲ General growth curve for young Sahelian male zebus reared on rangelands. From Guerin, 1987.

Curve A: traditional herding on rangelands
Curve B: with feed supplementation as of 30 months old
C: compensatory growth periods
RS: rainy season • DS: dry season

As the livestock liveweight also varies according to the season, the weight gain is irregular throughout an animal's life *(see above figure)*. However, after a shortage period and by the compensatory growth phenomenon, calves partially catch up in their weight gain once abundant and high nutritional quality fodder is available.

* NDVI, or the normalized difference vegetation index, is calculated using satellite remote sensing data and is proportional to the green vegetation area. In dryland regions, it is related to the active plant biomass, which in turn is highly dependent on the extent of rainfall.

SOCIOECONOMIC RELEVANCE OF PASTORALISM

A system adapted to environments with sparse or variable natural production

Pastoralism still naturally prevails in areas where various favorable features make it a more advantageous option than other production systems: (i) mixed uncultivated vegetation, that is relatively unproductive, but with substantial fodder plants, (ii) access to watering places, (iii) adapted livestock (species, breeds), (iv) shepherds (with their roles in managing their herds and practical aspects of mobile rangeland grazing). It is better adapted than any other production system (except forestry) to contrasted climatic conditions and lands that are unsuitable for crop farming due to infertile soils or rugged landscape. In most areas worldwide, pastoralism therefore coincides with steppeland, mountain or barren limestone plateau vegetation, and even savannas and dry forests.

In dry tropical Africa, especially in West and Central Africa, the recent increase in constraints to pastoralism has therefore not kept it from developing and expanding, as a function of the current rapid population growth rate, even in pastoral areas.

An essential economic role

The economic value of pastoralism should be roughly assessed:

First, the direct economic value accounts for the measurable and quantifiable products such as on-the-hoof animals, meat, milk, skins and hides. This should, where possible, be supplemented by the economic cost of animal draught transport and employment in the livestock-farming sector.

Current statistical data give valuable clues despite quite varied degrees of accuracy. For Sahelian countries alone, the livestock-farming sector contributes significantly to the national wealth *(see table below)*, even though a slow decrease over the years may be noted. Pastoralism itself represents a major share of the overall livestock-farming sector (up to half).

▲ Farmers and livestock farming. Mali.

Through a manure supply agreement between pastoralists and crop farmers around the village of Wuro Neema, fields are fertilized and herds graze the harvest residue. This mutual aid situation sometimes degenerates into a conflict if the herd arrives before the end of the crop harvest.

Secondly, the indirect economic values should also be taken into account, some of which do not always correspond to monetary exchanges:

- byproducts: handmade products, gathered substances (gum arabic, honey, medicinal substances, etc.)
- social capital represented by technical know-how, cultural wealth and social ties
- various ecosystem services such as biodiversity, water transfers and carbon storage (Hartfield & Davies, 2006), which is now sometimes assessed and pastoralists are even paid for this latter service in some parts of the world, but not yet in Sahelian countries.

Sahelian pastoralists—despite their important economic role in making effective use of areas where conditions are harsh—continue to cope with the obstacles and especially high **transaction costs**: long distances to travel to market their products, many livestock markets are still insufficient in some regions, the weight of negotiations on resource access rights, asymmetry in transaction information, the minimal presence, or even absence, of financial services for pastoralists (e.g. microcredit and insurance). Investments on livestock-farming infrastructures (markets, veterinary stations, herd watering facilities, roads) and the modernization of practices (lorry livestock transportation, use of telephone and internet) reduce transaction costs.

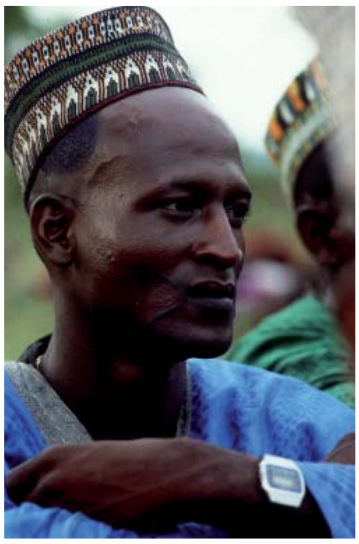
▼ Contribution of livestock farming to the agricultural gross product in Sahelian countries.

Country	Livestock-farming contribution (%)	Country	Livestock-farming contribution (%)
Burkina Faso	30	Mauritania	83
Cameroon	18	Niger	36
Guinea	15	Senegal	23
Mali	32	Chad	32

Source: FAOSTAT, 2009, according to the world market value of the products.

▼ A Fulani camp.
The young men are away tending their herds.
Northern Senegal.

© B. Toutain



J.-J. Lemasson © IRD

▶ A M'Bororo Fulani man.
Northern Cameroon.

> FOCUS | A few biases and misconceptions concerning pastoralists

Glorifying prejudices

The common bucolic idealized Western vision of pastoralists' lifestyle reflects a yearning for exotism, space and freedom, which is far removed from the reality of the pressures and difficulties that pastoralists deal with in their daily lives. Some peoples thus have idealized reputations, for instance Touaregs (or so-called 'blue men'), with their proud mastery of the desert, or the *Wodaabe* Fulanis, symbolizing freedom, a simple lifestyle and wandering. These glorified views reflect a lack of understanding of the reality and constraints that pastoralists face.

Demeaning prejudices

Some of these prejudices, which have been around since colonial times, are still vivid:

- Inefficiency and uselessness: pastoralists are considered just as gatherers, inefficient producers or, even worse, destroyers of nature. Pastoral livestock farming is considered to be 'contemplative', with pastoralists focused mainly on accumulating cattle for prestige, and relatively unresponsive to progress.
- No future: pastoralism is considered as an archaic activity derived from backward traditions, and destined to disappear with modernization and streamlined livestock farming. Pastoralists are tolerated because they are residual.
- Undisciplined: for administrators, pastoralists are considered to be hard to control, 'vagabonds for the pleasure', 'perpetually wandering' and elusive. They dodge national integration, taxpaying and conscription.
- Uncontrollable competition: for settled populations, transhumant farmers are considered to not respect local rules and regulations, or are viewed as invaders and competitors.

What is the best attitude?

These long-standing, unfounded and humiliating prejudices have led many pastoralists to have a poor opinion of themselves and become marginalized. The specificity of the lifestyle of these peoples should be recognized, as well as their numerical, economic and cultural importance.

Essential social functions

Pastoral livestock farming systems and transhumance—the key component—are based on solid rationales inherent to pastoral communities. For pastoral societies, pastoralism and mobility have the following main functions:

- Basic support for herding families through the production of food (milk, meat), energy (transportation, animal draught), exchangeable or marketable products (on-the-hoof animals, milk, processed products). This function is based on the herd's health and breeding situation. All technical elements that foster livestock productivity (veterinarian progress, networks of wells and boreholes, anti-bushfire initiatives, livestock breeding, etc.) contribute to improving this function.

- Livestock capital accumulation: a minimal number of animals is necessary for a family to be able to live and ensure transmission of this asset (around 20 TLUs [tropical livestock units] per family according to Faye, 2001, or a minimum of 3 **TLUs** per person, which is considered to be the poverty line in the Sahel). A supplementary herd helps ensure sustainability when dealing with the different hazards and uncertainties associated with pastoral farming systems, thus reducing the vulnerability of pastoralists and enabling household expenditures and investments.

- Social ties and exchanges between herding community members: this involves donations in kind (animals and products) as a token of allegiance or for services rendered, marriage dowries, inheritances, loans (especially milking cows) to needy families, and allocations to enable youths and shepherds to get set up and ensure their empowerment. The livestock owner's prestige is based on the animal number and quality.

- Social relationships with other, mainly agropastoral, communities: these mainly concern access to resources such as water, rangelands, crop residue, and donations and exchanges of food products and cereals, livestock, labour, etc.

- Maintenance and transfer of technical and cultural knowledge: this varied know-how concerns domesticated animals, livestock-farming techniques, mobility, other communities, properties and cycles of wild plants, wild animals, environments, climate, nonbiological resources (water, salt cures, etc.), as well as folklore, history, tales, poetry, etc. The pastoralist's ancestors are remembered and respected due to the presence in the herd of cows that had been offered by them.

> FOCUS | Women—pillars of pastoral families

Women are the cornerstones of herding families. They generally take care of most household tasks such as cooking, getting water and fuel supplies, handicraft making, putting up and taking down tents, and packing baggage. They are also involved in herding activities such as milking, tending to weak animals and small ruminants, making butter and cheese, movements and transhumance. They often leave the household to barter or sell their products in exchange for cereals or other commodities. Their children are therefore generally less subject to nutritional deficiencies than those of farmers who do not own dairy animals. Indeed, priority is given to feeding children and pregnant and nursing women in herding families during shortage periods.

When the men are absent, which frequently occurs during crisis periods, the women manage the family and the herd. During normal periods, they have a say in household decisions, depending on their experience and personality, but also because they own some of the animals and the family tent. Women are at the heart of matrimonial alliances and social ties.

© B. Toutain

▲ Fulani women from Ferlo, Northern Senegal.

Although these women have little education, they are still acknowledged as being better managers than the men, especially in associative activities—they often serve as treasurers in mixed-gender groups. They have a foothold in the present while transmitting education and culture to the younger generations, despite the many changes that are taking place in pastoral societies. It is hoped that women will keep this role and position in pastoral communities because, as the Tamashek saying goes, *"women, like rangelands, cannot be fenced in."*

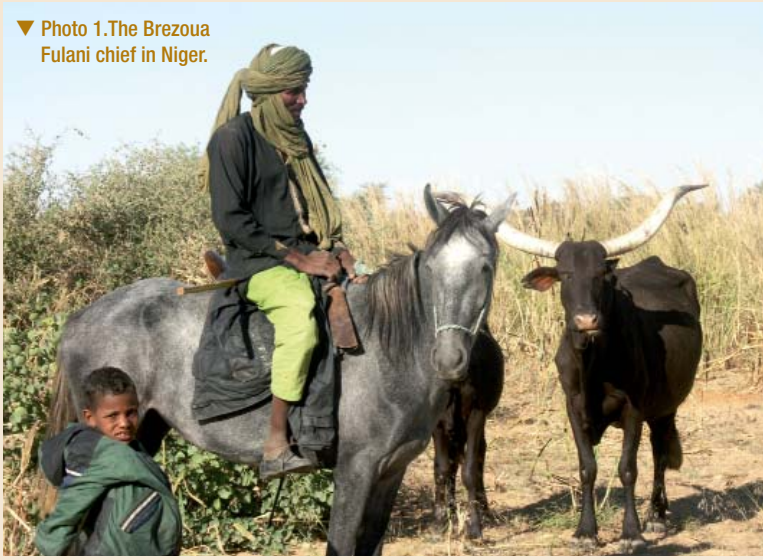
> EXAMPLE | **A herding family in Niger**

Ardo Bandé Orodji is an Oudah Fulani and tribal chief of the Brézoua group *(photo 1)*. He considers that his home area is around Maja, 19 km north of Gouré. His herd is mainly made up of Mbororo zebu cattle and sheep, along with a few goats *(photo 2)*. The families and herds move throughout the year along a long-distance (around 500 km) transhumance route. He leaves with the different family groups and is responsible for organizing the transhumance. He passes through 18 towns in the Zinder region during this migration, whereas another part of the tribe follows an annual route further south, through six northern Nigerian states.

In the rainy season, the families of this group disperse the herds in their home area. The herds graze on Sahelian type dune rangelands on which small grasses that are highly appreciated by the livestock grow in a few weeks. During this period, rainwater fills the many surface watering points so the animals have ready access to water. Shepherds are thus spared the laborious task of drawing water from relatively deep wells, as they are obliged to do in the hot dry season.

In good years, at the end of this period of dispersal and quite abundant grazings, families scattered in small groups organize their annual get together with the tribal chiefs. This is the annual *gerewol**, get together, which is an occasion for traditional festivities on the annual *Oudah* calendar. It is the time of marriages, when the pastoral year has been good and the livestock has fully benefitted. These festive intercultural get together bind social ties and enhance cohesion within the group and between groups. Each pastoral community takes advantage of this opportunity to confirm and build recognition for its cultural identity through rhythmic songs and dances *(photo 3)*.

▼ Photo 1.The Brezoua Fulani chief in Niger.



© B. Bonnet

Alongside these festivities, the tribal chief and his scouts review the past rainy season in preparation for the harsher dry season period. Depending on the seasonal pattern, several possible routes are assessed and the decisionmaking process may take several days if there are serious potential risks. Then a long series of dry season steps begins, leading first through the crop farming area until reaching the outskirts of Zinder, the regional capital. The group stays there for around 15 days to take advantage of various available services, especially to get health care for needy children and elderly people and for whom travelling is especially difficult and tiring. At the end of this step, and depending on the conclusions of the seasonal assessment, two groups are formed from the different tribal groups to travel along two different routes so as to maintain a good adaptation capacity:

- One group (10 households) takes the eastward route and then heads towards the town of Gangara, Tanout department *(see map on next page)*, and continues until reaching Gouré at the onset of the rainy season.

- The other group heads southward, crossing six Nigerian states (Katsina, Kano, Kaduna, Bauchi, Jigawa and Yobé), and then it gradually returns to Niger via southern Bouné as the cropfields are planted and the rains begin.

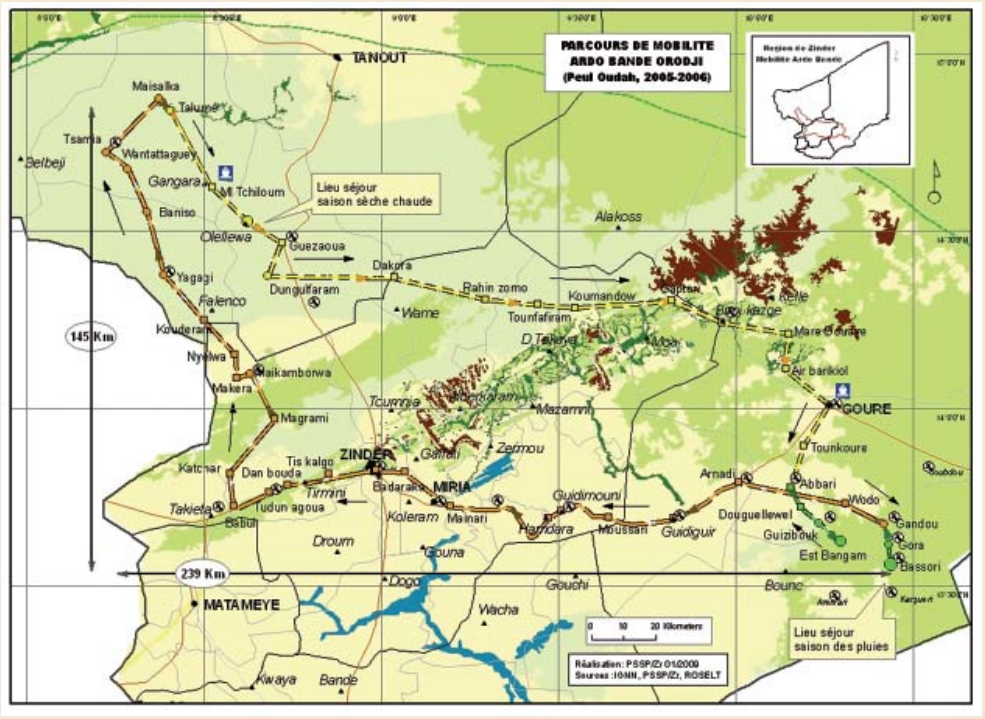
Cont'd on next page...

▼ Photo 2. A herd of Mbororo zebu cattle and small ruminants.

© B. Bonnet

▼ Photo 3. Young *Oudah* Fulani girls and men in a state of trance at Filin Jirgi, Niger.

© D. Hérault IRAM-PSSP



© IRAM

◀ Annual transhumance route taken by Ardo Bande Orodji, an Oudah Fulani pastoralist from Niger, *in* 2005-2006 (Gouré, Zinder and Tanout regions).

Long-distance family movements throughout the year over long distances require considerable community organization. For this purpose, Ardo Bandé uses scouts on horseback or camelback, equipped with cell phones, to prepare movements during each new step *(photo 4).* Travelling families have pack animals, donkeys and a few oxen to carry the tents and all of their personal effects *(photo 5).* Young children and lambs still too young to walk under the sun are also carried on these donkeys. In normal times, women lead the donkeys to transport water.

Some difficulties may also be encountered along the transhumance routes followed by this group—the pastoralists have to deal with pressures from some local authorities and the negative attitudes of security forces when crossing towns. Harvested cropfields (heads harvested), but which are not cleared (stems still standing), and the absence of corridors and rest areas complicate transhumance movements.

▶ Photo 4.
A transhumance scout on his camel.

© B. Bonnet

© B. Bonnet

▲ Photo 5. Pack donkeys during a transhumance.

Well access is difficult and must be paid for to an increasing extent, so the most convenient watering places are temporary ponds. Social ties with settled pastoralists facilitate transhumance.

Pastoral mobility is only possible through constantly changing, maintained and developed social networks, especially with settled pastoralists. Pastoralists therefore have capacities for adaptation and negotiation with other communities.

Conversely, settlement can lead to a certain degree of social isolation and thus increase the pastoralist's vulnerability to resource and climate related hazards, but without providing any greater land security.

* Other herding groups have their own separate festivities, e.g. the *sharo* (caning) in some Fulani groups (*Uda'en* and *Katsinanko'en*) and the *tende* of Touaregs (women sing around a mortar that serves as a tam-tam, while the men turn around them in a circle and parade on camelback). Moreover, in Niger, post-rainy season salt cures during transhumance have become an occasion for festive get-togethers, with the participation of local authorities.

CURRENT DIFFICULTIES AND THREATS TO THE FUTURE

Drought and climate change

Climatic variability is clearly the most outstanding challenge. The drought periods that occurred in the 1970s and 1980s were unexpected because they followed a long period of relatively constant rainfall, i.e. much higher levels than would be expected by the usual interannual rainfall pattern of arid climatic regions.

