THE FUTURE IS AN ANCIENT LAKE

Traditional knowledge, biodiversity and genetic resources for food and agriculture in Lake Chad Basin ecosystems

FAO INTERDEPARTMENTAL WORKING GROUP ON BIOLOGICAL DIVERSITY FOR FOOD AND AGRICULTURE

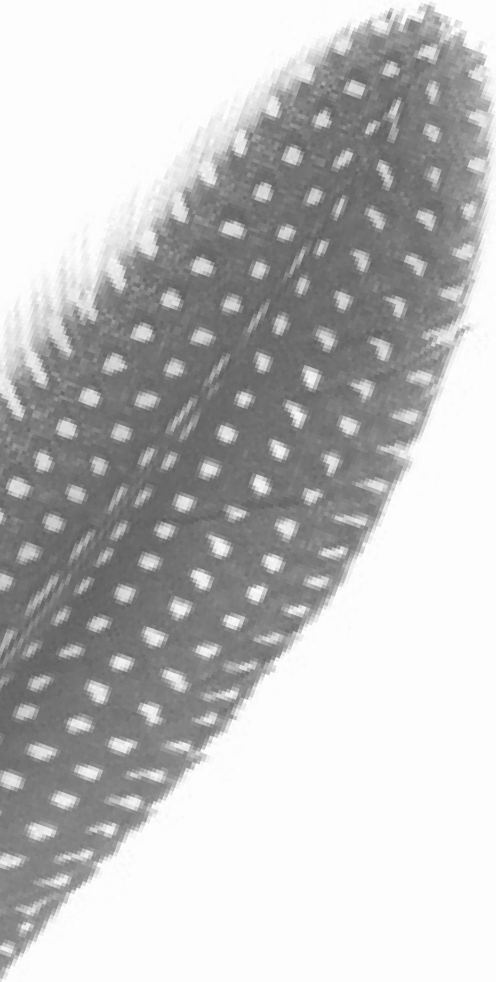
FAO FIAT PANIS

The uniqueness of Lake Chad Basin ecosystems derives mainly from the location of the lake. Nowhere else in the world is such a large freshwater reservoir found so far from seas and oceans and in such a hot and arid climate.
The lake has always been a point of attraction for humans, animals and plants, all of which have had to learn how to live in balance with a fragile environment that is changing over time in response to both slow and fast variables.

This book suggests that a disappearing traditional practice of food production from wild grasses called *kreb* has many hopes for the future if supported by appropriated science and policies. The same is true of *dihé*, the alga harvested locally by Kanembu Kadjidi women.

The faint borders of agriculture and the narrow distinction between cultivated and collected vegetables are discussed in the book. The role of farmers in maintaining local cereal varieties and the way they use all available resources, such as *Calotropis*, with imagination and experience, are also described. Fisheries are dominated by traditional management systems, and the relationship between economics, livelihood impact and poverty is shown. Traditional polders and integrated pastoral, fishery and cropping systems are examples of the wise use of water and its fluctuations.

It is the authors' belief that local people should be made to feel proud of the traditional practices on which their production systems are founded. Once adapted to changing needs or combined with new technologies, many of these practices will continue to serve them in the future. Recognition and reward should be given to local communities who conserve biodiversity through observation, selection and management.



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Caterina Batello

Marzio Marzot

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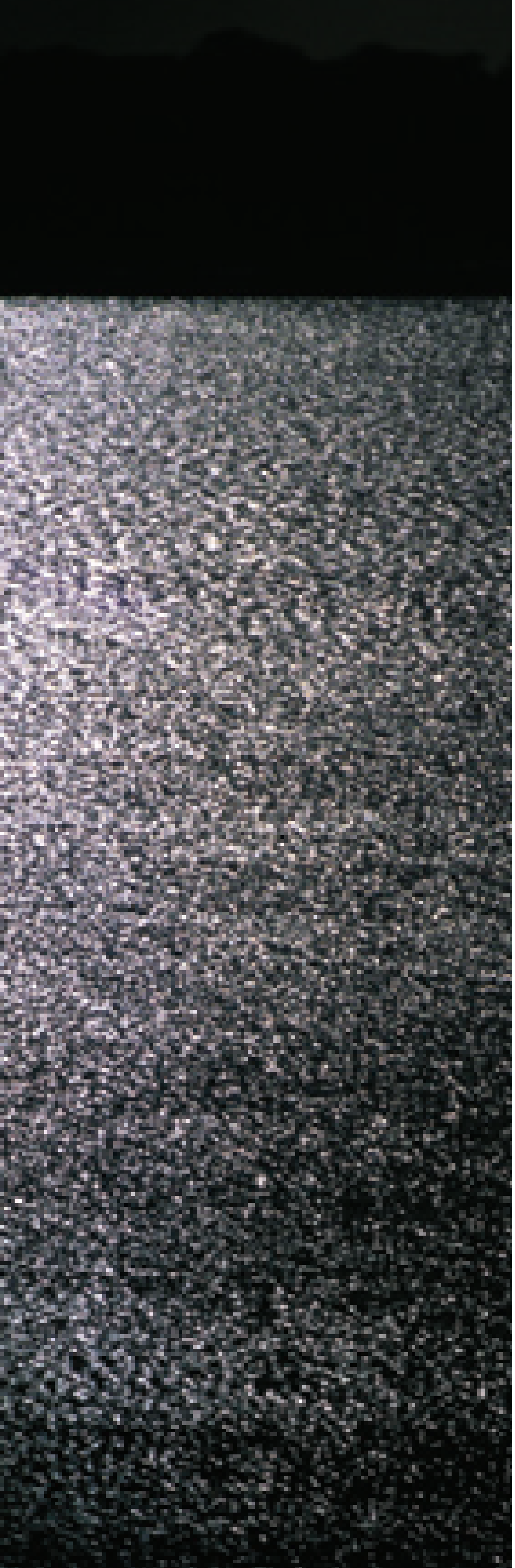

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KINASSEROM ISLAND (BOL), CHAD

FOREWORD

This book is a tribute to the strength and intelligence of the people of the Lake Chad Basin who, over centuries, have developed a wealth of local technologies enabling them to survive the harsh and uncertain conditions of the region. Most Lake Chad Basin people today engage in some mixture of agriculture, fisheries and pastoral activities. People in highly uncertain and marginal habitats clearly have a heightened awareness of the importance of biological diversity in their lives. A diversity of potential food sources, over a range of times and places, with different types and levels of demand on the environment minimizes the risk of a potentially deadly shortfall in food resources. Biodiversity, to the people living in this region, is not the mere subject of an academic debate with political overtones, it is the substance of survival.

Threats to biodiversity, and therefore to long-term well-being, have come in the form of population growth and economic pressures to move into possibly unsustainable production methods. The challenge now is to find original solutions that lead to better productivity, but not at the cost of biodiversity and long-term sustainability. The best solutions will derive from local creativity and engagement, and will maintain natural resources and ecosystem functions for future generations. To meet these challenges will require understanding existing social, economic and ecological systems, in order to find ways to help local populations to improve conditions without putting at risk the long-term stability and resilience of these systems.

Human well-being, poverty reduction, sustainable use of resources and the importance of biological diversity for food security was reconfirmed by the World Food Summit in 1996 (and again in 2002). These are not independent domains, but involve a high level of cross-cutting interrelationships and imply the need for regional political and scientific action. The Lake Chad Basin Commission must be assisted to help develop ecosystem management strategies based on up-to-date environmental science and economics, together with the knowledge and appreciation of the traditional practices of local peoples.