A standardized precipitation index (SPI), which represents the annual mean cumulated rainfall, was calculated with data from 600 selected Sahelian stations for over a half a century, from 1950 to 2006 (AGRHYMET, 2009).

The opposite figure highlights three clearly distinct periods:

❶ 1950-1969: a period when there was a series of very humid years with considerable rainfall (unusually humid as compared to previous years for which data is available)

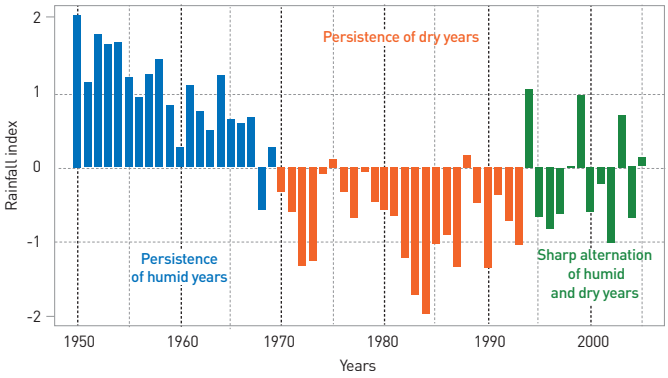
❷ 1970-1993: a period of over 20 dry years marked by two catastrophic droughts (1973-1974 and 1983-1984)

❸ after 1993: a period marked by a sharp alternation of very humid years (1994, 1999, 2003) and very dry years (in 2009-2010, loss of up to 60% of the livestock population reported in Niger, Chad and Mali); the patterns are quite comparable to those noted in the years prior to 1950. This sudden climatic change in the 1970s affected the entire Sahel region at once, but was not observed anywhere else in the world.

Concerning another change, rainfall was lower in the western part of this Sahelian region, between Senegal and Chad, whereas there was a gradual return to more humid conditions in the east, as reflected by the marked regrowth of shrubby vegetation in several regions, especially in Mali (Bégué *et al.*, 2011).

The persistent drought in part of the Sahel could be explained by the combined effects of oceanic warming in the intertropical region, especially in the Indian Ocean equatorial zone, as well as the relative warming of the South Atlantic and cooling of the North Atlantic. A potential link with climatic warming has not been confirmed.

For the Sahel, beyond the increase in temperature, long-term forecasting models on the impact of climate change show contradictory patterns—some suggest an aridification trend, while others indicate greater rainfall. In Sudanian regions, the effects of climate change are not very clear-cut, or the trend is more in favour of increased rainfall.



▲ The standardized precipitation index (SPI) for all Sahelian meteorological stations in CILSS (Permanent Inter-State Committee for Drought Control in the Sahel, 1950-2006 period) countries. From AGRHYMET, 2009.

Positive values indicate years when rainfall was above average over the entire period, while negative values are lower than the average.

However, an increase in the frequency of extreme meteorological phenomena is being observed and predicted: droughts, torrential rains and periods of high or low temperatures. This increase in interannual variability and climatic extremes in Sahelian regions is very destabilizing for pastoralists and has a serious impact on the most vulnerable*, despite the fact that the pastoral system is highly flexible and there are many adaptation mechanisms.

* This situation triggered rural outmigration, with almost 65% livestock mortality noted in the Sahel in 1973-1974, and an increase in 'climate refugees' in urban areas. Herding communities were threatened with famine during the droughts.

> EXAMPLE | Droughts and torrential rains in Niger

Throughout the history of the Sahel, major droughts have occurred that induced high livestock mortality (1914, 1973, 1984, 2005), and there have also been periods of famine and torrential rains—both phenomena occurred in the 2009-2010 period. Because of the short rainy period in 2009, pastoralists were obliged to get informed, discuss the situation with other pastoralists and opt for highly varied mobility strategies.

At Tanout, Niger, part of the *Wodaabé Suudu Suka'el* group thus decided not to take their usual southern route, preferring to head northwards where grazings were much better and where wells (accessed via negotiation) could be found. Upon their return, however, they encountered a flooding situation induced by the exceptionally high rainfall in 2010—the weakened animals were trapped in the water and mud. The situation was catastrophic—the livestock mortality induced by the flooding was higher than that associated with the drought *per-se*.

The evolution of pastoral societies—poverty, vulnerability and inequality

Poverty is a complex concept that refers to the physical (risk of material incapacity), economic (loss of income) and social (risk of exclusion) vulnerability. If we consider other criteria that are more in line with actual national situations than those set out by the World Bank (which sets the per-capita poverty line at $1/day), pastoralists in Chad and Burkina Faso, who possess on average 60 head of large livestock per family, are far from being poor (Clanet *in* Duteurtre & Faye, 2009) because of the different goods and services that they provide. However, pastoralists are threatened by poverty in various ways:

- Sudden loss of livestock due to epizootic diseases, droughts or other severe climatic events, robbery or acts of war—pastoralists may thus lose all or part of their productive capital, which they will have to rebuild.

- Due to a production and accumulation capacity that is not sufficient to sustain their families while also enhancing the herds, the poorest pastoralists may be obliged to depend on different types of assistance (local solidarity, family transfers, humanitarian interventions), go into debt or diversify their local or remote activities, thus boosting rural outmigration and regional migration flows. Members of herding families may head towards urban or agricultural areas looking for seasonal salaried jobs or a completely new main occupation.

Then part of the income is sometimes sent to the family. In reported cases from Niger (Ancey, 2006) and Senegal (Azoulay and Ancey, 2011), these subsidies were mainly used to fulfil daily needs but were not sufficient to start an accumulation or investment process.

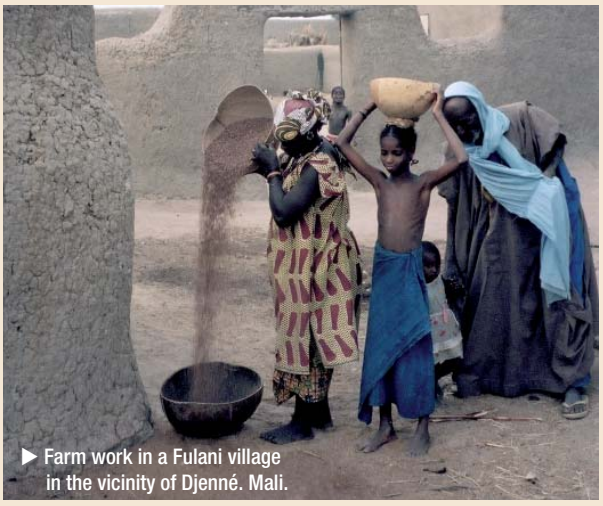
In pastoral areas, many collective risk-sharing mechanisms are based on mobility, livestock-farming diversification and alternative income sources (temporary salaried jobs). There are also social security systems, via donations (*zaqat* or Muslim handouts) or livestock placements (e.g. *habbanaae* of the Fulani, *tiyit* of the Touaregs, *azum* of the Toubous and *wudah* of the Chadian Arabs). Animal loans have an important solidarity role (Duteurtre & Faye, 2009).

New inequalities have arisen in herding communities—apart from the ongoing gaps between livestock capital and income in herding societies, goods are developing from 'new rich pastoralists' originating from commercial or public service sectors. These new pastoralists invest their savings in livestock and own large herds that are managed by salaried shepherds. Some of them have benefitted from livestock sales at discount prices during the 1970s and 1980s droughts. These new pastoralists, despite the fact they often live outside of the herding areas ('absentee owners'), have the means to impose their own conditions with respect to mobility and resource access, and they are even sometimes able to obtain exclusive rangeland grazing rights.

> FOCUS | Habbanaae—a mutual aid mechanism

Oudah Fulani herding households have access to *habbanaae*, a solidarity system specific to Fulani groups, to cope with their increasing monetary needs associated with the payment of services. This system involves lending a female animal, generally a cow, to a deprived pastoralist for a certain number of births. The borrowing pastoralist owns all of the products generated by the borrowed animal during this time. This is a kind of community anti-poverty insurance to assist pastoralists when they have lost their animals.

As described by Maliki (1982), in *Wodaabe* communities, there is substantial between-herd circulation of livestock through complex systems of temporary loans, donations and guarding. From a social standpoint, these animal exchanges promote reproduction, even in the herding community—generating friendships and interdependence. They are even the basis of marriages and may lead to the founding of new families.



▶ Farm work in a Fulani village in the vicinity of Djenné. Mali.

M-N. Favier © IRD

Habbanaae extends increasingly beyond the Fulani community. It is practiced by other transhumant herding groups and with other communities, including settled pastoralists as an element of an integration and mobility assistance strategy. It is a way to strengthen alliances with settled families along the transhumance route. Beneficiaries thus become 'tutors' for transhumant pastoralists.

▲ Fulani life, Burkina Faso. J.-F. Molez © IRD

Complex land rights

Land rights define the rules for access, usage and control of land and renewable resources. They do not outline the relationship between humans and the land, but rather relationships between humans concerning land and its resources. They involve social and power relationships and, like their legal implementation, are the result of top level political decisions.

In West and Central Africa, land access is jointly controlled by traditional rules concerning land allocation to farmers who submit a request to the village authorities. Livestock farming involves the use of uncultivated or authorised land (but access to sacred woods or protected areas is forbidden). Mobile pastoralists must request authorisation for grazing when they are in cropping areas, and for access to private wells or to wells that they do not control. In solely pastoral regions, watering places determine the access to surrounding rangelands, but their status is variable, i.e. free access or under the authority of an entity or clan. Putting livestock out to graze does not give the farmer any rights to the land, contrary to crop farmers who produce crops on the land through cultivation, which is why landuse rights are asymmetrical and often the source of conflict (Ickowicz *et al.*, 2010).

There are several types of land rights: customary rights, Islamic rights and so-called 'modern' rights that are applied by administrative authorities. Irrespective of the type, land rights or rules involve:

- modes of appropriation, land-use rules and transmission practices
- authorities responsible for allocating these rights, applying or modifying the rules, and the power to mediate and adjudicate disputes.

Customary land rights have undergone considerable changes since the 19th century and have gradually run into competition with national policies or private initiatives, which has weakened them. They still, however, have a key role. Changes that respect the need for flexibility in pastoral livestock farming take conventional rights into account by introducing suitable modifications and allocating more negotiation and decisionmaking power to local communities (Swift, 1995; Lane & Moorehead, 1995).

Relationships with other rapidly changing rural societies

Relationships between pastoralists and crop farmers have evolved considerably over the last several decades because of the rapid population growth.

There are genuine traditional complementarities of different forms: exchanges, monetary or nonmonetary forms, products such as milk and cereals; guarding of settled farmers' animals by transhumant pastoralists; storage of pastoralists' food supplies by their crop farmer allies; contracts whereby crop farmers allow pastoralists to graze their animals in their crop fields after harvest in exchange for the generated manure; farmers harvested crops are transported to the granary by transhumant animals; guarding of pastoralists' plots by villagers during the transhumance period, and; provision of animals to crop farmers for animal draught in cropping areas. Conventional **common grazing rights** in fields after harvest were generally respected.

Beyond these practices, there are relatively long-standing local alliances between nomadic fractions or families and villages (*arkawal* concept in Mali and Niger [Grémont *et al.*, 2004] and *ahalié* concept in Chad [Marty *et al.*, 2009]), and sometimes also matrimonial ties. There were sometimes even servitude bonds, which are now disappearing.

These customs did not circumvent conflicts of interest. Such competition was in different forms, for instance: clearing and cultivation of rangelands and even cattle trails; conversion of **bourgou rangelands** (natural grazings that are highly important in the dry season) into rice fields; monopolization of pastoral watering places by farmers' groups, or even by other pastoralists, recently set up at the site; disrespect for agropastoral calendars (in principal, designed to hamper competition between crop farmers and pastoralists during critical periods) by either party, and; damage caused by animals in not yet harvested crop fields. In addition to conflicts between crop farmers and pastoralists, conflicts sometimes arise between pastoralists (access to and control of watering places, or access to bourgou rangelands when resources are scarce). Note that such disputes were usually managed locally, often by mutual consent, and only serious cases were dealt with via customary and administrative authorities.

> FOCUS | On marketing herding products...

Over the last 15 years, there has been a major boom in commercial exchanges, with an increase in the number of markets and in livestock prices. There is only a drastic decrease in these prices during drought years, with a concomitant increase in cereal prices. Pastoralists are aware that market livestock taxes generally contribute to municipal budgets.

In some areas where villagers prohibited livestock grazing in the vicinity of the village, pastoralists organized a full-fledged boycott (*dangol* in Fulfulde), refusing to supply the markets with milk or animals.

These villagers quickly felt penalized and asked the pastoralists to return to their previous grazing practices. Note, however, that there are still no markets in large parts of pastoral areas in several countries.

D. Rechner © IRD

▲ Oursi cattle market which attracts Fulani and Touareg pastoralists. Burkina Faso.

In recent times, in association with the high population growth, there has been a sharp decrease in complementarity since many crop farmers now own livestock and no longer need pastoralists. In many agropastoral regions, pastoralists have begun growing crops and most of the herd is now settled and managed by farmers. The converging pathway of production systems towards agropastoralism has not reduced competition (Thébaud, 2002). The result is that crop farmers now keep their crop residue to feed their own animals; bartering is disappearing in favour of commercial trade, and; long-standing alliances are eroding. For instance, Fulani agropastoral plots on which a high amount of manure has been deposited by their herds have been the focus of indigenous farmers' interest, forcing pastoralists to move their camps despite having occupied them for decades (southern Burkina Faso, northern Côte d'Ivoire, northern Cameroon, southern Niger).

Loss of access to rangeland resources

The most long-standing and constant challenge is clearly the increase in agricultural activities in a high population growth setting, but without a substantial increase in soil productivity. The need for new cropland is primarily fulfilled to the detriment of pastoral areas. Even transhumance trails, which are normally reserved for herding, are sometimes restricted or even blocked by new crop fields. Areas around wells, where manure levels are high, are also often taken over. It has even been reported that so-called 'trap' fields are intentionally set up near rangelands by crop farmers and then they demand that the pastoralists pay them a financial compensation for any crop damage caused by the livestock herds, thus forcing pastoralists to leave the region.

Large irrigated areas set up along rivers and lakes, and the development of flood-recession cropping, has reduced herd access to water while also transforming often very high quality natural grazings into cropland, thus forcing pastoral livestock farmers out to the benefit of crop farmers (for more intensive cropping). Such situations are common in dryland regions: development of the Senegal River, agricultural development around Fitri Lake (Chad), Guier Lake (Senegal) and in the Inner Niger Delta region (Mali), and extension of flood-recession sorghum cropping (Chad, Nigeria, northern Cameroon).

'Land grabbing' operations, i.e. cropping rights granted to foreign companies and countries on large tracts of land, can lead to resource depletion and create impassable zones that hamper herd movements. This situation has had a profound effect on herding by reducing herd mobility, thus forcing pastoralists to completely alter their movement routes and schedules.

It is hard to gather natural products in degraded environments, so it is thus necessary to switch to expensive substitute products: wood for domestic uses, gathering of thorny branches for fencing, gathering of medicinal plants and gums, harvesting of tall grasses to make mats and roofing, etc. Pastoralists consider the increasingly common collection of dry grass and

▲ A cattle market in Benin. M. Donnat © IRD

wood by outsiders from other regions, for the purpose of selling this material as fodder and cooking fuel, as forms of ecosystem degradation and fragilization.

These phenomena should also be related to the increase in pastoral and agropastoral herds which has been under way as a result of the heavy losses incurred during drought periods. Competition for grazings between pastoralists and between pastoralists and crop farmers has led to an increase in disputes. This increased tension for resource access has already given rise to serious clashes with injuries and deaths*. To quote a Fulani pastoralist in southern Niger: *"shepherding has become the most dangerous of all occupations—when you leave home in the morning, you're not sure that you'll make it back in the evening."*

* Fortunately, massacres like those that took place at Toda (Niger, October 1991) and Moïto (Chad, January 2003) are uncommon.

> FOCUS | Conflicts and insecurity

For a long time, conflicts mainly concerned crop farmer-pastoralist relationships (field damage, injuries inflicted on animals), with different extents of severity depending on the country, area and period. Since then, prevention projects have been under way and have led to a sharp decline. They generally recommend that disputes be dealt with through local discussions rather than being taken to higher levels, which is much more costly and the judgements are often arbitrary.

Insecurity has increased considerably, as noted in Chad, where civil wars are under way and armed gangs extort animals from herding camps. It is known that in the Central African Republic, children are abducted from pastoralists' households to obtain high ransoms, which has increased migrations of people fleeing from this dangerous situation.

Illegal trafficking (arms, drugs, cigarettes), as well as the lucrative transport of migrant people looking for work in North Africa and Europe, gives some local young people, fuelled by their idleness and a degree of social unrest due to the lack of prospects, the hope of getting rich quickly. Moreover, there is often deadly score-settling between rival Mafia-like gangs, with inevitable collateral effects.

Finally, Islamic terrorist groups have also gained a foothold in the northern Sahel region. It should be noted that it is first and foremost the local inhabitants, and especially pastoralists, who pay the highest price for this situation because their rangelands are being turned into undeveloped lawless areas, further aggravated by the taking of foreign hostages.

▲ A herd passing through the Arly reserve via a corridor trail. Burkina Faso. © B. Toutain

Interactions with protected areas

So-called 'protected areas' encompass various categories, with different names and statuses. For instance, in the considered African region, there are national parks (e.g. Zakouma in Chad and Djoudj in Senegal), regional parks (W in Niger, Burkina Faso and Benin), some of which have been classified as biosphere reserves by the United Nations Educational, Scientific and Cultural Organization (UNESCO, e.g. Niokolo-Koba in Senegal and Pendjari in Benin, W), partial or total wildlife reserves (e.g. Dosso in Niger and Arli in Burkina Faso), hunting reserves, forest reserves, classified forests, etc.

Most protected areas located within or in the vicinity of pastoral areas contain resources required by livestock (grass, watering places, shrubs, forage trees), while also providing shade and peaceful environments far from cropland and villages. Pastoralists therefore find them very attractive. Some of these areas were avoided for a long time because they were a health danger for humans (black flies/onchocerciasis, mosquitoes/malaria) and livestock (tsetse flies/trypanosomiasis), but these barriers have been partially overcome through climate change, land clearing, progress in the treatment of animals that are pest and disease vectors and medical and veterinarian preventive control measures.