This publication has been prepared by FAO technical people from different Departments and Services, through the collaboration made possible by the Priority Area for Interdisciplinary Action on Biodiversity, and support received by the FAO/Netherlands Partnership Programme on Agrobiodiversity, for the participatory preparation and distribution of this book.

Peter Kenmore
Chair
Interdepartmental Working Group on Biodiversity
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NEAR DIFFA, THE NIGER

PREFACE

An important aim of this book is to give people living in the Lake Chad Basin pride in their knowledge, their land and their future. It focuses on small farmers, pastoralists and fishermen who need to improve their food security, their income and their rural livelihood. A second aim is to deepen the awareness of diverse policy–makers of the significance of this important ecology and the people who live there.

The growing population is putting increased pressure on natural resources and new solutions have to be found to enhance productivity in a sustainable manner without sacrificing the possible prosperity of future generations.

This publication highlights a selection of traditional practices that are valuable in ensuring food security, income and sustainability. It aims to show that a middle way exists; that it is possible to increase food security and still preserve the environment by combining traditional knowledge with new technologies. Traditional practices described here are adapted to local environmental and social circumstances and some of them represent new income opportunities for local and regional markets or for international demands for high-quality and diversified food.

Traditional knowledge has contributed for centuries to food security of farmers and pastoralists. They developed many techniques to protect and manage wild plant and animal species in order to eat them. They also adopted low risk strategies and low input cultural practices as a response to unreliable rainfall and pest attacks. They maintained a high level of heterogeneity in their seed stock to respond and produce in varying climatic conditions. But today many of these practices are associated with poverty, lack of education and poor capacity of adoption of new technologies. Often, scientists and policy-makers know very little of these traditions, and even local people themselves are losing this heritage.

We hope that this book, drawing from many disciplines, will provide readers with new ideas and new instruments for their policies, projects and studies, promoting a dynamic and modern agriculture based on scientific knowledge, new technologies and traditional production systems.

We would like to acknowledge the support and the work of Eric Kueneman, Service Chief of the Crop and Grassland Service and Caterina Batello, Coordinator of the awareness component of the FAO/Netherlands Partnership Programme on Agrobiodiversity, who promoted this book as one step towards raising awareness of the lives, knowledge and agricultural systems of people in the Lake Chad Basin.

Mahmoud Solh
Director
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FAO

WAZA NATIONAL PARK, CAMEROON

LAKE CHAD

INTRODUCTION

"Knowledge is the only treasure you can give entirely without running short of it."

[African proverb]

The superficial impression of the Lake Chad Basin is of a desperate and desolate region that appears to hold little promise for the future. The region suffers from irregular and insufficient rainfall, poor soils and high temperatures. It is totally landlocked, far from the sea and from major markets and transport routes. In short, the area has all the classic indicators of poverty, deprivation and chronic food insecurity.

Nevertheless, a closer look reveals that there is considerable potential in this ecosystem. A mosaic of people with their different cultures, a rich flora and fauna, large spaces, the sun and the freshwater fluctuations have generated many different strategies and technologies for exploiting this richness. Central to the use of these strategies has been the notion of balance, an understanding that everything is connected and each component of the ecosystem has a specific function. Farmers, pastoralists and fishermen understand their environment and are able to manage it. They manage genes by their decisions on crop varieties, species by their selection of animals and the ecosystem by their decisions on pastoral mobility, fallow systems and crop rotations, irrigation, fishing methods and harvesting of wild crops.

Currently, an expanding population with increasing social and economic needs is challenging policy-makers, researchers, industry, farmers, pastoralists and fishermen to increase productivity in the Lake Chad Basin.

This book aims to show that a middle way exists; that it is possible to increase food security and still preserve the environment by combining traditional knowledge with new technologies. It is the authors' belief

MALAM MINOURI VILLAGE [DIFFA], THE NIGER

A CLOSER LOOK REVEALS THAT THE LAKE CHAD BASIN HAS CONSIDERABLE POTENTIAL IN TERMS OF LAND, WATER AND NATURAL RESOURCES

>> RIGHT: BY COMBINING TRADITIONAL KNOWLEDGE WITH NEW TECHNOLOGIES, IT IS POSSIBLE TO INCREASE FOOD SECURITY AND STILL PRESERVE THE ENVIRONMENT

that local communities should be made to feel proud of the practices on which their traditional production systems are founded and that, once adapted to changing needs and pressures, many of these skills and techniques can continue to serve them in the future.

This is all the more important because much of the precious traditional knowledge held by people in the Lake Chad Basin is now at serious risk. In some cases, traditional methods are being abandoned in favour of more intensive systems. Traditional ideas and practices are becoming tainted by negative connotations. Many are being discarded as they become associated with poverty and everything that is outdated. Often, scientists and policy-makers know very little of these traditions, and even local people themselves are losing this heritage. Much of the knowledge has been lost in the span of just one or two generations. If the process is not halted quickly, it could prove irreversible, particularly because these are oral traditions that have never been recorded for posterity.

This book does not claim to have all the answers. Nor does it seek to offer a definitive recipe for the advancement of people in the Lake Chad Basin. It is not an exhaustive study of the region, nor is it intended to be. Instead, it puts forward a collection of concrete examples showing how the livelihoods and prospects of the people can be improved and assured in a sustainable manner without sacrificing the prosperity of future generations. More than anything else, it is intended to stimulate further debate, research and study in the hope that bridges can be built between traditional technologies, traditional ways of life and the new demands of today's society.

DUMBA VILLAGE (BAGA), NIGERIA

ABOUT THIS BOOK

CHAPTER 1 – **THE LAKE AND ITS ECOSYSTEMS** describes the unique lake ecosystem and the rhythm of life as determined by the periodical fluctuations of the lakewater. Unpredictable rainfall patterns, high evaporation rates and the shallowness of the lake are all obstacles to a precise definition of Lake Chad. The presence of prehistoric humans in the basin is well documented and present populations are a mosaic of pastoralists, fishermen, farmers and traders, all with different cultures, habits, skills and needs. A definition of the basin is also given; this book refers mainly to the area covered by the four riparian countries, i.e. Cameroon, Chad, the Niger and Nigeria.

CHAPTER 2 – **GRASSLANDS** describes the natural grassland ecosystems and the close link between arid, semi-arid and wet ecosystems that allows the survival of wildlife, livestock and vegetation. Pastoralists move their animals according to the availability of fodder and water. Their knowledge of the different ecosystems is an example of timely, flexible and sustainable use of the natural resource. Combining traditional knowledge with new technologies will allow pastoralists to maintain their mobility while improving their living conditions.

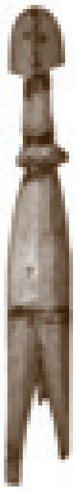
CHAPTER 3 – **LIVESTOCK BREEDS** discusses how livestock breeds evolve on the basis of human needs, as well as the close relationship between humans, animals, plants and the environment. Conserving animal genetic resources is guided by environmental, economic, social and cultural choices. The breeds are not necessarily selected in order to maximize milk or meat production; non-food products, such as dung, skins and wool, are also an important consideration when creating and maintaining different animal breeds. Kouri cattle, which graze the vegetation of the floating islands, occasionally swimming from one island to another, form an interesting example of successful adaptation to the ecosystem: a breed in evolution.

CHAPTER 4 – **KREB** is dedicated to a food resource that has been used for centuries in the Sahel. It is a mixture of non-domesticated grass species that people harvest from the natural grasslands. The harvesting of *kreb* is a sustainable pastoral practice that makes the best use of the potential of the environment to produce food for both humans and animals, while at the same time protecting soils against erosion. Samples of *kreb* have been analysed and its high nutritional potential has been confirmed. However, the practice is under threat because the area of grasslands is being reduced as a result of expanding cultivation, overgrazing and narrowly based, specialized pastoral systems.

FERTILITY PUPPETS
USED BY ATI PEOPLE IN THE LAKE CHAD BASIN

CHAPTER 5 – **FARMING SYSTEMS** describes a selection of agricultural systems as an example of the huge number of combinations of cropping systems existing in the Lake Chad Basin. Traditional selection techniques of local genetic resources of sorghum are discussed, as well as the narrow distinction between cultivated and collected vegetables and fruit. Examples are given of economic practices used by local pastoralists that could be introduced in many other regions of Africa. These include the use of *Calotropis* to coagulate milk for cheese production and the various uses of the dum palm and other trees.

CHAPTER 6 – **WATER AND LAND** is dedicated to water management techniques. Lake-level fluctuations are exploited to create polders, which are a type of dammed inlet that enables the cultivation of crops during the dry season. Other simple, locally adapted and locally managed water-harvesting systems are also presented and discussed, such as the use of pastoral wells, wadis and irrigation systems.



CHAPTER 7 – **FISHERIES** provides a wealth of data collected by the authors in over ten years of work and describes fish, fishing activities and fish consumption. Commercial trade in fish originating from the Lake Chad Basin is very important in West Africa. In 2001 total marketed fish products amounted to more than 57 000 tonnes, with an estimated value of over US$24 million. These figures do not take into account fish directly consumed within households. The relationship between economics, livelihood impacts and poverty is discussed, as well as how fisheries are dominated by traditional management systems.

CHAPTER 8 – **WILDLIFE** describes the unique ecosystem that supports a large variety of species, including mammals, birds and reptiles. The main protected areas of the Lake Chad Basin are described. Options for wildlife conservation and wise use are also discussed, such as tourism, the ranching of the Nile monitor (a large lizard that is hunted for its excellent meat and skin) and the control of the red-billed quelea (a grain-eating bird that is considered to be a pest by farmers but as excellent meat by the Hadjerai people).

CHAPTER 9 – **ATROUN AND DIHÉ** presents two natural products that have formed the basis of trade for centuries. *Atroun*, or natron, is a sodium carbonate complex that is extracted from wadis in the proximity of the lake and used as salt. *Dihé* is the local name for desiccated chips of an alga with extraordinary nutritional powers. The alga grows naturally in the wadis and is harvested by Kanembu women. Both products represent an important source of income for the impoverished local population.

CHAPTER 10 – **THE ECOSYSTEM APPROACH AND THE LAKE CHAD BASIN** shows how the 12 principles of the ecosystem approach, as identified by the Convention on Biological Diversity (CBD) for the integrated management of land, water and living resources, can be applied to the Lake Chad Basin. Each principle is summarized and connections are made with subjects developed in this book.

KINASSEROM ISLAND (BOL), CHAD

PRESERVING BIODIVERSITY HELPS PEOPLE TO DEVELOP A SUSTAINABLE LIVELIHOOD BASED ON THEIR OWN RESOURCES

BIODIVERSITY, GENETIC RESOURCES AND FAO

The erosion of agricultural diversity is a consequence of the abuse of the Earth's natural resources, producing rapid and deep-seated degradation of the environment and generally impoverishing conditions of life in the biosphere, specially of rural people who depend on diversity to support their daily lifes.

The conservation of genetic resources is essential if we are to ensure that any processes unleashed into the environment remain as manageable and reversible as possible. An enduring solution will require a fresh perception of our relationship with the different ecosystems of the planet, accepting and recognizing the planet's limitations and the vulnerability of its natural balances.

FAO is committed to preserving biodiversity as a means of helping people to develop a sustainable livelihood based on their own resources. FAO's goal is to alleviate poverty and hunger by promoting sustainable agricultural development, improved nutrition and food security- the access of all people at all time to the food they need for an active and healthy life. The importance of biological diversity for food security has been recognized by FAO and the Organization is working to promote its conservation and sustainable use in an agricultural context. FAO assistance is channelled through various avenues including for example programmes and activities such as Participatory Training for Integrated Pest Management and Advice on Soil and Water Conservation. FAO provides intergovernmental fora where biodiversity-related policy is discussed and relevant agreements negotiated and adopted by member countries. One such forum is the Commission on Genetic Resources for Food and Agriculture

FROM LICHEN TO WHEAT, WHETHER HARVESTED FROM NATURAL GRASSLANDS OR CULTIVATED, A MOSAIC OF SPECIES CONTRIBUTES TO THE DAILY SUBSISTENCE OF LAKE CHAD'S INHABITANTS

(CGRFA), which was established in 1983 and now includes 165 countries and the European Union.

Agreements negotiated in FAO include the International Plant Protection Convention, the Code of Conduct for Responsible Fisheries, the Global Strategy on the Management of Farm Animal Genetic Resources and the International Treaty on Plant Genetic Resources for Food and Agriculture. This is a legally binding agreement, adopted in 2001 at the FAO Conference, which recognizes farmers' rights and highlights the role and importance of cultural and identity values for the maintenance and sustainable use of biodiversity.

The International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA)

PGRFA are crucial in feeding the world's population. They are the raw material that farmers and breeders need to improve the quality and productivity of crops. No country is sufficient in itself in these resources. International cooperation is vital to ensure global food security and sustainable agriculture.

The International Treaty is the first ever legally binding agreement on biodiversity for food and agriculture.

The Treaty's objectives are the conservation and sustainable use of plant genetic resources for food and agriculture, and the fair and equitable sharing of benefits derived from their use to promote sustainable agriculture and food security.

The main beneficiaries of the Treaty will be farmers, especially those in developing countries. This treaty includes farmers' rights, in recognition of the enormous contribution that farmers and farming communities have made, and continue to make, in conserving and developing plant genetic resources. The Treaty gives governments the responsibility for promoting and protecting these rights, adopting measures to protect traditional knowledge and giving farmers the right to participate equitably in benefit-sharing and in national decision-making about plant genetic resources.

In fact, all of society will benefit when the Treaty comes into effect: consumers, because of the greater variety of foods and agricultural products that it promotes, underwriting their food security; the scientific community, through access to plant genetic resources that are crucial for research and plant breeding; international agricultural research centres, whose collections the Treaty places on a long-term legal footing; and both the public and private sectors, which are assured access to a wide range of genetic diversity for improved agricultural development.