In West Africa, official guards in protected areas, including **buffer zones**, are foresters, sworn state officials, and sometimes local inhabitants (in some hunting reserves). Foresters—depending on the extent of funds they are allocated—also manage tree stands and wildlife in pastoral and agropastoral areas, in addition to State tree plantations.

In principle, no crop or livestock-farming activities are allowed in these areas. However, this principle is actually applied to different extents depending on the monitoring capacities of forestry services and the importance of the areas from environmental or forestry standpoints. There may also be social pressure. In recent decades, the main natural parks and wildlife reserves in West and Central Africa have benefitted from a renewed international focus and external funding in reaction to the worrisome drop in wild populations of many species in natural environments. At the same time, traditional pastoral areas have been reduced in size, fragmented and environmental degradation has made them less productive. Protected areas are thus now coveted by pastoralists, at least temporarily during their transhumance movements. However, pastoralists caught grazing their livestock in conservation areas face severe penalties, ranging from heavy fines (the value of several cows) to slaughter of their animals (which is always traumatizing for pastoralists). The increase in monitoring measures has reduced herd intrusions in protected areas, but often without completely stopping them because the technical benefits gained through such grazing intrusions justify the incurred risks.

Forage tree branch cutting by shepherds in rangeland areas to feed their herd sometimes leads to disputes with foresters because this practice is regulated. However, there are seldom reports of pastoralists poaching, or only when carcasses have been poisoned to reduce big cat numbers.

Current policies concerning relationships between protected areas and pastoralism are focused on development initiatives, land management and the preservation of pastoralism outside of these areas, especially in buffer zones and peripheral areas of influence. This land and resource management is under the responsibility of a set of stakeholders who must oversee conflicts of interest. Pastoralists may graze their animals in some classified forests on condition that the specified sylvopastoralism rules are respected and access fees are paid, which enables the forest managers to more or less control the usage periods and the number of animals.

ADAPTATION CAPACITY AND VITALITY OF PASTORALISM

The gradual decline and extinction of pastoralism was predicted just a few decades ago. However, this activity clearly still continues to adapt year-after-year to the changing situation with respect to development, evolution, landuse, ways and qualities of life, urbanization, commercialization of activities, monetization of exchanges and globalization. Some pastoralists have diversified their mobility strategies, increased their activities and income and made several changes in their production techniques.

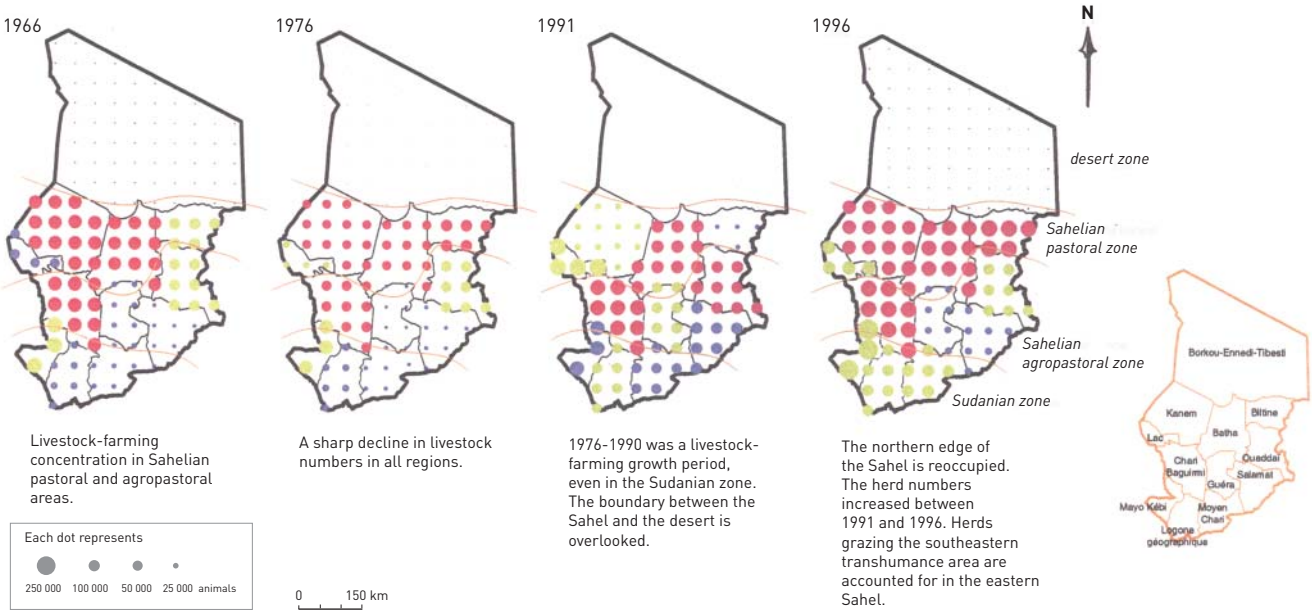
Changes in mobility strategies

Transhumance routes have been tailored to new prevailing situations and hazards. Some herding groups have switched from their previous rainy season northward movements, to areas where they found nutrient-rich fodder and **salt cure** sites, to transhumant southward movements to wetter and greener areas. By this strategy, all of the pastoralists are back in the home area to help out at the time when the cultivation activities begin. Other groups practice two transhumances.

Transhumances extend towards more humid southern regions, often close to highly cultivated areas. This, for instance, is the case in eastern Chad where some herds are driven more than 700 km from the home area. Pastoralists thus spend most of the dry season in the south before heading northward during the rainy season (Clanet, 1994). This phenomenon has particularly increased since the droughts of the 1970s and 1980s.

Many pastoral societies are affected by a slow but already long-standing herding movement to new regions or countries. This trend is a response to the need to leave areas that have become less productive, over populated or insecure. Sahelian Fulani pastoralists from Chad and Sudan began heading towards the Central African Republic as early as the 1920s, those from Mali and Burkina Faso towards Côte d'Ivoire in the 1950s, and recently Arab camel drivers moved from central Chad towards western Chad and eastern Niger. These transhumances and migrations were highly facilitated by the progress achieved in health and veterinary prophylaxis and investments in pastoral water control initiatives.

Herding families are settling to an increasing extent, but the herds are still mobile, being led by shepherds, with only a few milking females being kept to feed the settled families. This form of partial settling facilitates access to medical care, schools, food supplies and participation in the political life of the country. Hence, many Touaregs and Moors have built homes combining '*banco*' (a mixture of mud and straw used as construction material) with their traditional tents.



▲ Regional herd distributions in Chad between 1966 and 1996.

There have been massive herd movements triggered by the climatic conditions along with partial shifts in the agropastoral area. From Toutain et al., *2000.*

Production system changes and diversification

Activity and income diversification has become widespread in response to climatic crises or a decline in pastoralism productivity. This could concern commerce, craftwork, or salaried work in crop and livestock farming or in any other field, even in urban areas, on a seasonal basis, or by some family members who then send money back to their families from the countries where they have migrated.

Combining crop farming and pastoral livestock farming is the most common form of stabilization in semiarid and subhumid areas. Harvested cereals provide part of the family's food, thus reducing the need to spend money on buying cereals. The semi-settling of nomadic pastoralists is sometimes the result of national policies, especially for the purposes of territorial development, which favours or leads to a relative reduction in population movements.

'Land anchoring' has become a widespread objective. It involves greater geographical settling of families in areas where there are fields or properties and where part of the family permanently resides. For instance, we could mention the case of transhumant *Wodaabe* Fulanis who seek rights to drill a well with the intention of appropriating it, or Chadian pastoralists who obtain the right to cultivate southern areas reached during their transhumance movements.

Privatization of land or even wells has been noted in pastoral areas that are usually governed by collective usage rights. The owners are not always pastoralists. This removal of collective resources contributes to rangeland fragmentation and to the reduction in pastoral areas.

Changes in production techniques

One way that pastoralists are adapting to variations in their economic capacities or in environmental conditions is by changing the composition of their herds and the animal species they rear. In the most arid parts of the Sahel, a return to camel and small ruminant rearing has been noted, instead of cattle, which are more sensitive to variations and require more fodder. In order to reduce the risk of mortality during southward transhumance movements, some pastoralists have gradually crossed their animals (or allowed them to spontaneously cross) with trypanotolerant savanna breeds, e.g. *méré* cattle in southern Mali, which are the result of a cross between trypanosensitive fulani zebus and n'dama cattle*.

Pastoralists' increased use of salaried workers is a response to uncertainties concerning the availability of shepherds in the family and the scarcity of natural resources (Wane *et al.,* 2010b). Pick-ups and lorries are used to transport animals (especially small ruminants) and water in Sahelian rangelands in the hot season, otherwise these grazings would remain inaccessible.

There has been a sharp increase in the marketing of livestock and derivative products, especially following the devaluation of the African Financial Community Franc (FCFA) in 1994. The hazardous and uncertain situation in which pastoralists are still living has forced them to take advantage of all opportunities (Wane *et al.,* 2010a). They also take advantage of market opportunities, even though they do not necessarily take this into account when making their production decisions. This calls into question the popular opinion that pastoralists practice a strictly contemplative form of livestock farming.

* This trend even threatens the preservation of these trypanotolerant breeds.

> EXAMPLE | **In northeastern Mali...**

As the predictions were highly pessimistic concerning the capacity of rangelands to meet herding needs, pastoralists and agropastoralists (Touaregs, Arabs and Songhay) decided to sell their animals to purchase cereals, fodder, bourgou grass and feed for their livestock. Separation of families from the herds enhanced food security for the families (based in centres) and provided more freedom of movement for the livestock and shepherds. Some of them began the transhumance early, travelling exceptionally long distances to unusual destinations. Finally, the use of cell phones clearly improved information and communications on resources and markets, while the use of automobile transport (food, water, fodder, livestock) reduced losses. These new technologies were fully integrated, even though the final outcome varied depending on the families and local situations.

▲ Drawing water by cattle draught from a modern cement well in southern Kanem, Chad. © A. Ickowicz

Infrastructure changes

Various collective or more specifically pastoral infrastructures have been developed. Managed pastoral areas are more suitable for hosting livestock and pastoralists, thus facilitating the development of many different associated activities:

- The road network has increased in size and improved: more carriage roads extend into pastoral areas, livestock trails have been developed, with transhumance corridors being marked.
- The water supply network for pastoralists has increased in size: open wells, sometimes deep (60 m or more), deep drilled wells and, on the surface, artificial ponds and small dams with an upstream reservoir. This has fostered livestock movements, the setting up of camp and village sites, while boosting animal and human population densities. Pastoral hydraulic programmes and the distribution of water supply facilities have become important levers to support pastoral livestock-farming and natural resource management.
- National newsletters on pastoralism are being published, e.g. the regional 'Information system for pastoralism in the Sahel' network (SIPSA). Some pastoral villages now have telephone and internet access, and some pastoralists located in remote regions have equipped themselves with satellite telephones. Radio station broadcasts can be picked up in most pastoral areas. Professional (resource status, market prices, etc.), social and technical information may be conveyed via these media. Early warnings may also be disseminated.

In summary, technical innovations, production system adaptations, institutional changes, negotiation processes, information dissemination and changing views on land and mobility rights are modern dynamics geared towards preserving the essence of pastoralism.

> FOCUS | Adaptation to a changing political setting

In recent decades, Sahelian pastoralists have had to adapt to major political and institutional changes, such as the introduction of multiparty democracies and decentralization, often involving new territorial divisions. Some people initially feared that these pastoralists would be only marginally interested because of their mobile lifestyle and occupations. In fact, as considerable efforts were made through awareness and training meetings, clear progress was noted in pastoralists' actual involvement in local decision-making bodies, even though collaborations between migrant and settled communities have remained complicated.

It was also feared that municipalities would be unable to appropriately tax herd movements when new transhumant pastoralists showed up. Fortunately, however, this problem was circumvented by the institution of a law that was drawn up to promote inter-municipality relationships between neighbouring municipalities without being detrimental to pastoral mobility.

In Niger, municipal authorities were also able to secure pastoralists' access to new wells through social agreements between the different concerned groups.

Desertification and pastoral livestock herding in the Sahel

Certain general signs of desertification may be readily observed in the Sahel: the disappearance of woody plants, land denudation, spectacular eroded land shapes, the scarcity of wild animals and, finally, the poor performance of livestock herds and soil impoverishment.

Although public opinion may be aroused by sudden, rapid changes triggered by an external phenomenon such as drought, the impacts are not always lasting. The process is often slow, insidious and therefore relatively imperceptible. To assess the progress of desertification, comparisons should be made at sufficiently long intervals so as to avoid annual variability effects. This may be done by listening to elders in the region, historical narratives, analysing photographs, remote sensing images and accurate vegetation survey findings.

In order to assess the aspects of environmental changes that specifically affect pastoral livestock farming, different elements are monitored depending on the scale considered. Some are visible in the field, such as impacts on the soil and vegetation, while others concern less visible resources such as water and biodiversity. On a regional scale, land use and landscape changes are assessed and, more generally, the impacts on the atmosphere and climate change.

GENERAL DESERTIFICATION FEATURES IN THE SAHEL

Desertification signs are similar throughout Sahelian areas where livestock herds wander or not. The state of desertification in a pastoral region was clearly summarized by P. Grimaud (2009) with respect to the Karamoja region in semiarid northeastern Uganda: *"loss of biodiversity through the disappearance of all wildlife, scarcity of trees, erosion, settling [Karamojong pastoralists] could explain the local overpopulation—these are some of the alarm signals."* These general desertification features may be noted at different levels of severity in many pastoral regions.

Degrading land

The vegetation cover loses its land protection capacity due to repeated grazing or land clearing. Gullies are created by runoff, surface water is loaded with solid particles that are subsequently carried to lower areas in runoff waters. Sediment builds up on the river beds, thus increasing the flooding risk, or it is deposited in faraway lakes and even estuaries. The finest dust particles are borne by the winds and dispersed in the atmosphere, thus increasing atmospheric aerosol levels. Erosion signs increase: on the surface, some soils become compacted, while others deepen and part of the surface layer is lost ('scoop-shaped' erosion, uprooting of trees, remobilization of fixed dunes). This gives rise to problems of rainwater infiltration, thus reducing soil moisture and groundwater recharge. Consequently, the plant cover becomes sparse and bare land areas expand. This excessive pressure on the environment creates a vicious circle that may be aggravated by climatic variations.

Depletion of the living environment

All biological activity declines: annual biomass production decreases, natural stand regeneration capacities are affected, and balances between species in ecosystems change. Biological diversity seems to be simplified to the benefit of a few dominant species.

Woody vegetation is especially affected: some dry forests are highly degraded, some species age without being replaced and become scarce, leaving a small number of shrubs that are well adapted to arid conditions. Annual wood and leaf production of this vegetation declines. There is a decline in the genetic diversity of populations, based on ever lower numbers of individuals, which is detrimental to the long-term capacity of species to adapt to environmental change.

The symptoms are less obvious in herbaceous vegetation. However, some perennial grasses are becoming scarce (e.g. the acanthus fodder species

▼ Very scattered grasses between stones grazed by camels in a reg at Butana, central-eastern Sudan.

© A. Ickowicz

Blepharis linariifolia, or the grass *Andropogon gayanus*) to the benefit of annual species. In contrast, others have become locally invasive. On temporarily submerged land, grassy plant covers that host the activity of a range of natural fauna risk extinction.

Overall, the vegetation is thus retracting—the highest lands and slopes are becoming bare, while low points benefit from the increased runoff water and sediment, leading to an increase in the density of shrubs and young trees.

Wildlife has decreased considerably throughout the region in recent decades. Big game has been decimated by hunting, disturbed by livestock herds, and affected by habitat degradation and drought.

Impact on humankind

Desertification is perceptible by local inhabitants when they realize that some common environmental resources decline or disappear, such as fuelwood and timber, good fodder species, gathered products and other non-woody products, game, water availability and quality, good land, air quality and the healthiness and cleanliness of sites.

This perception is hazier when the change is gradual because it is necessary to compare present situations with memorized elements. Dry regions are subjected to high climatic variation, so discontinuous variations may mask long-term evolutionary trends. Conversely, a sudden marked climatic crisis, with the spectacular environmental, natural resource and population disturbances that it may cause, raises public awareness, sometimes excessively, but is not necessarily considered as desertification if it is only temporary. However, the two large-scale droughts that occurred in the 1970s and 1980s in the Sahel, and the high resulting livestock mortality, revealed that the vegetation and soils had been overexploited for a few decades in many regions.

The availability of fodder (which is also degrading) on **rangelands** is tending to decline year after year. In addition, two patterns are worsening this trend: (i) rangeland areas are shrinking with the extension of cropland; and (ii) climatic patterns in favour of increasing irregularity have induced a decline in annual biomass production. For livestock farmers, this has led to an increase in risks for their livestock in crisis situations, an increase in daily tasks, longer distance movements, the necessity to extract water from deeper layers, **transhumances** to more faraway areas, and the necessity to rear more animals to ensure a sufficient income.

▼ Typical snout-to-the-ground attitude of a flock of grazing sheep. Ferlo, Senegal.

© B. Toutain & S. Pédurthe

An in-depth study of the vegetation composition and changes enables an accurate assessment of changes in the pastoral rangeland value. The fact that the highly grazed dominant rangeland species are also fodder species and that the biomass generally continues to follow the rainfall patterns minimizes the perception of long-term changes.

In agriculture, many indices can highlight environmental degradation, but these are not discussed in detail in this *Dossier*. Production levels partially depend on the rainfall conditions. The risk of poor harvest yields forces farmers to clear new lands, even in areas with poor soils, which are often quickly abandoned. In dry climatic conditions, land clearing is a brutal assault on the environment that often leads to erosion. Several years of fallows are then necessary to get back to a relatively balanced ecological situation.

SPECIFIC ENVIRONMENTAL IMPACTS OF LIVESTOCK

The environmental imprint of pastoral livestock farming builds up gradually over time and is the result of the spatial increase in many seemingly insignificant but repeated and sometimes overlapping impacts that worsen the situation, e.g. soil compaction caused by livestock trampling.

Livestock grazing transforms the vegetation

Vegetation is the landscape element that shows the most clearcut signs of herd visits. Repeated livestock grazing modifies the density, height and distributions of the grass and woody plant cover and thus the vegetation structure, i.e. the combined distribution of herbaceous and woody plants:

▪ The grass cover in dryland regions is dominated by annual plants and often very low due to livestock grazing. At the end of the season, straw debris, as well as stumps of perennial or non-fodder plants is often all that is left on the surface. This situation is the result of extensive grazing, but is not abnormal or *a priori* excessive. Once the annual plants die, they eventually disappear and are replaced by the next generation arising from germinated seeds (which are generally preserved during livestock grazing).

▪ The grass cover in subhumid regions (savanna) is dominated by perennial grasses: grazing partially shortens clumps of grass, thus uniformizing the height of the grass cover. Pending suitable climatic conditions, the regrowth emerges from the base of the plants and sometimes from the stem nodes. On humid floodplains, heavily grazed grasses even tend to form a close-cropped sward.

▪ The lowest parts of fodder trees are defoliated, up to the highest point that the animals can reach, or their growth is stunted by intense browsing. The following may be noted concerning the presence and density of woody plants in grazed areas:

- In dryland regions, a substantial decrease in their density: livestock herds destroy some of the young plants. However, the composition of the plant cover tends to become specialized since the animals also contribute to the dissemination of some fodder tree seeds.

- In subhumid regions, various impacts: intense grazing weakens the competitiveness of grasses to the benefit of woody species (bush encroachment). However, grass fires promote the development of grass cover to the detriment of trees and shrubs

(savanna transition). Consequently, depending on the soil type and grazing intensity, savanna landscapes sometimes occur with a few scattered trees, or thickets, or densely wooded savannas that are relatively unsuitable for grazing.

Is a herbivore a kind of plant predator? When feeding, animals' teeth cut and tear plant organs and uproot seedlings. Branches are broken. Low plants are trampled by animal hooves. The resulting reduction in leaf area in turn reduces the photosynthetic activity until the foliage canopy reforms. The plant reproduction capacity is also reduced by livestock grazing on the fruits and seeds (e.g. acacia pods and grass seeds).

Rangeland plants can actually withstand this grazing—many of these plants have biological mechanisms that enable their regeneration. For instance, perennial grasses regrow and produce lateral tillers as long as there is some moisture in the ground. Lateral buds are activated in woody plants and reform new organs. Some seeds enclosed in a thick cuticle are not digested when eaten and can even germinate after being excreted in dung *(Acacia, Balanites)*. Some woody species in pastoral areas propagate vegetatively from roots, thus not via seeds. Plant biomass produced under the effects of grazing is usually inferior or roughly equivalent to that produced by the same species without grazing pressure, but there have been cases where the grazed ecosystem produces more than the preserved ecosystem.

> FOCUS | **Coevolution of fodder plants and herbivoress**

Since geological time, vast grasslands have prevailed on the African continent. This ecosystem has been the cradle for many herbivorous animal species. The plants and animals have evolved simultaneously, adapting to each other—animals to cull and digest these plants and the plants to withstand animal predation. Hence, there are many high quality fodder species in Africa.

In some ways, herbivores promote the vegetation dynamics:

- They contribute to 'cleansing' the vegetation cover by eliminating part of the biomass in the herbaceous layer.
- By reducing the dead plant material mass at the end of the season (litter), these animals indirectly participate in establishing the following generation of grass.
- Through this partial straw and litter cleansing, they indirectly reduce the risk of unwanted accidental fires or at least reduce their severity—a fire cannot spread widely when the standing dry biomass is under 1 t/ha. It has been noted that, in the Sahel, years of high grass production coincide with years with the most threatening bush fires, which may spread dozens of kilometres from the source.
- They also transport and bury seeds, while recycling part of the organic matter and minerals, returning them to the soils in a digested biologically transformed form.

Livestock also has an impact on soils…

Hoofprints generally persist in moist plastic soils (loamy/clayey soils), and repeated passages of animals lead to soil compaction and reduce its water retention and drainage capacity. This in turn reduces root water supplies, soil biological activity and humification. The formation of a surface crust also stalls the germination of some plants and sometimes promotes the development of a hydrophobic cyanophyta (blue-green algae) film.

In areas where the soil is dry and composed of fine particles, disintegration of the surface layer often leads to the loose soil being picked up by the wind, which is often high in dryland areas, and sometimes carried to high altitudes and long distances. In addition to the loss of soil material via wind erosion, this suspended dust may be irritating to the respiratory tract. The dust may be trapped on the ground and filtered by rough surfaces, natural protuberances, branches and straw. Livestock trampling is conducive to the incorporation of litter (dead plant debris on the soil surface), dung and seeds into sandy soils.

In some soils that have undergone surface disintegration or deep compaction, water erosion often removes the most fertile surface layer, laying bare a more compact sublayer which has a lower organic matter content. Natural restoration of a humic surface layer is a very slow process. Solid materials carried by erosion often sediment and build up in natural outfalls (wadis, ponds, lakes, etc.). Wind erosion moves and carries fine soil particles and creates build-ups, sand-strewn areas and dunes.

> FOCUS | Cattle water consumption patterns

In the tropics, a cow drinks 15–25 l of water a day. This represents around 7–9 m^3 a year. A herd of 200 head of cattle thus drinks 1 400 m^3 a year, or 1 800 m^3 at most. This could be compared to the amount of rain that falls on the rangeland, i.e. 5 000 m^3/ha of rain in areas with a rainfall level of 500 mm/year.

The mean carrying capacity of a rangeland under such climatic conditions is around 0.4 cow/ha. The theoretical annual proportion of rainfall water resources drunk by cattle in such areas is therefore under 1%.

▲ Herd watering, Niger.

E. Bernus © IRD

If the soil is not carried away by erosion, cattle tracks gradually disappear through natural mechanisms such as clay swelling and retraction, soil macrofauna activities and root growth forces.

Animals leave dung on the soil surface. Feces (cow patties, droppings and pellets) end up being incorporated into the soil via coprophagous insects (mainly dung beetles). The grass is soiled by urine, which becomes temporarily inedible. However, all of these droppings have a high partially digested organic matter and mineral content, especially nitrogen and phosphorous. In this way, cattle participate in the natural cycle of these elements. Former night paddocks are thus especially fertile sites.

… and on water resources

The quantities of water used for watering cattle are much lower than those naturally evaporated from free water surfaces (a height of several millimetres of water daily) lost by infiltration, or tapped for small-scale irrigation. Note, however, that:

- Surface water pools are the main resources utilized for watering herbivorous livestock. If the animals wade into the water to drink, it becomes turbid and polluted due to mud trampling and defecation. Diseases and parasites may then be transmitted via this water.

- Water extracted from deep water aquifers via dug or drilled wells for watering livestock herds may also be used for other domestic or agricultural purposes. Some water pools are naturally refilled every year (surface water, water table, certain deep aquifers). Only fossil water deposits are not renewable.

- Ecosystems around and in water are suitable for parasite vectors such as mosquitoes (malaria), tsetse flies (animal and human trypanosomiasis), black flies (human onchocerciasis) and aquatic gastropods (human schistosomiasis). These watering points are therefore potentially important sites of contamination of both animals and humans.

- Animal trails to and from watering places are quite concentrated. Animals create corridors in the vegetation that are regularly used to reach these watering places: they erode access slopes and banks and make them slide, while trampling wet ground and shallow free water.

Complex interactions with wildlife and biodiversity

Domesticated or wild herbivores interact with other animal species. For all animals, the ecosystem is a habitat and shelter, a pantry, a place of encounter and thus of predator/prey and host/parasite relationships, or competition/complementarity interactions. Each animal therefore involuntarily promotes, disturbs or destroys the life or habitat of some large or small species. For instance: parasites such as ticks propagate in rangelands with heavy grazing activity; cattle may hamper bird nesting or disturb the calm atmosphere necessary for some antelopes, and; herbivores, especially young animals, are the choice prey of big cats. There are also attractions: cattle egrets *(Ardeola ibis)* often accompany grazing livestock and wild buffaloes. Cattle also often carry and disseminate certain microorganisms and parasites to and from wild populations.

Grazing does not markedly change the composition of the plant cover (species present). However, the abundance of each plant species and their relative proportions differ in grazed and nongrazed areas. For instance, some tree species, such as the baobab *(Adansonia digitata)* or *Anogeissus leiocarpa*, do not

▼ A heifer and commensal cattle egrets *(Ardeola ibis)*, Cameroon.

J. Bonvallot © IRD

▲ A Fulani pastoralist tending his herd. Mali.

H. Guillaume © IRD

regenerate well in highly grazed areas. Other species, such as *Acacia tortilis* and *Balanites aegyptiaca*, grow well despite their attractiveness as fodder sources, partly due to the dissemination of their seeds by grazing animals and root suckering after trampling. Livestock also promote the mixing of herbaceous species and the spreading of some of them. This is the case for fodder plants such as karengiya *(Cenchrus biflorus)*, a grass that produces burred seeds, or *Panicum turgidum*. The growth of unwanted hard to control weeds is also sometimes promoted in the Sahel, e.g. the inedible Caesalpiniaceae species *Cassia obtusifolia* in moist soils or the thorny Mimosaceae species *Prosopis juliflora* and *Dichrostachys cinerea*.

These features confirm the basic principles of ecosystem functioning, i.e. relationships between species living in pastoral environments are multifaceted and complex. Moderate plant predation by herbivores is one of these natural interactions. Ecosystems—depending on the dynamics of the species they host—generally offset the impacts of disturbances. When there are lasting changes or repeated disturbances, interactions between species within the ecosystem are modified and continuously adjusted. The **climax** concept is a timeless reference but it does not apply in this ever-changing setting. The succession concept is more applicable: a new ecosystem forms after a disturbance, which resembles the former ecosystem but is never identical and the entire ecosystem evolves from disturbance to disturbance. A pastoral landscape is therefore not a degraded landscape but rather the reflection of the ecosystems that form it and in which livestock are key interacting elements. This has been illustrated in many exclosure situations (fencing and exclusion of livestock for several years).

ENVIRONMENTAL IMPACT OF PASTORAL PRACTICES

Livestock farmers and **shepherds** have learned about resources so as to be able to use them better and lead their animals to areas with the best conditions. They only intervene in the environment to ensure the well-being of their herds. However, since rangelands are collective, they do not actually have the means to maintain or manage these resources—their main concern is to have daily access to the rangeland.

Access to rangelands and fodder

Livestock farmers, depending on their herd management strategy, select specific grazing sites or they may leave their animals free to roam through the rangeland for hours. In their herd management role, they sometimes keep the herd grouped, disperse them in the range, or drive them to different grazing areas. An experienced and skilled **pastoralist** takes the quality of the grazings into account when organizing grazing routes, including special resources such as fodder trees or herbaceous lowlands, for instance.

In rangelands, the animals disperse to graze, which means that the areas grazed are also scattered. Traces of grazing on the vegetation are more obvious when grazing has been heavy and constant throughout the year. When the grazing has been moderate, the impact depends on the extent of natural predation by wildlife* without any livestock pressure.

* It has been shown that levels of herbivorous livestock biomass on rangelands in tropical Africa are normally around the same as those of herbivorous wildlife in protected areas.

▲ *An Acacia seyal* tree felled by a shepherd during transhumance to provide access to the leaves for his herd. Salamat region, Chad.

© B. Toutain

▲ A savanna bush fire in December. Burkina Faso.

© B. Toutain

Pastoralists sometimes simply lop branches off trees for their animals to graze on the leaves. Pruning (moderate trimming of branch tips on trees) is practiced by some shepherds to enable their animals to feed on the green leaves when there is a scarcity of grass. This practice favours tree regrowth and sometimes even stimulates its growth. In contrast, tree topping (cutting much of the crown), which is more common, induces wounds that take a long time to scar, thus jeopardizing flower and fruit production. The tree may die if this topping operation is excessive. So-called 'umbrella pruning', whereby the lowest branches are pruned at half length and left attached to the trunk by a strip of bark, can be fatal for trees in areas where bush fires occur regularly.

The intentional lighting of fires is only of pastoral interest in savanna regions—early fires will eliminate hard inedible straw and excessive numbers of woody shoots, while stimulating grass shoot growth. Conversely, late fires are violent and destructive, even within the top few centimetres of soil. They burn fodder and repeated fires impoverish the plant community, upset wildlife and reduce the soil organic matter content, thus hampering the recovery of fertility. Such fires are not ignited for pastoral purposes. Apart from pastoralists, other people light savanna fires, including walkers to broaden their field of vision in tall grasses and to reduce the risk of dangerous encounters with wild animals, hunters to flush game from their hiding places, and farmers to clear a new field.

The continuous use of rangelands by an excessive number of animals and over a quite long period will inevitably lead to habitat degradation. This situation arises in regions where human and animal population densities have markedly increased beyond the production capacity of the environment. This is overgrazing.

> FOCUS | The carrying capacity concept

If we consider grassland production as being constant and known, then it is theoretically possible to compare the fodder supply with livestock needs—the carrying capacity is the number of standard animals that a given grassland area can feed.

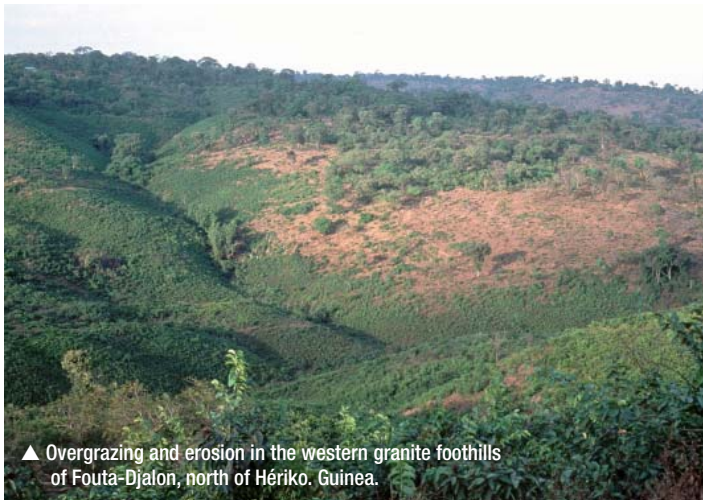
The following is an example of a rangeland that produces 3 t DM/ha/year of fodder. It is known that the daily grass intake of a **TLU** is 6.25 kg DM, or 2.3 t DM/year. If we assume, on the basis of experience and observations, that livestock can graze up to 75% of all produced grass without risk of degrading this type of rangeland, then 3T DM would be required to feed a TLU. The carrying capacity is 1 TLU/ha (or 1 ha/TLU).

The carrying capacity of a rangeland is thus determined by measuring the annual fodder biomass production and estimating a maximum grazing rate. This rate, which is assumed to be compatible with the ecological balance and the **resilience** of the environment, varies substantially depending on the type of vegetation. For instance, it is 35–40% in Sahelian rangelands where annual grasses prevail (Toutain & Lhoste, 1978), and over 80% in intensively grazed grasslands in wet regions (Boudet, 1991).

The theoretical basis of this concept, when applied to rangelands and a usage suitable for rough assessments, has nevertheless been criticized and challenged *(see page 42, the out of balance rangeland concept).*

▲ A Sahelian rangeland degraded by overgrazing in the Markoy region, Burkina Faso.

© B. Toutain



▲ Overgrazing and erosion in the western granite foothills of Fouta-Djalon, north of Hériko. Guinea.

Y. Boulvert © IRD

Mobility is the main herd management strategy, i.e. moving to a different rangeland when necessary. It is in the pastoralists' interest to graze his animals just long enough for them to easily feed on the best grazings before moving to another place. In a new rangeland, the animals select their preferred plants and plant parts. When the rangeland has already been grazed, the animals must graze on whatever fodder remains, which is not as good quality and is harder to graze. In situations when a pastoralist is unable to drive his herd to a new site, he is obliged to leave his livestock in the same area with the risk of overgrazing.

Most pastoralists milk their livestock to fulfil their daily needs. When there is less milk in the calabash, pastoralists move their herds well before overgrazing occurs. Pastoralists are also somewhat aware of the fact that they should share this common good with other pastoralists in the framework of collective rangeland grazing rights, and also that they will have to graze their herds on these same lands in the future *(see the studies of Ostrom, 1990)*. Indeed, good herd management requires good plant resource management.

Access to watering places

Water resources geographically structure the pastoral area, while watering (daily if possible) punctuates livestock movements. Watering places and rangelands selected by shepherds are interdependent because water access possibilities determine the access to rangelands that they serve.

Surface water bodies are the most suitable for watering livestock: rivers, wadis (temporary), lakes (permanent), ponds (generally temporary), and springs. Surface water is maintained in retention structures, i.e. pastoral ponds, hillside reservoirs, or small dams. In all cases, the animals generally drink directly from the water body, except in cases of managed fenced ponds equipped with external livestock watering troughs.

Ground water is tapped via several different structures. Traditional wells and drain wells that are renovated yearly and often serve a relatively small number herding stakeholders, whereas pipe wells are for more collective use.

> EXAMPLE | **Livestock herd mobility and resource preservation in Niger**

Two experts who were called in to provide support for a pastoral resource management project in Zinder region assessed the results of studies focused specifically on the impacts of livestock on ecosystems in the region. They concluded that the effects of grazing were less marked the more often the herds moved. The overgrazing concept mainly concerns the continuous use of pastoral resources because livestock, even in small numbers, selectively graze and tend to eliminate the most palatable species.

Herd settling has ecosystem degradation impacts: *"Overall, in pastoral areas, few environmental risks are associated with pastoral livestock farming because of herd mobility, which tailors the grazing pressure to the local seasonal availability of fodder. However, cropping in pastoral areas boosts the vulnerability of arid ecosystems to soil erosion, especially wind erosion, as well as water and biochemical erosion. In addition, the expansion of cropping reduces local and regional herd mobility, which may ultimately be detrimental to pastoral livestock production and worsen the environmental impact of pastoral livestock farming"* (Hiernaux *et al.*, 2006).