KOURNADI VILLAGE (DIFFA), THE NIGER

THE TREATY RECOGNIZES THE ENORMOUS CONTRIBUTION OF FARMERS TO THE CONSERVATION AND DEVELOPMENT OF PLANT GENETIC RESOURCES

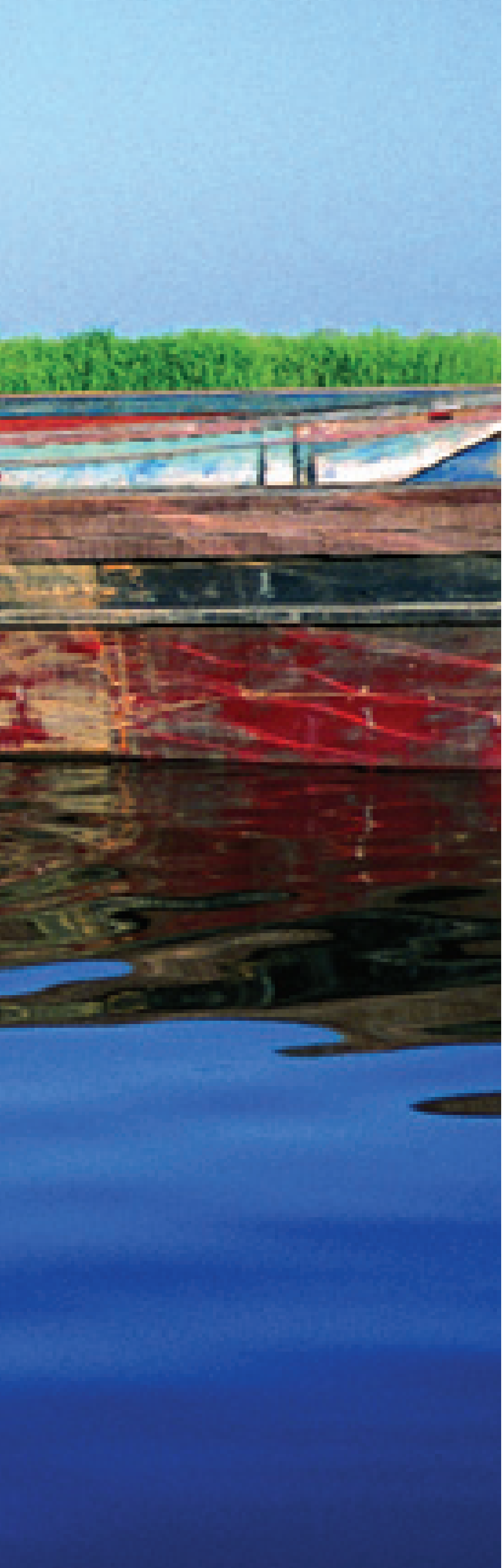
NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

ABOVE: COUNTRIES AROUND LAKE CHAD

>> RIGHT: A CLOSER VIEW OF THE LAKE WITH ITS NATURAL ZONES **[A BLACK AND WHITE COPY OF THE SAME MAP CAN BE FOUND ON THE BACK COVER FLAP]**.

THE NIGER
N
CHAD
NORTHERN FLOATING ISLANDS
NORTHEASTERN ARCHIPELAGO
KANEM
NORTHEASTERN FLOATING ISLANDS
NORTHERN FREE WATERS
GREAT BARRIER
LAKE CHAD
SOUTHEASTERN ARCHIPELAGO
EASTERN ARCHIPELAGO
SOUTHEASTERN FLOATING ISLANDS
SOUTHEASTERN FREE WATERS
SOUTHERN FREE WATERS
BORNU
SOUTHERN FLOATING ISLANDS
YAERE FLOODPLAINS
NIGERIA
CAMEROON

CHAPTER 1



THE LAKE AND ITS ECOSYSTEMS

"I apologize for
not having seen,
not having understood
and not having
remembered everything."

[Manfred J. Kriegl]

THE LAKE AND ITS ECOSYSTEMS

1

NEAR DIKWA VILLAGE (BAGA), NIGERIA

LAND, WATER, VEGETATION, ANIMALS AND PEOPLE COMBINE TO FORM MANY DIFFERENT ECOSYSTEMS

INTRODUCTION

The vast lands of the Lake Chad Basin are one of society's most ancient dwelling places. Encompassing territory from four different countries, the area is home to about 11 million people, who depend for their daily survival on the lake and its hinterland. The lake itself, and the wetlands of its basin, harbour a range of biodiversity that is of global importance. To give some idea, the area is the habitat of 176 species of fish and over 500 species of birds (including both resident and migrant species). This delicate ecosystem presents special challenges for the region but, managed wisely, the lake and its basin offer immense potential for genuine sustainable development and a sound future for the people who live there.

For thousands of years, Lake Chad has been an important cultural and commercial crossroads in Africa. The people who live in the region are drawn from a wide variety of different ethnic backgrounds and their very diversity represents one of the area's greatest assets.

Centuries of living on the shores of Lake Chad and in its basin have given these people an intimate knowledge of how best to make use of the lake's lands and water fluctuations. However, although many people continue to practise these techniques, much of the precious knowledge is now at risk as new technologies and crops, not necessarily suited to the terrain and the peoples, are introduced.

PORT OF DORO LELEWA (N'GUIGMI), THE NIGER

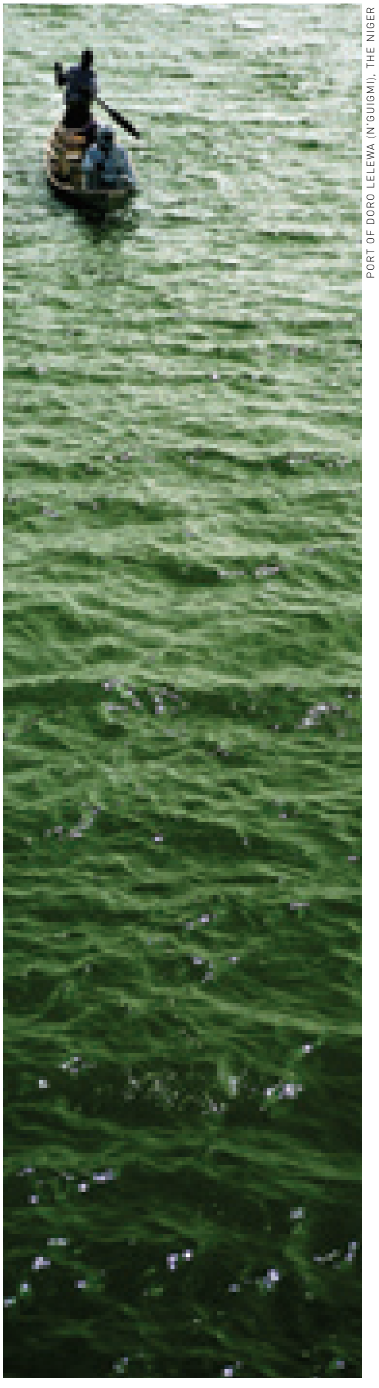
IS IT A LAKE?

Chad is a peculiar type of lake. Because of the wide seasonal and year-to-year fluctuations in water supply (rainfall and flow from tributary rivers), and high evaporation rates, its water volume can vary over the years from more than 70 billion m^3 to less than 10 billion m^3 [1.1]. *
The visual impact is striking: there are periods in which most of it becomes a vast, swampy land, hardly identifiable as a "lake" in the usual sense of the word (this happened, for example, during the severe droughts of the 1980s), and periods in which open waters cover such a large surface area that it looks like an open sea (for example in the early 1960s but, unfortunately, not in recent years).

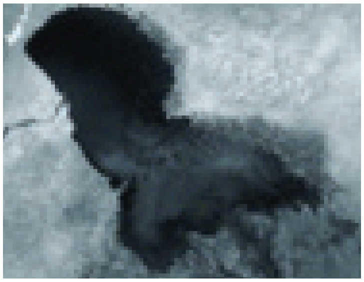
With these large variations, measuring the lake's surface area and comparing it with other lakes becomes a tricky exercise. Three different conditions of the lake have been identified according to its water level [1.1], [1.2], [1.3].

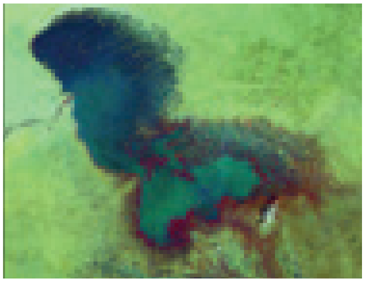
*** Numbers in square brackets refer to the bibliographic references on page 298**

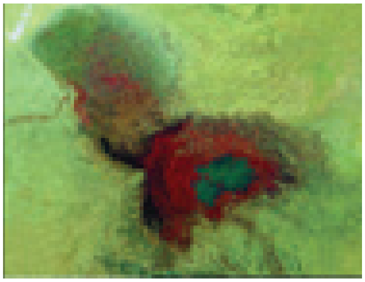
- When the water level is around 282 m above sea level, the lake is called *Normal Chad*. Open waters form two large basins, a northern and a southern one, almost completely separated by a narrow strip of land (the Great Barrier) located between Baga-Kawa on the western shore and Baga-Sola on the eastern shore. The northeastern parts of both basins are dotted with islands (which are the tops of sandy dunes) and with floating islands (named *îlots-bancs*) composed of vegetation. At a water level of 282 m above sea level, the surface area of the lake is about 20 000 km^2 and the water volume is 50 billion m^3, with an average turnover period of 1.2 years. The maximum depth is about 5.5 m in the northern basin and 3.5 m in the southern basin. The last time the lake was in this condition was in the 1960s.
- At water levels lower than 281 m above sea level, the lake is called *Lesser Chad*. The two basins become completely separated by the Great Barrier. At lower levels, the surface area of open waters is reduced, large areas being covered with vegetation. Water levels can be different in the two basins; the northern basin often dries out completely (generally in July). In the southern basin, a surface area of 1 500–2 000 km^2 of open water normally remains near the delta of the Chari River, and around 6 000 km^2 are covered with floating vegetation. The lake has been in the Lesser Chad condition since 1973.
- At water levels higher than 283 m above sea level, the lake is called *Great Chad*. Open waters form a single large basin, exceeding 25 000 km^2 in surface area. Many islands disappear, and water can overflow into the Bahr-el-Ghazal depression, which becomes an effluent of the lake. This condition has not been reached in the last hundred years.



PORT OF DORO LELEWA (N'GUIGMI), THE NIGER


SATELLITE IMAGE OF THE LAKE IN 1963 [1.4]


IN 1973 [1.4]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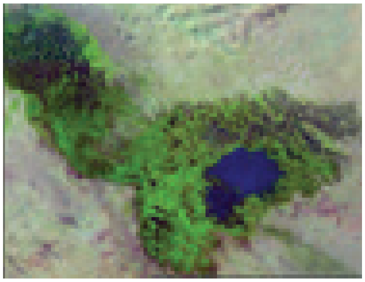
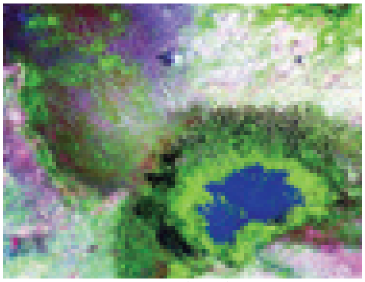
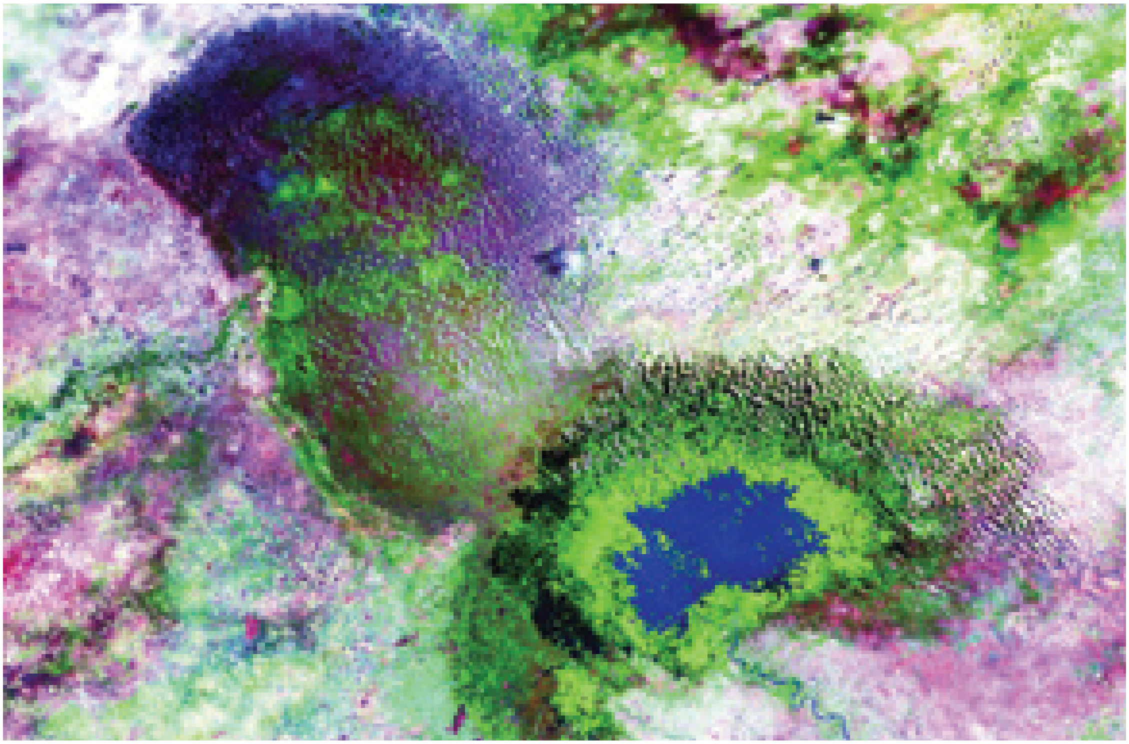
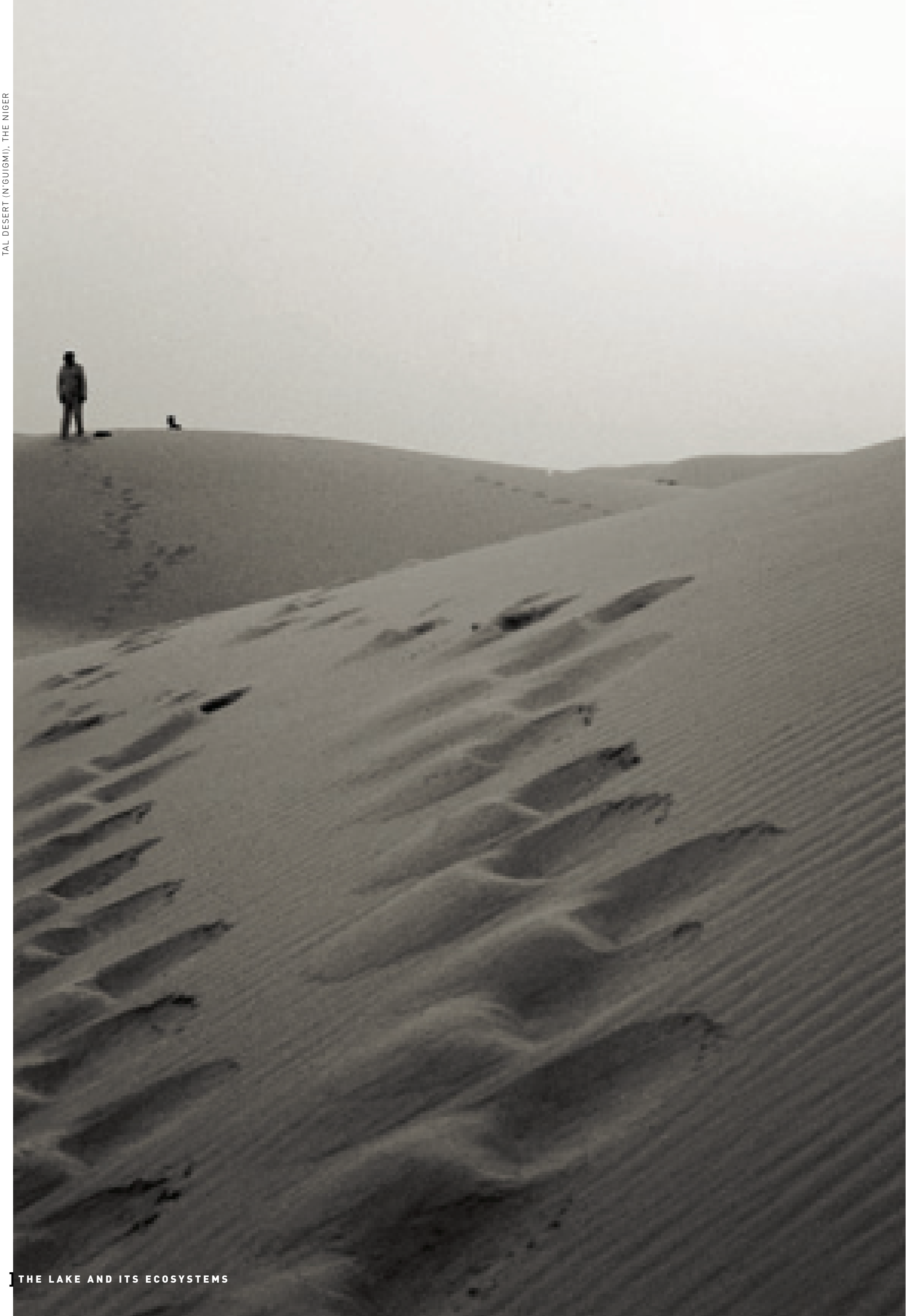