▲ Livestock herd concentrations raise clouds of dust in the dry season. Here in northern Senegal.

Drawing water manually or with draught animals is a considerable task. However, boreholes with a high flow rate and mechanical pumping are sites of heavy herd activity. Pastoral hydraulic programmes under way in the Sahel (mainly Chad and Senegal) since the 1960s have substantially improved pastoral livestock watering conditions and extended grazing areas. Some of these boreholes have a number of peripheral extensions located several kilometres apart to avoid concentrating herds all at one site for watering. It is essential that pastoral hydraulic programmes account for the grazing biomass resources served by these watering facilities and that balanced hydraulic grids are developed to avoid the problem of excessive livestock concentrations.

On woody vegetation growing along entrenched river banks, repeated passages of herds can trigger rill-wash, caving and irreversible silting. Areas in the vicinity of watering places are trampled and overgrazed, as are other herd assembly sites: night resting areas, livestock markets and herd trails. This leads to degradation of the grass layer, elimination of some woody plants, dung accumulation and sometimes **nitrophilous plant invasion**. Patches of degraded land form around large dug and drilled pastoral wells and the amount of damage depends on the extent and duration of herd activity—they sometimes have a radius of several kilometres. It has been noted, however, that these areas are localized and proportionally small in relation to the rangelands served.

Relationships with wildlife

Pastoralists often see and deal with wild animals in pastoral areas. Their reactions depend on the potential dangers that these animals represent. Pastoralists will try to protect livestock from big cats and other dangerous animals such as snakes, while striving to avoid dangerous areas (e.g. areas overrun with tsetse flies). They also try to drive away wild herbivores that compete with the herd for resources. However, pastoralists are seldom hunters.

Rangelands are natural areas with their hosted biodiversity. Many scientific studies have confirmed the 'wildlife-livestock' complementarity with respect to grazing resources and species diversity (de Haan *et al.*, 1997). A good example is the case of the hoards of elephants in the Sahel that coexist well with Fulani and Touareg pastoralists and herds during their regular migrations between northern Burkina Faso and the Gourma region in Mali (Blake *et al.*, 2003). Some species, however, especially some large herbivores or birds (nesting sites), do not tolerate the presence of humans and livestock and avoid areas where they are found, thus reducing these animals' vital habitat.

Impacts on land-use patterns

Pastoral activities sometimes hamper the extension of cropping areas. For land-use management reasons, some pastoral areas are legally protected against agricultural encroachment (pastoral areas in Burkina Faso, sylvopastoral reserve in Senegal) and also for environmental protection reasons (e.g. the 1961 northern cropping boundary in Niger). The environmental impacts of agriculture in dryland regions are greater and more severe than those caused by **pastoralism**: agricultural land clearing involves the destruction of all or part of the woody plants, elimination of the herbaceous cover, opening of the soil, thus exposing it to sun and drying. This leads to partial destruction of the soil microflora and macrofauna, organic matter degradation and the release of mineral elements that are exported during harvest or carried off in runoff water. The fields are fallowed for years after harvest to enable regrowth of the natural vegetation.

Impacts on the atmosphere and climate

Fine soil particles lifted by the wind, sometimes to great heights, in regions undergoing desertification, alters the transparency of the atmosphere. Livestock indirectly facilitate wind erosion by reducing the plant cover. These aerosols modify solar radiation and that reflected from the Earth into space (reflectance). The impacts on the climate are however still relatively unclear.

Livestock farming accounts for 18% of all natural and human-induced global greenhouse gas emissions (Steinfeld *et al.*, 2006). Ruminant livestock produce methane (CH_4) during digestion. Extensive livestock-farming systems are high methane emitters proportionally to the animal products generated since their low productivity is offset by the number of animals. In more intensive systems, however, agricultural production and transport of feed for livestock produces carbon dioxide (CO_2), nitrous oxide (N_2O) and other active gases which should be added to the livestock balance sheet (Blanfort *et al.*, 2011). The contribution of global warming to pastoralism should also be more accurately assessed, but this factor is possibly quite minor considering the low animal densities (0.1–0.4 TLU/ha) and the almost complete absence of inputs.

Rangelands sequester carbon in living and dead plant material, and especially in soil organic matter. This carbon is released into the atmosphere as the biomass is used and the organic matter degraded, and then it is reintegrated through photosynthesis and when dead material is buried in the soil.

Overall, only plant and soil degradation can contribute to sustained CO_2 emissions (Blanfort, *ibid*). All initiatives to combat desertification participate in carbon storage, even though the quantities involved are relatively low in dryland regions.

REVERSIBILITY OR IRREVERSIBILITY OF DEGRADATION?

Reversibility refers to the possibility of recovering biotic conditions comparable to those that prevailed before the degradation occurred. It is clearly essential to reduce or eliminate the constraints and pressures that have caused the degradation so as to be able to achieve this biological recovery. This reversibility can be natural or induced. If the natural regeneration process begins from very degraded states, the time required for ecosystem recovery is enormous and beyond human perception, i.e. one generation (around 25 years). The situation may seem irreversible, but actually not be so absolute. Induced reversibility involves rehabilitation work, which often requires considerable investment. Once the soils have lost their fine elements and fertility, the water tables have dried up, the plant seeds have disappeared and the sand has become mobile, then reversibility is difficult or even impossible.

The reversibility (or irreversibility) of degradation is hard to assess. It depends on the climatic zone considered—with the most arid areas being the most threatened because they have less biological activity—and the soil types, i.e. it takes time for compacted horizons to recover their permeability and become aerated, and for humic horizons to reform.

Resilience is the capacity of an ecosystem to recover following a disturbance. Many biological mechanisms of species and species communities contribute. In rangelands, grazed plants regrow or return via the abundant quantities of seeds produced (2 years of stock produced yearly on average), shoots on lateral buds, tillering, or vegetative propagation from roots. Vegetation in semiarid regions was shown to be highly resilient when monitored in different situations. Once the vegetation has recovered, wildlife patterns are established and the new ecosystems recover their complexity.

WHAT BALANCE BETWEEN RESOURCES AND LIVESTOCK?

The carrying capacity concept, as described earlier, does not make sense in **pastoral systems**. It can simply be used to roughly assess whether the number of animals present in a region is reasonable (and thus supportable) or excessive. This, however, requires knowledge on the sum of the palatable biomass, thus fodder resources, in the considered area as well as the exact number of livestock present. Herd mobility makes this type of assessment complicated, and therefore approximate.

Ecological studies on rangelands in dryland areas have shown that it is not possible to rationalize the situation in terms of the carrying capacity and the 'resources/needs' balance. Primary production, upon which fodder biomass depends, is closely dependent on the rainfall level. On one hand, there is high annual variability, while on the other wild and domesticated herbivore populations grow slowly at the generation renewal rate, therefore depending on their overall feed needs. It is hard to regulate needs according to the extent of fodder available. During droughts, animals are obliged to migrate or else some of them will die at the site. When the vegetation returns, the remaining animals have abundant resources and their populations reform, until the next drought. The regulation between primary production (pastoral vegetation) and secondary production (animal biomass) takes place naturally, but is never in a steady-state balance. Rangelands are thus considered to be imbalanced (Behnke *et al.,* 1993).

This finding highlights the following points:

- **The natural mechanism for regulating the balance between resources and needs is strengthened by livestock herd mobility, while avoiding dramatic massive mortality and their economic, social and zootechnical consequences.**
- **Hampering this mobility, for instance by artificially maintaining a high permanent animal overstocking rate, increases the risk of long-term desertification.**

Humans—who are also part of the ecosystem—use the ecosystem while also being subjected to its inherent variations and disruptions. Pastoralists' lives become more difficult when desertification reduces the availability and quality of pastoral resources and the environment, which forces them to innovate and take unusual measures. The resilience of **pastoral societies** is based on the technical and social adaptation capacities discussed in the first part of this *Dossier (see page 12).*

▲ A trough formed near a conventional well to water livestock, eastern Chad.

© A. Ickowicz

Towards sustainable pastoralism?

Pastoral systems obviously have relevant and efficient features but still face incredible challenges! Will this long-standing heritage be cut short by obstacles encountered in this sharply contrasted setting? Or, conversely, has the full scope of the challenges been understood and will decisions be made that will enable pastoral stakeholders to deal with these challenges, thus preserving the viability of pastoral systems?

The term 'viability' has a dual meaning based on its Latin roots, i.e. *vita* for 'life' and *via* for 'pathway'. When applied to pastoralism, viability first reflects the ability to live and to last, while also implying the good state of the pathway leading to the rangeland and that of transhumances. In addition, it incorporates political, economic, social and ecological dimensions. It is essential to respect and understand the specific traits and activities of pastoralists, beyond our own personal images and models of livestock farming, in order to be able to help enhance the viability of pastoral systems (Krätli, 2010). Pastoralists therefore must be involved in making decisions concerning their activities, despite the fact that the decisionmaking stakeholders are generally associated with national governments, civil society, legislation bodies and international organizations.

On an Africa-wide scale, the African Union Commission has acknowledged the importance of pastoralism and is examining ways to protect the livelihoods and rights of pastoral communities. A series of consultations and workshops at Isiolo (Kenya) in 2007, Ouagadougou (Burkina Faso) and then Nairobi (Kenya) in 2010 resulted in the drawing up of a policy framework for pastoralism in Africa (African Union, 2010).

ROLE OF NATIONAL PUBLIC POLICIES

The colonial administration was unable to fully assert its power on herding communities and therefore tried to weaken them by separating them from other rural elements. This was the beginning of the broadening gap between settled and nomadic farmers, and between cantons and tribes. As the administration was unable to force nomadic pastoralists to settle, it began trying to control their movements and confine them as much as possible within administrative units. It was not until much later that the administration became involved in pastoral hydraulic projects, veterinary protection and, to a lesser extent, schooling and human health.

In turn, with international aid, the independent States continued and boosted hydraulic programmes and major epizootic disease control campaigns (especially rinderpest and pleuropneumonia). Herds increased until they were decimated by the 1970s and 1980s droughts, which drove pastoralists into serious poverty, sometimes buffered by emergency operations or herd restocking aid.

Structural adjustment plans were then implemented with divestiture of the State being recommended by major international institutions (International Monetary Fund, World Bank). Technical services, such as livestock-farming services, were abandoned and the substitution strategy via privatization of veterinary services often failed, especially in pastoral areas where there was a dire need for support because of the remoteness from large centres, the vast areas involved and operational costs.

Towards better recognition of pastoralism...

However, since the 1990s, often in a democratization and decentralization setting, there have been marked changes, resulting in better recognition of pastoralism (Marty, 2011). The focus has been centred especially on two aspects.

The first infrastructure aspect has been substantially supported by international aid: major pastoral hydraulic programmes were developed, along with the marking of transhumance trails, the construction of public buildings (schools, health centres, grain banks, non-profit stores, town halls, etc.). These investments have helped change the image of old pastoral areas, with an increase in the number of gathering points, alongside the relatively recent trend

▲ Daily life in the Inner Niger Delta region, Mali. A young Fulani girl during a milking session in the village of Wuro Neema.

O. Barrière © IRD

whereby many pastoralists settle part of their families on a relatively permanent basis in one place. Some of these programmes, such as those funded by the French Development Agency (AFD) in Chad and Niger which have jointly improved the network of watering places and transhumance routes, have improved the security of mobile herds and boosted local tolerance of transhumant pastoralists. Unfortunately, the building of many facilities (especially buildings to host social services) has not been supported by the provision of basic goods and services required for development (insufficient training, lack of qualified staff and adequate operating resources).

The second aspect concerns legislation on pastoralism. In practical terms, all Sahelian countries have renewed their legal system, with definite advances achieved in terms of recognition of mobile herding practices. Only Chad has not yet modified its law N°4 of 31 October 1959 to "regulate **nomadism**", but it has just begun preparing a pastoral code. Previously the State regulated pastoral resources, with pastoralists only having precarious rights of usage of "unowned vacant lands". Now, however, pastoralists have explicitly recognized rights—at least in theory—and management responsibilities in association with professional organizations and decentralized local communities. Of course there are still shortcomings, e.g. lack of streamlining with other official texts (concerning water, forests, protected areas, etc.) and ambiguous areas (e.g. on the key pastoral development concept, providing legal recognition rights). Another major and well known problem concerns the actual field application of the theories. This latter factor could only legitimately succeed in a calm collaborative atmosphere between concerned parties and joint prevention of conflicts between the different users.

◀ A sign for an operational branch of a Nigerien development project. Tahoua, Niger.

© B. Toutain

...But there are still shortcomings

Other essential areas affected by public policies are often still orphan sectors of development, especially in pastoral areas, these include: education (schooling for boys and girls, functional adult literacy training) and human health and veterinary protection. Despite the obvious expressed needs, there is a lack of trained, motivated and supervised teachers and canteens (when the families live faraway); health centres attract little attention; and livestock-farming support structures lack sufficient resources to ensure the sanitary protection of herds and to promote animal products and their marketing under optimal conditions.

Since the onset of severe droughts, there has been an obvious and major focus in political discussions and the national media on preserving ecosystems and combating desertification. However, only a few limited one-off initiatives have been undertaken in pastoral and agropastoral areas. An approach involving local agreements between various users seems the most promising. Clearcut sustainable progress will likely be facilitated when the two following beliefs are more widely shared by the different parties present: first, herd mobility is relevant from an ecological standpoint and, secondly, it is essential to work towards the appointment of legitimate and legal management authorities.

Note also that over the last decades many projects and studies involving many different disciplines have been implemented in markedly different fields, involving national research centres as well as development projects and non-governmental organizations (NGOs). These have clearly generated a more refined view of pastoralism, highlighting its specificity, adaptation flexibility and benefits. These initiatives have definitely contributed to the progress observed with respect to the recognition of mobile herding systems by public authorities and other partners.

Globalization has also had an impact on the sub-Saharan pastoral community, including: volatility in world market prices, international speculation, the emergence of new production policies (biofuels), the allocation of land to foreign 'liberal international' companies and fostered by certain governments, and the attribution of hunting concessions to rich foreigners. The rapid dissemination of modern means of communication, such as satellite mobile phones, radio and television (broadcasting international news stations), also deserves mention. Moreover, new religious trends, especially emanating from the Middle East and Pakistan, the emergence of new ways of thinking and living inspired by migrant people and, locally, the set up of large-scale mining and petroleum extraction concessions, are also noted.

> FOCUS | Excerpts from the main legislative texts in the Sahel

■ **NIGER.** Guiding principles of the Rural Code Order N°93-015 of 2 March 1993

Art. 5. Both customary and written legal laws on natural resources benefit from equal protection.

Art. 23. Pastoralists, owners or stewards of livestock capital have free access to natural resources (according to two types of law: common rangeland usage rights and nonexclusive priority rangeland usage rights concerning the host region).

■ **MAURITANIA.** Law N°2000-044 pertaining to the Pastoral Code

Art. 12. No development [...] shall be undertaken if it could be detrimental to the vital interests of pastoralists, or seriously reduce pastoralists' access to pastoral resources [...] or generate a value lower than that produced by the former usage system. Economic, ecological and social aspects will be taken into consideration in the value assessment.

Art. 14. All forms of exclusive appropriation of the pastoral area are illegal.

■ **MALI.** Law N°01-004 of February 2001 pertaining to the Pastoral Charter

Art. 1. The present law puts into force and specifies pastoralists' essential rights, especially with respect to livestock mobility and access to pastoral resources. It also delineates their main obligations when carrying out their pastoral activities, especially concerning preserving the environment and respecting other persons' property.

Art. 56. Local authorities must manage pastoral resources with the participation of pastoralists' organizations and in collaboration with other natural resource users.

■ **BURKINA FASO.** Law N°034-2002/AN of 14 November 2002 pertaining to the Pastoralism Framework Law

Art. 6. Within the framework of territorial development policies, the State and local authorities oversee the identification, protection and development of pastoral areas.

Particularly, within the framework of the development of periurban areas, the State and local authorities reserve areas necessary for carrying out and developing livestock-farming activities.

The State and local authorities also oversee the preservation and protection of traditional pastoral areas. Particularly, in pastoral regions, they promote the preservation of lowland and bourgou rangelands for herding activities.

Art. 45. Herding trails are classified, depending on the case, in the public domain of the State or the local authorities. They are therefore inalienable, imprescriptible and exempt from seizure.

■ **SENEGAL.** Law N°2004-16 pertaining to the Agrosylvopastoral Framework Law

Art. 20. Family, industrial and commercial farms must ultimately modernize their production tools, implement improved livestock-farming practices and use modern management techniques in order to be competitive.

Art. 44. Pastoralism is recognized as being a means to ensure the development of rural areas and natural resources. Pastoral activities should be environment friendly, while also respecting other agricultural, silvicultural and rural activities.

■ **NIGER.** Order 2010-029 of 20 May 2010 pertaining to pastoralism

Art. 3. Mobility is a basic right of livestock farmers, nomadic and transhumant pastoralists. This right is recognized and ensured by the State and local authorities.

Mobility is a rational and sustainable means of making effective use of pastoral resources and can only be temporarily impeded for reasons of human, animal, forest and crop security under the conditions defined with respect to current laws and regulations, habits and customs.

Pastoralists should be legitimately represented by delegates who have been independently authorized by them in all bodies having authority in managing natural resources.

In all developed areas, land designated for rangeland and herding trails should be reserved.

Art. 5. [...] All forms of exclusive appropriation of the pastoral area under the public domain of the State or public authorities is prohibited. Particularly, no rural concessions may be granted if it could result in hampering the mobility of pastoralists and their herds and their free access to pastoral resources.

In all cases, an environmental and social impact study is required, accompanied by an environmental and social management plan approved by the relevant authorities.

Art. 52. When mining and petroleum extraction titles cover all or part of the areas in which pastoralists have priority usage rights, the right to occupy land required for mining and petroleum extraction activities can only be granted after the pastoralists have received due compensation.

The amount of this compensation is calculated on the basis of the income loss of pastoralists and is set by consensus between the holder of the mining and petroleum extraction rights and the pastoralists.