IN 2003 [1.4]


ABOVE AND BELOW: IN 2003 (ZOOM)


WITH ITS FLUCTUATIONS, LAKE CHAD IS EVER CHANGING



TAL DESERT (N'GUIGMI), THE NIGER

NOWHERE ELSE IN THE WORLD IS SUCH A LARGE FRESHWATER RESERVOIR FOUND SO FAR FROM SEAS AND IN SUCH A HOT AND ARID CLIMATE

<< LEFT: LAKE CHAD IS LOCATED AT THE SOUTHERN LIMIT OF THE SAHARA DESERT

GEOGRAPHY

Lake Chad is located at the southern limits of the Sahara Desert, and lies between latitudes 12°30′ and 14°30′N and longitudes 13° and 15°30′ E. The nearest sea is the Gulf of Guinea, about 1 000 km to the southwest. The Mediterranean Sea lies about 1 750 km to the north. Lake Chad is the only lake in the world of such a size to be located at these latitudes and in such arid climatic conditions. Normal Chad, as defined above, with a surface area of about 20 000 km^2, is the fourth largest of the great African freshwater lakes, after lakes Victoria, Tanganyika and Malawi. However, it is the world's third largest, totally landlocked lake, smaller only than the Caspian and the Aral seas in Asia. The lake is shared by four countries: the Niger in the northwest, Chad in the east, Nigeria in the southwest and Cameroon in the south.

The western shore of the lake is rather flat and smooth, the only significant exceptions being the delta of the Komadugu-Yobé River and a peninsula near Baga-Kawa village. The southern shore consists mainly of the delta of the Chari River. The northern and eastern shores are full of dunes, formed during prehistoric arid periods; these also cover part of the surface of the lake, creating a great number of inlets and small islands.

According to water level, the outline of the lake varies significantly, as do the shape and surface area of open waters. The eastern section of the lake is a network of narrow, shallow canals among the islands, making navigation almost impossible. The number of sandy islands in the lake can vary between 400 and 800 according to the water level [1.5]. They form a northeastern archipelago (in the northern basin), and a southeastern and an eastern archipelago (in the southern basin). Apart from these islands, the eastern part of the lake is dotted with floating islands, formed by aquatic vegetation of phanerogams (*Papyrus, Phragmites*, etc.) [1.6].

Notes from a journey

The floating islands of Lake Chad

7 March 2002
Bol, Chad

Leaving Bol, we make our way out into the open waters of the lake, aboard a long, motor-powered canoe (pirogue), through the floating islands: an experience worth remembering. Moving slowly and with considerable difficulty, the canoe follows a narrow and twisting path that has been opened up with immense patience by local fishermen.

The floating islands are dense and compact enough to bear the weight of the timid sitatunga gazelle[1]; enough to support the weight of the cattle that graze here; and enough to support the weight of fishermen, when the only way forward into the open waters is to get out of the boat and physically push the islands away with long poles.

Sometimes the canoe gets entangled, squeezed between islands propelled by the wind, as if trapped by ice floes in the northern seas. This did not happen to us, but some Nigerian fishermen, who generally own larger boats, have been known to have their vessels trapped by the islands for several days.

Luckily, we move forward, albeit at a painfully slow pace for kilometres, awestruck by the giant papyrus that towers over our heads. We find ourselves constantly bumping into the light trunks of *Aeschynomene elaphroxylon*, covered with yellow flowers that open like butterfly wings. The sides of the canoe brush noisily against the thick reeds, grasses and rushes that grow all around us. Innumerable aquatic birds rise up in flight as we approach, only to settle again at a safe distance soon afterwards.

Our invaluable guide from SODELAC [2], Abdallah Adam, observes: “You see, it’s all this massive vegetation which deceives satellite photographs. The fact is that the water increases and diminishes depending on the amount of rain, the year and the influx of water from the rivers. It’s true that the level shrank a great deal after the drought of the 1970s, but to determine the real surface of the lake the satellite is inadequate. From up there the immense masses of vegetation that you see seem like solid ground, but instead they are all Kirtà, the floating islands. Underneath them there is water, kilometre after kilometre, and there are fish, lots of them”.

“You need to see it for yourself; if you don’t verify it in person, the satellite photographs tell

LAKE CHAD (BOL), CHAD

THOUSANDS OF FLOATING ISLANDS, COMPOSED OF *PAPYRUS* AND *PHRAGMITES*, MAKE NAVIGATION AND FISHING DIFFICULT a pack of lies," comments Abdallah, "because they can't perceive how much the tendency has been reversed in the past four or five years. The water level is rising again, much more than anyone thinks."