PASTORALISTS AND CIVIL SOCIETY

In this *Dossier*, the often poorly defined civil society concept refers to organizations and individuals striving to enhance dignity, human rights and equity for all people, especially marginalized or even stigmatized groups. Civil society can thus apply to both pastoralists and those seeking to support them in global society (national or international).

Let us briefly recall the history of pastoralists' organizations and the hardships they have undergone. For a very long time, the pastoral community was only represented by traditional chieftaincies, which served as intermediaries between their citizens and the general administration. The State then set up cooperative structures to deal with a number of economic functions (such as supplying staple commodities, etc.). Cooperatives in Mali were thus precisely structured according to the district divisions and each taxable family head was considered as a cooperative member, which meant that each cooperative entity could pool a very broad range of interests. Despite internal reform efforts promoting real appropriation of the structure by the cooperative members, this model (originally topdown) disappeared when the freedom of association was fully recognized. The period that followed involved the set up of groups (of around 30 families) or small associations that were more conducive to promoting local grassroots solidarity.

In parallel, in the 1980s, pastoral associations were formed in several countries. This trend was driven by the major donor agencies, including the World Bank, to ensure that they would be 'attributed' the management of pastoral resources and equipment within 'pastoral units', which corresponded to recognized demarcated areas of previously identified pastoralists' groups. However, these associations did not manage to gain a sustainable foothold or achieve a sufficient consensus between the different local users.

This was also the case for 'pilot pastoral area' type approaches*, involving a system of plot rotations and substantial appropriation of the area by beneficiaries, to the detriment of transhumant pastoralists.

The formulas clearly simplify prevailing pastoral systems, which are actually characterized by mobility, flexibility, acquired rights and ongoing negotiations. The best long-term study on this type of intervention is undoubtedly that of Widou Thiengoli in the Senegalese Ferlo region (Thébaud *et al.*, 1995), concluding on the marked superiority of 'traditional pastoral efficiency'. Such approaches were initially geared towards fostering collective rights management but, in several places, finally promoted the private appropriation of the pastoral area by rich pastoralists and the concomitant exclusion of others—in complete opposition to a peace- and equity-oriented civil society type approach.

Finally, since the beginning of this century, standalone organizations of intellectual leaders and pastoralists have emerged. These organizations function like civil society units with the capacity to refer to official texts (constitution, laws, etc.), request their application, defend poorly recognized pastoralists and thus carry out specific operations that address the real needs of herding families. This new strategy has been successful, especially in Niger, in generating effective collaboration, workshop and discussion dynamics just at the time when a new pastoral law was drawn up (order of 20 May 2010 pertaining to pastoralism). This approach has prevailed for almost a decade, through many exchanges between the baseline (in the field) and the summit. It is representative of what civil society is capable of doing to manage sensitive issues. This could also be said with respect to civil society organizations interjections to regulatory authorities concerning serious drought situations (in 2005, and again in 2009-2010).

* According to the holistic management principles developed by Savory and Butterfield (1999).

> FOCUS | **Regarding civil society...**

In developing countries threatened by desertification, this includes all man and women—rural and urban dwellers, farmers and/or pastoralists, entrepreneurs—and traditional or legally-recognized village organizations, professional and private groups, unions, local, national and international NGOs that are present, political parties and companies.

The partners are the State and its centralized and decentralized administrative departments, local and national elected officials and their assemblies, village and regional councils, as well as parliaments. Special attention is paid to those who produce and disseminate knowledge: teachers, researchers, trainers and extension agents. They are members of civil society and privileged partners when negotiating with the State. Their activities are supported by the State.

From Bied-Charreton & Requier-Desjardins, 2007.

▲ A discussion meeting held at Barani, a Fulani village in northwestern Burkina Faso, on the pastoral area close to this village.

© B. Toutain

▲ Child schooling, Niger.

E. Bernus © IRD

Civil society type approaches—before reaching this level of pressure on public policies—are now being applied in different Sahelian band countries. Operations geared towards strengthening rights are relatively common as a follow-up to development studies or projects. This is the case in Chad, a country that has been crippled by a series of civil wars and where several projects, especially pastoral hydraulics projects (funded by AFD), and different NGOs, have ultimately adopted a decisive approach aimed at preventing (via nonviolent solutions) conflicts between farmers and pastoralists, or between different pastoralists. Tensions have thus diminished considerably in several Chadian regions.

In this respect, training on pastoralism is essential. The experiment developed in Senegal by Associates in Research and Education for Development*, with the support of the International Institute for Environment and Development, was subsequently disseminated in other Sahelian countries. It is of interest to pastoralists (men, women, youths and elders) and intellectuals from the State service or development bodies. Pastoralists are thus shown how their system is far from being outdated or ill-adapted, while intellectuals are advised that their criticism or misestimation of the pastoral system must be reconsidered. Hence, for pastoralists this is an occasion to boost their dignity, while for intellectuals it is an invitation to review their unfounded opinions. The fact that these training sessions manage to bring together trainees from such diametrically different fields and to question a range of generally unspoken prejudices, is real progress for a civil society that is becoming aware of the need to change its line of thinking and to assess real pastoral life differently.

* See the ARED website: www.ared-edu.org/fr/Pastoralisme/tabid/148/Default.aspx

THE LONG STRUGGLE FOR RIGHTS

In a changing setting, new strategies are being investigated at the interface between pastoralists' groups and other civil society stakeholders. They aim to enhance recognition of the rights of these people who, because of their mobility, could appear to be widely dispersed on the historical sidelines. However, there are still some well known shortcomings:

- Pastoral mobility rights are being officially recognized to an increasing extent, but their application in the field still often fails. Real progress requires an ongoing collaboration between users, while also accounting for herd movements in rural area development plans on local, intercommunal and sometimes even transboundary scales.

- Access to natural resources, i.e. rangelands, watering places, saline soils, natron, transhumance trails, herd resting areas, etc., is still often problematic. In this respect, pastoralists' rights are not sufficiently guaranteed. There is still a tendency towards whittling away pastoral resources and their private appropriation.

- Pollution of groundwater or soils due to discharges from industrial companies, waste deposits or even intensive agriculture, is a further health threat to inhabitants and herds. All users of these areas can no longer be considered as insignificant elements.

- As users, pastoralists must be fully integrated in initiatives focused on land degradation prevention, biodiversity and plant (especially woody) cover. As pastoralists have long been exempt from and not taken into serious account in ecological monitoring or desertification control initiatives, their involvement can actually only progress if they are granted recognized and guaranteed usage rights.

> FOCUS | **The regional *Billital Maroobé* network**

This network of African livestock farmers' and pastoralists' organizations managed to organize a forum on transboundary transhumance in Benin in April 2010. It brought together representatives of public authorities and regional institutions, umbrella pastoralists' organizations and technical and financial partners. The recommendations stress the importance of maintaining herd mobility and on improving regulations and equipment concerning herding trails.

Following a workshop that was held in Burkina Faso in October 2011 reviewing texts that regulate transhumance, this network pointed out the need to improve and streamline national and regional regulatory frameworks on this topic, while also stressing the importance of strengthening links between socioprofessional organizations in order to improve their efficiency.

For further information: www.maroobe.org

■ Effective access to social, administrative and technical services is very insufficient despite some improvements, or only concern some families: better access to water, better water quality via wells, better means of communication, etc. Access rights concerning schooling, health and supplies (when markets are faraway) have been granted, but their enforcement is rather ineffective. The operational conditions are sometimes even regressing: lack of qualified and motivated staff, not very operational school cantines, teacher, and male/female student absenteeism. School marks are well below expectations. Most young girls do not finish their primary schooling. In the health field, there are also obvious shortcomings in terms of staff, resources, care, etc. Sometimes, street vendors benefit from the situation by proposing pharmaceutical products of questionable (or even dangerous) quality, and generally to unsuspecting people. Veterinary services are now often absent since the profession was privatized.

■ Public participation in local and national political life is essential. Many pastoralists obtain very little reliable information on electoral processes and development programmes that directly concern them. They participate very little in information, decisionmaking and follow-up meetings. Little is known about decentralization mechanisms, which they cannot benefit from on a bush camp level. Elected representatives are therefore not very eager to account for their activities and promises.

The scope for progress in applying rights that concern the pastoral community is generally enormous: rights within families (between men and women, youths and adults, owners and shepherds), rights relative to other users (farmers, hunters, gatherers, etc.), with other types of livestock farmers (including new investors geared towards obtaining exclusive resource monopolies). Setting up legal services with advisors specially trained to work with the herding community is well worth considering.

Based on the 'tragedy of the commons' theory (Hardin, 1968), some people foresaw an inevitable degradation of common property. However, this did not take place with respect to collective rangelands. Conversely, Ostrom (1990) concluded from the findings of her empirical analyses of real situations that individuals making use of a common resource try to solve their problems efficiently and that communities strive to deal with complex and uncertain environmental issues in a creative and constructive way. These individuals in communities thus require access to accurate information, recognition of their organization rights and conflict resolution mechanisms. The current dynamics of pastoralists' organizations, negotiating rights and decentralization of responsibilities seek to achieve this.

STATUS AND ROLE OF REGIONAL AND INTERNATIONAL INSTITUTIONS

Two other key domains for the future of pastoralism in sub-Saharan Africa seem to be improved: transboundary traffic of livestock within the regional area; and scientific and technical research in research and development institutions at all levels (local, national, regional and international).

How could transboundary circulation of livestock be improved?

Some Sahelian countries are squeezed between borders with North Africa and with coastal countries. Based on available data, the latter can especially be dealt with, notably countries within ECOWAS (300 million inhabitants), around southern countries where herds are routed for seasonal transhumance, or to be marketed.

Transboundary transhumance is essential for many Sahelian pastoralists because plant resources are generally more abundant (but of poorer quality than in pastoral areas) southward, where rainfall levels are higher. However, problems may arise that are

relatively similar to those encountered further north, i.e. a reduction in grazable areas, binding agropastoral calendars, herd mobility obstructions, diseases, conflicts and insecurity. The ECOWAS International Transhumance Certificate aims to facilitate and regulate access. However, its interpretation and application vary, which often penalizes pastoralists, who are obliged to comply with the conditions established by local officers. Some States, such as Benin and Nigeria, have taken conflicting measures prohibiting transboundary transhumance, despite the fact that livestock from other countries account for part of the animals traded in their markets. As pointed out by pastoral associations, substantial progress is required to ensure the security of livestock movements.

Transboundary livestock trade clearly contributes to fulfilling part of the enormous needs of an ever-growing and increasingly urban population. These Sahelian products are greatly appreciated but faced with high competition from products imported from other parts of the world (especially frozen chickens, fish and beef), even though they are often considered to be of poorer quality, but sold at much lower prices. The figure below shows the main marketing routes in West and Central Africa. Large urban centres in the coastal countries, especially Nigeria, are the main centres of attraction.

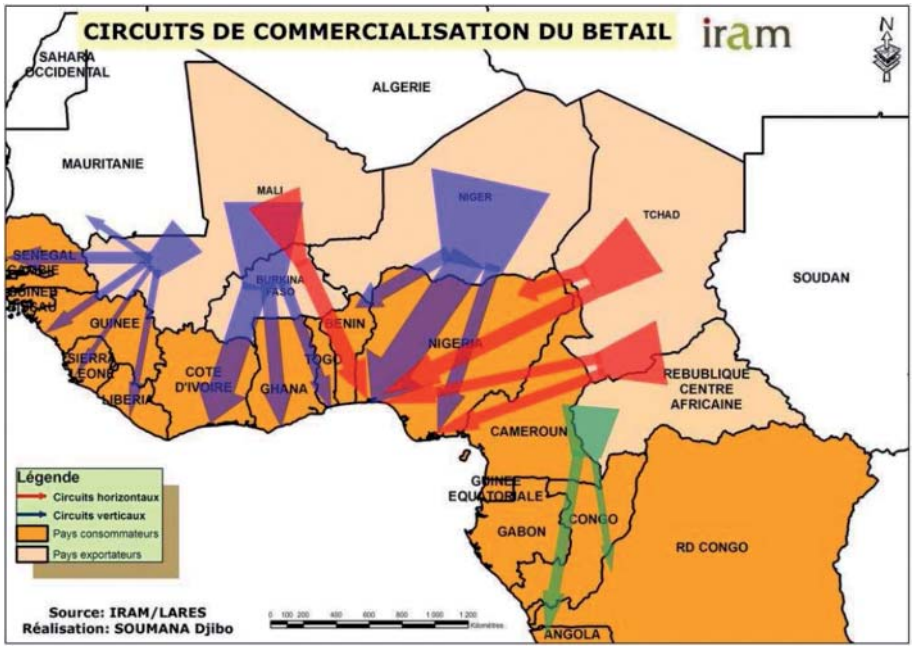
Many studies are under way to address these issues, which are contributing to refining data on pastoralism. Pastoralists' organizations are striving to make their voices heard with the aim of generating respect for farmers' interests.

Scientific and technical research to deal with these different challenges

Beyond the first travellers' tales describing the peoples encountered, **pastoral societies** in sub-Saharan Africa have captured the attention of many observers from various disciplines (including anthropology) who have described operating modes and analysed the social and technical factors that ensure their sustainability, as illustrated in the works of E. E. Evans-Pritchard on the Sudanese Nuer people (1930s), M. Dupire on the Nigerien Wodaabe people (1960s), A.M. Bonfiglioli (1980s), P. Bonte, etc.* Renowned geographers (J. Gallais, E. Bernus, J. Boutrais, H. Barral, M. Benoit, C. Santoir, etc.), have also contributed substantially to boosting awareness on pastoral peoples and the areas they wander with their herds.

The colonial administrations also delegated veterinarians to reduce epizootic risks that could be detrimental to livestock-farming food production. Moreover, hydrogeological studies highlighted water resources, especially groundwater, available for human populations and livestock farming.

* In particular, the 'Ecology and Anthropology of Pastoral Societies' team at the French *Maison des Sciences de l'Homme* published the *Production pastorale et sociétés* newsletter in the 1970s-1980s.



◀ Livestock marketing routes in West and Central Africa.

Legend
Red arrows: horizontal routes
Purple arrows: vertical routes
Orange coloured countries: Consumer countries
Beige coloured countries: Export countries

The other factor hampering livestock-farming enhancement concerned livestock feeding. In the latter half of the 20th century many agronomists and fodder plant specialists focused studies on grazings and rangelands for the purpose of enhancing livestock farm productivity, even in pastoral regions which were already the most productive. Scientific policies were geared towards the 'optimization' of available resource use. Then the situation was affected by the onset of the severe droughts of the 1969-1973 period (a cause of widespread famine) and 1982-1984 period. This increased awareness of the fragility of these semiarid environments affected by the regular increase in the number of animals and the production limits of these vast pastoral areas. The orientation of the approach then gradually shifted from 'productivist' to 'ecological' (Toutain & Lhoste in Bourgeot, 1999).

Rangelands are now considered as complex environments consisting of many interacting ecosystems whose 'sustainability' must be maintained. The carrying capacity concept, which is relatively non-applicable to Sahelian rangelands that have variable and unpredictable productivity, prompted ecologists (mainly British and American) to propose the 'range ecology at disequilibrium' concept *(see page 42)*. The ecosystem **functional integrity** concept was developed especially for pastoral environments and accounts for the productive capacity of rangelands and their livestock feed value, as well as their natural renewal capacity (Kammili *et al.,* 2011). Many other research disciplines are currently focused on pastoralism and the research findings are enhancing knowledge on this complex world.

Researchers and development organizations noted the low long-term adoption of their recommendations and thus focused on another area for thought and discussion, i.e. economics, social and political factors. The results of these studies have revealed current necessary interactions between the African pastoral community and society overall: agropastoral and market systems in dryland areas, as well as other production systems and consumption markets in general. The 'policies in the fight against poverty' topic supplemented discussions on development patterns in developing countries. The status of pastoralism in national economies and in revenues or in the economy of domestic units has become a topic for study. This pastoral activity is also a source of employment and stabilization for societies living in marginal areas.

However, due the increased inequality noted between pastoralists and other rural social categories with respect to the focus of development policies, it was necessary to find ways to achieve a better balance. Several fields have come within the scope of development-oriented research and advocacy: training and education, the promotion of local peoples' know-how, professional organizations, legal reinforcement of pastoralists' rights, etc. One of the major challenges is enhancing the dialogue and interactions between pastoralists and other professionals of pastoralism or their representatives, and secondly national or regional decisionmakers. To support the results of external interventions in sub-Saharan regions, a further important challenge is to ensure that they are in line with sectoral policies (agriculture, livestock farming, hydraulics, environment) and to link them with other policy sectors (education, health) through integration into a consistent long-term strategic framework.

Researchers and pastoralism development leaders are currently coping with several challenges or difficulties:

- First the debate between many stakeholders' convictions concerning the environmental opportunity and the economic and social benefits of pastoral systems, and also the vulnerability of pastoralists' families with respect to natural disasters, conflicts, market fluctuations, the political environment and increased inequalities. The issues must be further explored so as to overcome this apparent contradiction.

- The fact that the research results are poorly interpreted with respect to changing public policies. Could this be explained by research objectives, since researchers are mainly judged with respect to their publications, which are mainly read by other researchers, or simply by the fact that there are insufficient links between spheres that use different reference frames and vocabularies?

- It is also apparent that the practical application of a recommendation, decision (even when made participatively) or a legal text is laborious. Then there is the question of their relevance in the pastoral setting, marked by uncertainties, mobility, flexibility or a range of different and insufficiently understood interests. Research has to take this issue into consideration and highlight the actual choices, obstructions and obstacles.

- How do research findings reach pastoralists and to what extent do pastoralists put them into practice? Even though the information transfer is generally slow and more time is often allowed, substantial progress (although sometimes not spectacular) has been achieved, especially via civil society, professional organizations and NGOs. However, dysfunctions

▲ Researchers studying the vegetation composition in a rangeland and measuring the biomass present. Sine-Saloum region in Senegal. © B. Toutain

still exist in this respect. For instance, scientific and technical initiatives have been focused on improving information systems, even for pastoral areas. However, it has been seen that early warning systems activated during the 2009-2010 drought did not provide sufficient information to the different leaders or pastoralists with respect to the seriousness of the situation, or the signals did not come early enough.