After an hour of laborious navigating through the tangle of vegetation, with the impression of travelling on land rather than by boat, at last we find ourselves out on the wide open lake, a plain of calm waters as far as the eye can see, opaline blue, merging into the vast, uniform sky without a break at the horizon.

NOTES:

(1) The sitatunga gazelle (*Tragelaphus spekei*) is considered to be a living vestige of an ancient animal in danger of extinction. Until a few years ago, they could be seen swimming near land. It is now hard to see them, but they can be heard moving in the tall vegetation, perfectly at ease and safe even in these unprotected areas.

(2) M. Abdallah Adam is Chef de Cellule technique de la SODELAC (Societé de développement du Lac Chad), N'Djamena, Chad.

LAKE CHAD (BOL), CHAD

FLOATING ISLANDS ARE RICH SITES OF BIODIVERSITY

OPEN WATER (BOL), CHAD

BUSHFIRES DOT THE HORIZON OF THE LAKE'S OPEN WATERS

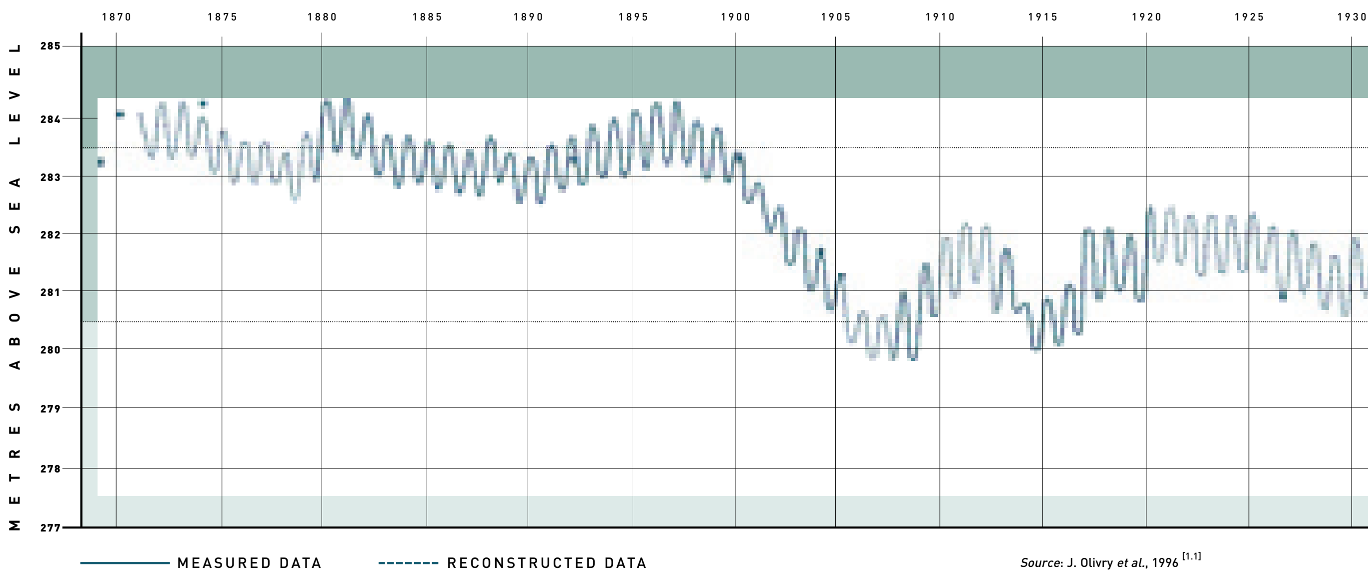
HYDROLOGY

The main influent rivers of Lake Chad are the Chari, which flows through Central African Republic, Chad and Cameroon and also collects the waters of the Logone (Cameroon and Chad), the Komadugu–Yobé (the Niger and Nigeria), the Yedseram (Nigeria) and the El-Beïd (Cameroon). Of the volume of water supplied to Lake Chad each year, the Chari accounts for more than 90 percent and is the only river that flows all year round; the others normally flow only for a few months.

The lake has no outlets and has a high water loss from evaporation. The mean annual evaporation from the lake surface, calculated on the basis of measurements in climatic stations around the lake, is 2 250 mm per year [1.7]. Annual losses in the *yaéré* (floodplains on the southern shore) are estimated at 5 billion m^3, equivalent to 30 percent of the annual flow of the Logone [1.6]. Despite this, the lake is not salty like other landlocked lakes, although the water tastes brackish. This is because the salinity of the river water is low and some of the dissolved solids precipitate, while some are absorbed by plants [1.3].

The lake is very shallow (its maximum depth is about 5.5 m in the Normal Chad condition [1.1]). This means that its water level is greatly influenced by the balance between water loss (mainly from evaporation) and water supply (mainly from tributary rivers, the flow of which depends, in turn, on rainfall patterns throughout the entire basin). Because of the large variations of yearly rainfall values, the water level varies consistently across the years, as shown in the figure below. For example, during the droughts of the 1980s, the 200 mm isohyet was some 300 km south of its position in the 1950s [1.6], which meant practically no rainfall at all for some years over most of the lake area. The maximum flow of the Chari in 1984/85 was less than 20 percent of that in 1961/62. The surface area of open waters in the lake shrank dramatically to about 2 000 km^2 in 1990 [1.1].

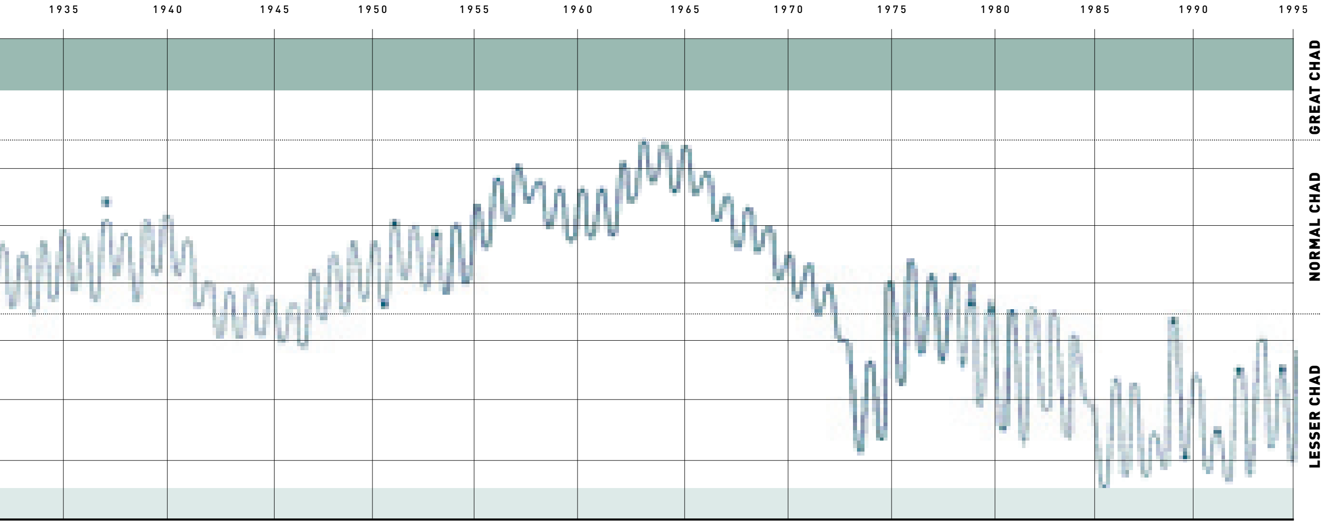
LAKE LEVELS AT BOL (CHAD) FROM 1870 TO 1995, SHOWING YEARLY AND SEASONAL FLUCTUATIONS