Environmental services are a new research focus. It seemed that those who provide environmental services through their practices should benefit more. In hot countries, research is now geared towards assessing greenhouse gas emissions and carbon sequestration associated with various activities, including pastoral activities. The findings could ultimately serve as a basis for payment of environmental services.

These issues are just starting to be included in agricultural policies.

Finally, university research training in areas concerning pastoralism is now being offered at Abdou Moumouni University in Niamey (up to the Master's level) and Cheikh Anta Diop University in Dakar (up to the PhD level). These universities train young scientists in specialized areas who will ultimately be employed as senior staff and researchers in this specific field in sub-Saharan countries.

These new developments are directly linked with those concerning ecosystems and their viability. Pastoralism cannot be practiced and develop under proper conditions if it is not sustainable. Pastoralism will be environment-friendly or not.

Key points in this *Dossier*

▲ A pastoral scene in Niger.
M-N. Favier © IRD

Combating desertification and protecting the environment in areas currently utilized by pastoralists enhances pastoral viability by enabling **pastoralists** to have negotiated control of their resources, while taking advantage of their technical know-how and boosting their knowledge and adaptation capacities.

PASTORALISM PROVIDES INVALUABLE SERVICES

In sub-Saharan Africa, pastoralism is still a very important rural activity. A significant share of the population (up to one person in six in some countries) gains a decent pastoral living, and a larger share gains income throughout the economic chain up to the consumer. Pastoralism makes effective use of large areas in some countries, especially in semiarid regions without many other economic resources.

Pastoralism makes effective use of marginal resources which would otherwise remain unused and unproductive in areas where agriculture is risky. It provides support for people living in such marginal areas and enables them to have a social organization and promotes exchanges, thus contributing to national control of these areas.

Pastoralism contributes to food security in producing countries and neighbouring countries benefiting from imports of high protein products. Crucially, it thus contributes to the production of foodstuffs such as red meat and milk.

When there is efficient sanitary control, the **productive capital** represented by the herd has a competitive growth capacity with other forms of investment—the economic profits generated are even attractive for some investors. Livestock sales fuel export trade to other countries in the subregion. **It also enhances economic support and the sustainability of agricultural systems** with which there are established technical relations.

PASTORALISM IS DYNAMIC

Pastoralism is not an endangered activity in the Sahel. Conversely, it is based on strong internal dynamics, as reflected by its **high adaptation and change capacity.** Pastoral herds are involved in the current increase in national livestock numbers and animal production. The high economic weight of the pastoral sector and the increase in market meat and milk needs further support pastoralism and ensure its future.

However, the **conditions under which pastoralism is practiced are increasingly difficult and complex.** The future of pastoralism depends especially on the status that each national society allocates to pastoralists and the legislation that applies to them. The only potential threat to Sahelian pastoralism could result from public opinion and the prevailing economic conditions rather than the environmental constraints.

PASTORALISM LEAVES A POSITIVE ENVIRONMENTAL FOOTPRINT

Clearly, **pastoral livestock interferes with natural ecological dynamics** and leaves its footprint on grazed ecosystems. The vegetation grazed by herbivores modifies the proportions of herbaceous and woody plants, fodder and nonfodder species. Dung dispersal alters the soil nutrient distribution, pollutes water, and disperses pathogens. The carbon impact, especially greenhouse gas emissions, is substantial. The competition between livestock and wildlife and the degradation of some habitats affect biodiversity.

Pastoralism also provides basic ecological services (although quite invisible) that contribute to the sustainability of natural and cultivated ecosystems. Rangelands are relatively natural environments because they regenerate spontaneously. They have higher biodiversity than cultivated ecosystems in agricultural areas. Herds significantly contribute to fertilizing fields where they stay or where their dung is spread. Draught animals are also used for agricultural work and transportation.

In many cases, **substantial degradation induced by livestock farming is the result of overuse or poor management of resources.** The underlying causes must be sought in order to overcome this problem: limitations to herd mobility, poorly distributed watering places, or loss of essential pastoral areas such as lowlands that are essential feeding areas in the dry season.

WHAT CONDITIONS ARE REQUIRED FOR SUSTAINABLE PASTORALISM?

Governments and international aid agencies have long invested in animal health (vaccinations, control of major epizootic diseases, networks of veterinarian stations). There has also been investment to strengthen livestock-farming infrastructures, mainly networks of hydraulic structures, livestock markets, enhancing the security of herding trails, etc. **This has positive impacts** on production and cattle exchanges.

These investments should be continued since they have so far enabled greater pastoral herd distributions on grazable natural environments, the extension into agropastoral regions, a regular increase in animal numbers and in production volumes and quality. They should be supported by investments and the legislative progress necessary for improving the living conditions of Sahelian inhabitants. Pastoral activities are increasingly difficult due to the scarcity of readily accessible resources, increased competition between pastoralists, farmer-pastoralists, farmers, coveted international interest in resources, which blocks vast areas and results in conflicts.

Investments have been geared towards enhancing the sustainability of **pastoral systems**, while the indirect impacts on grazed ecosystems have varied considerably. The increase in herds has heightened global livestock pressure on resources and increased the risk of degradation. However, most of **these investments have had positive impacts on environmental sustainability, especially by improving the stocking rate distribution, reducing production loses for sanitary reasons** and strengthening joint agriculture/livestock-farming services.

Although the living conditions of herding communities seem to have somewhat improved, further progress is needed, especially with respect to education, health and security due to the current dangerous situation in the region (political-religious conflicts and drug trafficking). It should nevertheless be kept in mind that **the social organization of pastoral societies, through its structures and ties that bind members and their neighbours, promotes social stability and peace in pastoral regions.**

It is essential to develop a favourable political setting, in order to support animal-based food production, the herding sector, rural farmers in marginal areas, and environmental management in general. It could be advantageous in the long term, and reasonable from an environmental standpoint, to be attentive to pastoralist's needs, arbitrate conflicts of interest between pastoralism and other production sectors in a fair way, and invest in pastoralism. Sustainable collective management of pastoral resources could be possible by allowing pastoralism stakeholders the possibility of negotiating their rangeland usage rights and rules between themselves and with the relevant institutions. Authorities at all levels have the capacity to support pastoralism and contribute to maintaining and sustainably developing this invaluable economic activity in pastoral and agropastoral regions threatened by desertification.

For further information…

BIBLIOGRAPHY

AFP, 1990. *Pastum*, n° 19, juillet 1990, Association Française de Pastoralisme, page 11.

African Union, 2010. *Policy framework for pastoralism in Africa – Securing, protecting and improving the lives, livelihoods and rights of pastoral communities.* Addis Ababa (Ethiopia), AU/GITPA, October 2010. 44 pp.

AGRHYMET, 2009. *Le Sahel face aux changements climatiques. Enjeux pour un développement durable.* Niamey, CILSS/AGRHYMET, Bulletin mensuel, numéro spécial, 42 pp.

Ancey V., 2006. *Rapport du bureau d'évaluation du PAM sur la crise alimentaire du Niger en 2005. Evaluation Note 4 : Caractérisation de la crise pastorale*. Rome, OEDE/2006/8.

Azoulay G. & Ancey V., 2011. Migrations, Transferts et Développement Humain : Le Cas des Éleveurs Pastoraux du Sahel. *EADI/DSA Conference 'Rethinking Development in an Age of Scarcity and Uncertainty'*, York (UK), 19-22 September 2011.

Bégué A., Vintrou E., Ruelland D., Claden M. & Dessay N., 2011. Can a 25-year trend in vegetation dynamics (NOAA-AVHRR NDVI) be interpreted in terms of land use changes? A case study of the Bani catchment in Mali. *Global Environmental Change*, 21:413-420.

Behnke R.H., Scoones I. & Kerven C. (eds.), 1993. *Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savannas*. London, Overseas Development Institute.

Berte C.J., 2010. Lutte contre l'ensablement. L'exemple de la Mauritanie. *Étude FAO Forêts*. 158. FAO, Rome. 76 pp.

Bied-Charreton M. & Requier-Desjardins M., 2007. Science and civil society in the fight against desertification. *Les dossiers thématiques du CSFD.* N°6. October 2007. CSFD/Agropolis International, Montpellier, France. 40 pp.

Blake S., Bouché P., Rasmusen H., Orleando A. & Douglas-Hamilton I., 2003. *Les derniers éléphants du Sahel. Comportement migratoire, état de la population et histoire récente des éléphants du désert du Mali.* Save the Elephants, 50 pp.

Blanfort V., Doreau M., Huguenin J., Lazard J., Porphyre V., Soussana J.F. & Toutain B., 2011. Impacts et services environnementaux de l'élevage en régions chaudes. *INRA Productions animales*. 24(1): 89-112.

Bonfiglioli A.M. & Watson C., 1992. Pastoralists at a crossroad: Survival and development issues in African pastoralism. *In:* UNICEF/UNSO Project for Nomadic Pastoralists in Africa (NOPA). UNICEF, New York.

Bonte P., 1991. *Dictionnaire de l'ethnologie et de l'anthropologie*. 561 pp.

Boudet G., 1991. *Manuel sur les pâturages tropicaux et les cultures fourragères*. IEMVT, Ministère de la Coopération, République Française, 2e édition. 266 pp.

Bourgeot A. (éd.), 1999. *Horizons nomades en Afrique sahélienne. Sociétés, développement et démocratie*. Karthala, Paris. 491 pp.

Boyd C. & Slaymaker T., 2000. Re-examining the 'more people less erosion' hypothesis: special case or wider trend? *ODI, Natural Resource Perspectives*, N° 63, November 2000. 6 pp. www.odi.org.uk/resources/download/1703.pdf

Breman H. & De Wit C.T. 1983. Rangeland productivity and exploitation in the Sahel. *Science*. 221: 1341-1347.

Clanet J.C., 1994. *Géographie pastorale au Sahel central*. PhD thesis, October 1994, Paris-Sorbonne. 701 pp.

Daget P. & Godron M. 1995. *Pastoralisme. Troupeaux, espaces et sociétés*. Hatier-Aupelf-Uref. 510 pp.

De Haan, C., Steinfeld, H. & Blackburn, H. 1997. *Livestock and the Environment: Finding a Balance*. 186 pp.

Diop A.T., Ickowicz A., Nzimulinda J.C. & Schelling E. 2009. Production laitière dans la zone sylvopastorale du Sénégal : étude des facteurs de variation et modes de gestion par les populations locales. *Revue Élev. Méd. vét. Pays trop*. 62(1): 39-47.

Diop A.T., Toutain B., Touré I. & Ickowicz A., 2010. Comportement et stratégies du berger dans la conduite du troupeau en zone sylvopastorale du Sénégal. *Rev. Elev. Méd. Vet. Pays Trop*. 63.

Diop A.T., Toutain B., Wane A., Touré I. & Ickowicz A., 2011. L'élevage dans la zone sylvopastorale du Sénégal: situation actuelle. *Pastum*. 96-97: 41-45.

Dregne H. E. 1986. Desertification of arid lands. *In: Physics of desertification,* ed. F. El-Baz and M. H. A. Hassan. Dordrecht, The Netherlands: Martinus, Nijhoff.

Duteurtre G. & Faye B. (eds.), 2009. *L'élevage, richesse des pauvres*. Ed. QUAE, France. 284 pp.

Faye B., 2001. Le rôle de l'élevage dans la lutte contre la pauvreté. *Rev. Elev. Méd. Vet. Pays Trop.* 54(3-4): 231-238.

Faye B., 2008. *Bergers du monde*. Ed. QUAE, France. 230 pp.

Grémont C., Marty A., Ag Mossa R.. & Touré Y.A., 2004. *Les liens sociaux au Nord-Mali. Entre fleuve et dunes*. Karthala/IRAM, Paris. 257 pp.

Grimaud P., 2009. Vulnérabilité des populations pastorales dans le pays Karamoja en Ouganda. *Sécheresse*. 20(3): 271-278.

Guerin H., 1987. *Alimentation des ruminants domestiques sur pâturages naturels sahéliens et soudano-sahéliens : étude méthodologique dans la région du Ferlo au Sénégal*. Engineering doctoral thesis at ENSA de Rennes, France. 211 pp.

▲ Fulani dance during the transhumance in Mali.

G. Fédière © IRD

▲ Daily life in a Fulani camp. Benin.

M. Donnat © IRD

Guerin H., Friot D., Mbaye Nd., Richard D. & Dieng A. 1988. Régime alimentaire de ruminants domestiques (bovins, ovins, caprins) exploitant des parcours naturels sahéliens et soudano-sahéliens. II. Essai de description du régime par l'étude du comportement alimentaire. Facteurs de variation des choix alimentaires et conséquences nutritionnelles. *Revue Élev. Méd. vét. Pays trop*. 41(4): 427-440.

Hardin G., 1968. The tragedy of the commons: the population problem has no technical solution. *Science*. 162: 1242-1248.

Hatfield R. & Davies J., 2006. *Global review of the economics of pastoralism*. WIPS – GEF – IUCN, Nairobi. 51 pp. (also available in French).

Herrmann S. M., Anyamba A. & Tucker C. J., 2005. Recent trends in vegetation dynamics in the African Sahel and their relationship to climate. *In*: *Global Environmental Change*: 394-404.

Hiernaux P. & Bagoudou Maidaji, 2006. *Projet PSSP Zinder, évaluation des risques environnementaux liés à la gestion des ressources naturelles de la Région de Zinder*. Rapport de mission d'appui Iram au volet Gestion des ressources pastorales, 14 novembre – 2 décembre 2006. 63 pp.

Hubert B. & Ison R., 2011. Institutionalising understandings: from resource sufficiency to functional integrity. *In:* Kammili T., Hubert B. & J.F. Tourrand (eds.), 2011. *A paradigm shift in livestock management: from resource sufficiency to functional integrity.* 28th and 29th June 2008, Hohhot, China. Cardère éditeur, Lirac, France: 11-16.

Ickowicz A. & Mbaye M., 2001. Forêts soudaniennes et alimentation des bovins au Sénégal : potentiel et limites. *Bois et Forêts des Tropiques*. 270(4): 47-61.

Ickowicz A., Bah A., Bommel P., Choisis J.P., Etienne M., Gibon A., Lasseur J., Morales H., Toure I. & Tourrand J.F., 2010. Facteurs de transformations des systèmes d'élevage extensifs des territoires : étude comparée des dynamiques locales sur trois continents. *Cah. Agric.* 19(2): 127-134.

Kammili T., Hubert B. & Tourrand J.F. (eds.), 2011. *A paradigm shift in livestock management: from resource sufficiency to functional integrity.* 28th and 29th June 2008, Hohhot, China. Cardère éditeur, Lirac, France. 272 pp.

Khazanov, 1984. *Nomads and the outside world*, Cambridge. 17 pp.

Krätli S., 2010. Réflexion sur le pastoralisme et sa viabilité. *AGRIDAP – Agriculture durable à faible apport externe*. 26(1): 6-8.

Landais E. (éd.), 1986. Méthodes pour la recherche sur les systèmes d'élevage en Afrique intertropicale. Maisons-Alfort, coll. *Études et Synthèses de l'IEMVT*, n° 20. France.

Lane C. & Moorehead R., 1995. New directions in rangeland and resource tenure policy. *In:* Scoones I. (ed.), *Living with uncertainty – new directions in pastoral development in Africa.* London, IIED: 116-133.

Le Houérou H.N., 1968. La désertisation du Sahara Septentrional et des steppes limitrophes (Libye, Tunisie, Algérie). *Ann. Algér. Géogr.*

Lhoste P., 1987. *L'association agriculture-élevage : évolution du système pastoral au Sine-Saloum (Sénégal)*. Maisons-Alfort (France), IEMVT. 314 pp.

Lhoste P., 2007. Sociétés pastorales et désertification au Sahel. *Bois et forêts des tropiques*. 293(3): 49-59.

Ly C., Fall A. & Okike I., 2010. West Africa: the livestock sector in need of regional strategies. *In:* Gerber P., Mooney H.A., Dijkman J., Tarawali S., De Haan C. (eds.) *Livestock in a changing landscape: Experiences and regional perspectives.* Washington, Island Press, 189 pp.

Mainguet M., 1995. *L'homme et la sécheresse*. Masson, coll. Géographie. 335 pp.

Mainguet M. & Dumay F., 2011. Fighting wind erosion: one aspect of the combat against desertification. *Les dossiers thématiques du CSFD.* N°3. CSFD/Agropolis International, Montpellier, France. 44 pp.

Maliki A.B., 1982. *Ngaynaka: herding according to the Wodaabe*. USAID/NRL, Niamey, Niger.

Marty A., 2011. *Études sur le pastoralisme, droits, tenure et changement climatique*. IUCN – Right Resources – IRAM. 43 pp.

Marty A., Eberschweiler A. & Dangbet Z., 2009. *Au cœur de la transhumance. Un campement chamelier au Tchad central. Septembre 2006–avril 2007*. Karthala – IRAM – ANTEA, Paris.

MEA (Millenium Ecosystem Assessment), 2005. *Ecosystems and human well-being: Synthesis*. Island Press, Washington, DC. 155 pp.

Morton J. & Meadows N., 2000. Pastoralism and Sustainable Livelihoods: an emerging agenda. Social Sciences Department, Natural Resources Institute - University of Greenwich, *Policy Series*. 11: 6-7.

Niamir-Fuller M., 1999. *Managing mobility in African rangelands. The legitimization of transhumance*. FAO & Beijer Int. Inst. of Ecological Economics, IT Publications.

Ostrom E., 1990. *Governing the commons: the evolution of institutions for collective action*. Cambridge University Press. –French edition: 2010. *Gouvernance des biens communs -Pour une nouvelle approche des ressources naturelles*. Révision: Laurent Baechler, Éd. de Boeck, Coll. Planète en jeu. 300 pp.

Savory A.L. & Butterfield J., 1999. *Holistic management: A new framework for decision making*. Washington, DC: Island Press.

Steinfeld H., Gerber P., Wassenaar T., Castel V., Rosales M., & De Haan C., 2006. *Livestock's Long Shadow: Environmental Issues and Options*. FAO, Rome. 390 pp.

Steinfeld H., Mooney H.A., Schneider F., & Neville L.E., (eds.), 2010. *Livestock in a Changing Landscape. Volume 1, Drivers, Consequences, and Responses*. Island Press, Washington, DC.

Swift J., 1988. *Les grands thèmes du développement pastoral et le cas de quelques pays africains*. FAO/ESH, Working Papers on Pastoral and Agro-pastoral Societies, Rome. 83 pp.

Swift J., 1995. Dynamic ecological systems and the administration of pastoral development. *In:* Scoones I. (ed.), *Living with uncertainty – new directions in pastoral development in Africa*. London, IIED: 116-133.

Thébaud B., Grell H. & Miehe S., 1995. *Recognising the effectiveness of traditional pastoral practices: Lessons from a controlled grazing experiment in Northern Senegal*. Drylands Issues Papers, IP 55. International Institute for Environment and Development, London.

Thébaud B., 2002. *Foncier pastoral et gestion de l'espace au Sahel. Peuls du Niger oriental et du Yagha burkinabé*. Paris, Karthala, 318 pp.

Tiffen M., Mortimore M. & Gichuki F., 1994. *More people, less erosion. Environmental recovery in Kenya*. Nairobi, Kenyan Edition, ACTS Press.

Toutain B. & Lhoste P., 1978. Essai d'estimation du coefficient d'utilisation de la biomasse herbacée par le bétail dans un périmètre sahélien. *Revue Élev. Méd. vét. Pays trop.* 31(1): 95-101.

Toutain B., Touré O. & Réounodji F., 2000. *Étude prospective de la stratégie nationale de gestion des ressources pastorales au Tchad*. Ministère de l'Elevage du Tchad – Ambassade de France au Tchad/CIRAD. 102 pp.

Tucker, C. J., Dregne H. E. & Newcomb W.W., 1991. Expansion and contraction of the Sahara Desert between 1980 and 1990. *Science*. 253: 299-301.

UN, 2007. www.un.org/apps/newsFr/storyF.asp?NewsID=14375&Cr=d%E9sertification&Crl=UNU#

UNDP, 2004. *Pastoralism and Mobility in the Drylands*. The Global Drylands Imperative, p. 4.

Wane A., 2006. *Review of the literature on pastoral economics and marketing: West Africa*. Nairobi, WIPS – GEF – IUCN. 21 pp.

Wane A., Ancey V. & Touré I., 2010a. Pastoralisme et recours au marché – Cas du Sahel sénégalais (Ferlo). *Cah. Agric.* 19(1): 14-20.

Wane A., Ancey V., Touré I., Kâ S.N. & Dio-Camara A., 2010b. L'économie pastorale face aux incertitudes – Le salariat au Ferlo (Sahel sénégalais). *Cah. Agric.* 19(5): 359-365.

WEBSITES

ARED, Associates in Research and Education for Development
www.ared-edu.org/en/Home/tabid/120/Default.aspx

CENESTA, Centre for Sustainable Development & Environment
www.cenesta.org

Festival et Rencontres internationales du pastoralisme
www.alpages38.org/-Festival-du-Film-Pastoralismes-et-.html

IIED, International Institute for Environment and Development
www.iied.org

League for Pastoral Peoples and Endogenous Livestock Development
www.pastoralpeoples.org

PPZS, *Pôle Pastoral Zones Sèches*
www.ppzs2-esp.ucad.sn

Réseau* Billital Maroobé, *Réseau des Organisations d'Éleveurs et Pasteurs de l'Afrique
www.maroobe.org

WISP, World Initiative for Sustainable Pastoralism
www.iucn.org/wisp

JOURNALS

Revue d'élevage et de médecine vétérinaire des pays tropicaux
Publisher: CIRAD
Quarterly international peer-reviewed scientific journal.
ISSN 1951-6711
http://remvt.cirad.fr/gb/

***Pastoralism* (*a SpringerOpen journal*)**
Publisher: Springer
International peer-reviewed scientific journal.
ISSN: 2041-7136
www.pastoralismjournal.com

Glossary

Bourgou rangelands. Excellent natural grazings on floodplains in tropical Africa where bourgou grass, *Echinochloa stagnina*, grows. By extension, these are flood basins or floodplains located in the inner Niger Delta valley. Herds graze these rangelands in the dry season.

Buffer zone. A zone set up between a highly anthropogenic area and a natural resource area aimed at offsetting the negative impacts of direct contacts (concept introduced by UNESCO in 1977 under the World Heritage Convention).

Climax. The final development stage of a natural plant community at a site.

Common grazing rights. These rights are negotiable under rural land use laws that apply to citizens, farmers, livestock farmers or pastoralists, allowing livestock grazing (under certain conditions) on specific unfenced lands after the crops have been harvested. It is based on an existing customary contract or may be drawn up on the basis of a contract between concerned users.

Functional integrity of ecosystems or agroecosystems. A theoretical approach that accounts for interactions between production practices and ecological and social reproduction processes. By this approach, agriculture, including pastoralism, is considered in a broad sense as a system encompassing both resource use and ecosystem functioning (Hubert & Ison, 2011).

Herder. *See pastoralist definition.*

Lineage. A line of descent that includes all people derived from a real or fictive eponymous ancestor.

Livestock scientist. In French-speaking countries, a pastoral systems expert or researcher. Pastoralism therefore also refers to associated disciplines. "It is not a science but rather an actual professional orientation involving many different scientific fields" (AFP, 1990). In English-speaking countries, the term pastoralist only refers to pastoral livestock farmers, i.e. pastoralists.

Natron. A natural sodium carbonate compound that occurs in deposits in some dryland areas of the African tropics. Note that since ancient times slabs or bars of rock salt from the Taoudeni mines in Mali have been transported to markets via camel caravans to be sold to pastoralists.

Nitrophilous plant. A plant that prefers or thrives in soil with high organic matter and nitrogen contents.

Nomadism. This term refers to a lifestyle whereby people are mobile and have no fixed residence. It does not only apply to pastoralists. Nomadic pastoralists move around to take advantage of grazing opportunities that arise for their herds and they have no predefined wandering routes.

Pastoral livestock-farming system. This encompasses the 'pastoralist-herd-rangeland' system managed by pastoralists to rear their livestock mainly by making use of available natural resources (grazings and watering places) (Landais, 1986). It is, because of the range of the areas grazed and the low level of inputs used, a form of extensive livestock farming. This system is sustainable due to the mobility, supported by a very specific social organization that ensures the security of the families and herds during their movements.

Pastoral production system. For economists, this is a system in which livestock generates over 50% of the gross income of households (calculated on the basis of the marketed production value and the estimated self-consumed production value, and sometimes the values of associated services and other products*), or it is one in which milk and dairy products collected from their reared animals accounts for more than 15% of the household food energy consumption (Swift, 1988; Niamir-Fuller, 1999; Morton and Meadows, 2000; UNDP, 2004).

Pastoral societies. "Societies that rear herbivorous livestock herds that wander in search of fodder. This results [...] in the mobility of human groups associated with herds and specific forms of spatial organization" (Bonte, 1991). In other words, these are societies that practice "a specific type of subsistence economy in which extensive mobile pastoralism is involved in periodic pastoral migrations" (Khazanov, 1984).

Pastoralism. "All livestock-farming activities whereby animals are fed and watered by directly tapping natural resources available in specific areas and involving animal mobility" (framework law of Burkina Faso relating to pastoralism, order of 13 December 2002). Pastoralism also includes *"activities that associate livestock farming, agriculture and silviculture in a complementary way" (ibid)*. In other words, pastoralism refers to a type of production whereby the material existence and social reproduction of a human group is organized on the basis of livestock herd detention, exploitation and mobility.

Pastoralist (or herder). "A person for whom livestock farming is the main activity and whose production system involves spatial and seasonal mobility" (an order concerning pastoralism, Niger, 2010). The term pastoralist is more specific than livestock farmer, which refers to anyone who rears animals of any type. A community of pastoralists may depend almost solely on livestock to meet their material, familial and social reproduction needs. Many pastoral communities may structurally combine, or in complementary and secondary ways, pastoralism with other activities that may be quite important in their cultural organization and lifestyle.

In English-speaking countries, the term pastoralist only refers to pastoral livestock farmers, i.e. herders. In French-speaking countries, *"un pastoraliste"* is a pastoral systems expert or researcher. Pastoralism therefore also refers to associated disciplines. "It is not a science but rather an actual professional orientation involving many different scientific fields" (AFP, 1990).

Rangeland (*parcours* in French). All areas where pastoralists take their herds to graze—it is associated with the pastoral use concept. This includes various types of environment, i.e. natural vegetation (grasslands, savannas, steppes, dry forests, gallery forests, etc.) and man-made environments (fallows, postharvest cropfields, agroforestry stands, wasteland, etc.). Seasonal variations, fodder availability (often low), and the shortness of the period in which the fodder nutritional value is high are features common to all rangelands.

Resilience. An ability to recover a normal structure and functioning following a disturbance. This word may even be used in reference to societies.

Salt cure. In the Sudano-Sahelian region of Africa, herds are periodically led to areas where the soil has a high mineral content, e.g. sodium chloride, calcium carbonate, calcium phosphate and trace elements. The animals lick or eat the salty sand.

Shepherd or stockman. This is the person who tends the livestock and ensures that all of the practical conditions required for the animals' survival, production and reproduction are fulfilled. He/she may be the livestock owner, a family member or a hired worker.

TLU. Tropical livestock unit (in French UBT, *unité bovin tropical*) for one cow with a body weight of 250 kg at maintenance. On average, in the Sahel, one head of cattle represents 0.8 TLU, one sheep or goat 0.10 TLU and one camel 1 TLU (including young animals).

Transaction costs. All of the expenditures involved in carrying out an operation.

Transhumance (from the Latin *trans*, beyond, and *humus*, earth). The seasonal movement of livestock based partly on the 'common grazing rights' principle. Pastoralists look for the best rangelands for their livestock to graze each season. Transhumances take place yearly along generally similar routes that are constantly adjusted according to the prevailing conditions.

* For instance, caravan trade or the harvesting and marketing of natural products such as gum arabic, honey and traditional medicines.

LIST OF ACRONYMS AND ABBREVIATIONS

AFD	French Development Agency *Agence Française de Développement*
CESBIO	Center for the Study of the Biosphere from Space, France
CILSS	Permanent Inter-State Committee for Drought Control in the Sahel
CIRAD	Agricultural Research for Development, France
CNRS	French National Centre for Scientific Research
CSFD	French Scientific Committee on Desertification
DM	Dry matter
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
FCFA	African Financial Community Franc
IRAM	*Institut de recherches et d'applications des méthodes de développement,* France
IRD	*Institut de recherche pour le développement,* France
NDVI	Normalized difference vegetation index
NGO	Non-governmental organization
SIPSA	Information system for pastoralism in the Sahel
SPI	Standardized precipitation index
TLU	Tropical livestock unit
UNCCD	United Nations Convention to Combat Desertification
UNESCO	United Nations Educational, Scientific and Cultural Organization

CSFD
Les dossiers thématiques

Abstract

Often barren natural rangelands are directly utilized for pastoral livestock farming, which is by nature mobile (transhumance). This activity is on the rise in sub-Saharan Africa, providing a living for a great number of herders, generating marketable animal products, while also supporting pastoral-oriented societies.

Pastoral livestock farming prevails especially in dry tropical regions. The livestock farming techniques are continuously adjusted to adapt to extremely variable local conditions, i.e. the spatial distribution of resources (fodder, water) or sanitary, social and economic situations.

Pastoralism is a source of meat, even for export, and has an important role in the agricultural economy of Sahelian countries. This activity enhances social stabilization and peace in marginal dryland areas.

Pastoralism is becoming difficult in sub-Saharan Africa despite these advantages, especially due to the recent worsening of climatic conditions. Collective rangeland grazing rights are not legally recognized and protected sufficiently to stave off the problem of crop farming expansion and land-grabbing by investors. Sub-Saharan pastoralism has considerably evolved to cope with this situation—increase in transhumance into new areas, partial settling of herding families and income diversification.

Cattle grazing modifies the long-term evolution of rangeland ecosystems (soil, vegetation, biodiversity), but these impacts also have some advantages (soil fertility transfer, seed dispersal, maintenance of natural environments). Environmental degradation, which in extreme cases leads to desertification, is usually the result of localized overtapping of resources or poor management. The causes of this degradation must be assessed since it is ultimately detrimental to pastoralism.

The conditions required for sustainable pastoralism generally depend on the public policies of each concerned country and current legislation. Professional pastoral farmers are getting organized and international organizations are beginning to take stock of the economic and ecological challenges concerning pastoralism for the future.

Keywords: Pastoralism, desertification, West Africa, Central Africa, Sahel, extensive livestock farming, pastoral mobility, sustainability

Résumé

L'élevage pastoral exploite directement des espaces naturels spécifiques souvent pauvres, les parcours. Il est obligatoirement mobile (transhumances). Il continue à progresser en Afrique subsaharienne et à faire vivre de très nombreux pasteurs, à pourvoir le marché en produits animaux et à soutenir des sociétés pastorales spécialisées.

Il s'avère particulièrement pertinent dans les régions tropicales sèches. Les techniques d'élevage s'adaptent en permanence aux conditions ambiantes extrêmement variables, qu'il s'agisse de la répartition spatiale des ressources (fourrage, eau) ou des contextes sanitaires, sociaux et économiques.

Le pastoralisme, pourvoyeur de viande, y compris pour l'exportation, joue un rôle important dans l'économie agricole des pays sahéliens. Comme mode de mise en valeur, il participe à la stabilisation sociale et à la paix dans les terres marginales sèches.

Malgré ses avantages, le pastoralisme subsaharien devient difficile à pratiquer. L'aggravation récente des crises climatiques lui a fait payer un lourd tribut. Les droits collectifs sur les parcours sont insuffisamment reconnus et protégés du point de vue légal face à l'extension de l'agriculture ou l'accaparement des terres par des investisseurs. Pour s'adapter, le pastoralisme subsaharien a beaucoup évolué : progression des transhumances vers de nouveaux espaces, sédentarisation partielle des familles et diversification des revenus.

Le bétail modifie à long terme l'évolution des écosystèmes pâturés (sol, végétation, biodiversité), mais ces impacts revêtent aussi certains avantages (transferts de fertilité au sol, dispersion de semences, maintien et entretien de milieux naturels). Les dégradations du milieu, qui à l'extrême mènent à la désertification, relèvent le plus souvent de surexploitations localisées ou de mauvaise gestion, défavorables à terme au pastoralisme et dont il convient de rechercher les causes.

Les conditions d'un pastoralisme durable dépendent pour beaucoup des politiques publiques de chaque pays et des législations adoptées. Le milieu professionnel pastoral s'organise et les organisations internationales commencent à prendre la mesure des enjeux économiques et écologiques que représente le pastoralisme pour le futur.

Mots clés : Pastoralisme, désertification, Afrique de l'Ouest, Afrique centrale, Sahel, élevage extensif, mobilité pastorale, durabilité

In the same series

Available issues

Is combating desertification an environmental global public good? Elements of an answer...
(M. Requier-Desjardins & P. Caron)
English & French versions

Remote sensing, a tool to monitor and assess desertification
(G. Begni, R. Escadafal, D. Fontannaz & A.-T. Nguyen)
English & French versions

Fighting wind erosion one aspect of the combat against desertification
(M. Mainguet & F. Dumay)
English & French versions

Combating desertification through direct seeding mulch-based cropping systems (DMC)
(M. Raunet & K. Naudin)
English & French versions

Why we should invest in arid areas
(M. Requier-Desjardins)
English & French versions

Science and civil society in the fight against desertification
(M. Bied-Charreton & M. Requier-Desjardins)
English & French versions

Restoring natural capital in arid and semiarid regions. Combining ecosystem health with human wellbeing
(M. Lacombe & J. Aronson)
English & French versions

A land degradation assessment and mapping method. A standard guideline proposal
(P. Brabant)
English & French versions

Pastoralism in dryland areas. A case study in sub-Saharan Africa
(B. Toutain, A. Marty, A. Bourgeot, A. Ickowicz & P. Lhoste)
English & French versions

Ministère de l'Enseignement supérieur et de la Recherche
1 rue Descartes
75231 Paris CEDEX 05
France
Tel. +33 (0)1 55 55 90 90
www.enseignementsup-recherche.gouv.fr

Ministère des Affaires étrangères
27, rue de la Convention
CS 91533
75732 Paris CEDEX 15
France
Tel. +33 (0)1 43 17 53 53
www.diplomatie.gouv.fr

Ministère de l'Écologie, du Développement durable et de l'Énergie
Grande Arche
Tour Pascal A et B
92055 La Défense CEDEX
France
Tel. +33 (0)1 40 81 21 22
www.developpement-durable.gouv.fr

Agence Française de Développement
5 rue Roland Barthes
75598 Paris CEDEX 12
France
Tel. +33 (0)1 53 44 31 31
www.afd.fr

Secretariat of the United Nations Convention to Combat Desertification
P.O. Box 260129
Haus Carstanjen
D-53153 Bonn
Allemagne
Tel. +49 228 815-2800
www.unccd.int

Agropolis International
Avenue Agropolis
F-34394 Montpellier CEDEX 5
France
Tel. +33 (0)4 67 04 75 75
www.agropolis.org

HOW TO CONTACT US:

CSFD
Comité Scientifique
Français de la Désertification
Agropolis International
1000 Avenue Agropolis
F-34394 Montpellier CEDEX 5
France
Tel.: +33 (0)4 67 04 75 44
Fax: +33 (0)4 67 04 75 99
csfd@agropolis.fr
www.csf-desertification.org

Find us on
facebook
twitter
twitter.com/csfd_fr

Cover photos
1: A Fulani zebu herd in a millet field after crop harvest, Dori region, Burkina Faso.
© B. Toutain

2: Transport donkeys during transhumance.
© B. Bonnet

3: Artificial ponds serving as watering places during large-scale transhumances in the Sahel, eastern Chad.
© A. Ickowicz