Source: J. Olivry *et al.*, 1996 [1.1]

PORT OF BOSSO, THE NIGER

LAKE LEVEL IS GREATLY INFLUENCED BY RIVER FLOW



NEAR N'GUIGMI, THE NIGER

ABOVE AND RIGHT: THE RHYTHM OF LIFE AROUND THE LAKE IS DICTATED BY SEASONAL WATER FLUCTUATIONS

SEASONAL FLUCTUATIONS

Apart from the long-term periodic changes in lake level, the basin's ecosystems experience seasonal fluctuations that probably represent the most significant feature of the area, around which people, animals and vegetation have had to adapt their lifestyles.

The availability of water over the year depends on the seasonal peaks of rainfall, river flow and lake level that succeed each other from July to January. As a consequence, despite the shortness of the rainy season, two to four crops per year can be obtained by exploiting these natural fluctuations and the water storage capacity of the soils.

During the rainy season (from July to September), rainfed agriculture is practised. Both the lake level and river flows are at their minimum. In November, river flows reach their peak, and soils along the banks are flooded. In January, the river flows decrease, and agriculture is practised in the recessional land along the banks.

At the same time, the lake reaches its peak level and covers its maximum surface area. Immediately afterwards, in February, the lake waters start to recede and agriculture is practised in recessional land around the lake.

PORT OF BLANGOUA (KOUSSERI), CAMEROON

Seasonal water cycles in the Lake Chad Basin

1 The year shown in the figure below starts in July, i.e. at the beginning of the rainy season. At this point, there has been practically no rain for almost nine months; the land is dry and all the rivers are dry, with the exception of the Chari, the flow of which is a bare 10 percent of its maximum. The lake level is low. Temperatures are high (around 35°C at Bol).

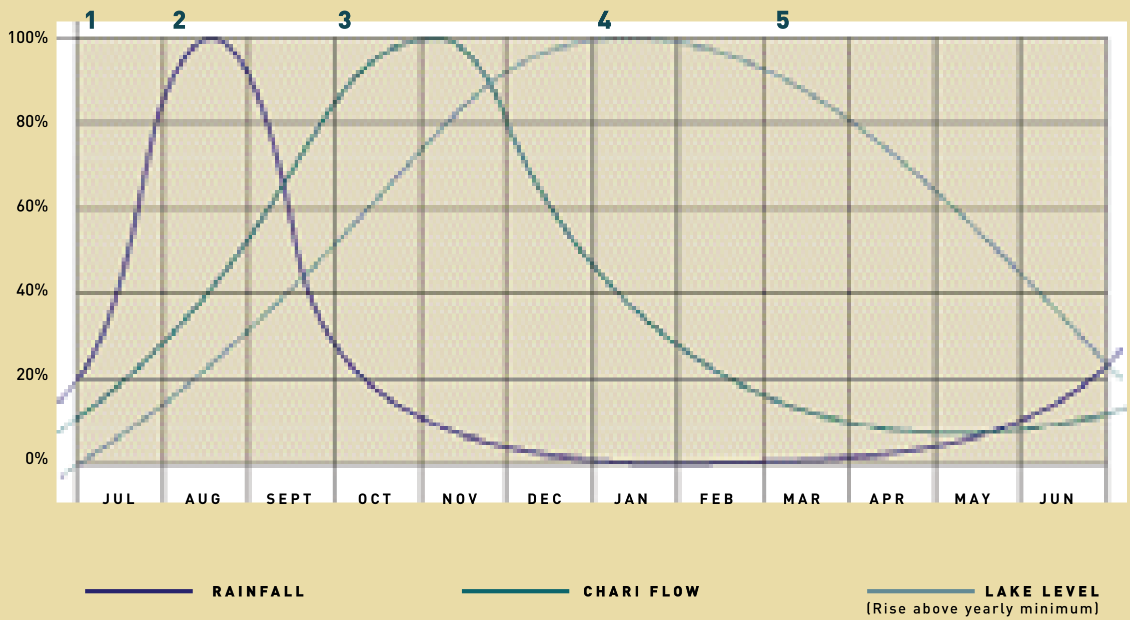
2 The rainy season lasts for three months, with peak rainfall in August and a sharp decrease during September. River flows start to increase, but at a somewhat slow pace: it takes time for them to collect rainwater from the large area of the basin. Temperatures start decreasing, but are still high. Owing to a negative balance between evaporation and supply, the lake level keeps decreasing, reaching a minimum in July.

3 By October the rains stop, but river flows quickly increase, reaching a maximum in November. The areas along the banks get flooded. Temperature decreases, reaching a minimum at the end of December (around 14°C at Bol). Water balance in the lake is now positive and the water level increases. Recessional lands along the shores begin to get flooded.

4 In January the season is still dry and river flows reduce dramatically. By February it is again only the Chari that keeps flowing. Temperatures start increasing again. The water level in the lake reaches its maximum in mid-January. The mean difference between high and low levels is about 0.7–1 m, which means that large areas around the lake are flooded.

5 March to June is the hot dry season, the most difficult season for people, animals and vegetation. There is no rain, very little water in the rivers and high temperatures. The lake waters progressively recede. At the end of June, the process starts all over again.

SEASONAL PATTERNS OF RAINFALL, CHARI RIVER FLOW AND LAKE WATER LEVEL RISE, EXPRESSED AS THE PERCENTAGE RATIO OF THE MONTHLY VALUE DIVIDED BY THE YEARLY MAXIMUM VALUE



Source: Based on data taken from C. Bouquet, 1990 [1.5]

The Lake Chad Basin Commission

Extract from the Convention and Statutes relating to the development of the Chad Basin, signed at Fort Lamy (N'Djamena), on 22 May 1964 [1.8]

"The Member States solemnly affirm their determination to intensify their cooperation and efforts towards the development of the Chad Basin ...

"The Chad Basin shall be open to the exploitation of all Member States who are parties to the Convention, in respect of the sovereign rights, of each of them and in accordance with the terms and conditions of the present Statutes, subsequent revisions or regulations or special agreements ...

"The exploitation of the Chad Basin and especially the utilization of surface and underground waters has the widest meaning and refers in particular to the needs of domestic and industrial and agricultural development and the collecting of its fauna and flora products ...

"The Member States undertake to refrain from adopting, without referring to the Commission beforehand, any measures likely to exert a marked influence either upon the extent of water losses, or upon the form of the annual hydrograph and limnograph and certain other characteristics of the Lake, upon the conditions of their exploitation by other bordering States, upon the sanitary condition of the water resources or upon the biological characteristics of the fauna and the flora of the Basin ...

"The Member States shall draw up common rules to facilitate as far as possible navigation and transport on the Lake and the navigable waterways of the Basin and to ensure the security and control thereof."

PORT OF BOL, CHAD

THE RECENT PROGRAMME OF ACTION BY THE LAKE CHAD BASIN COMMISSION EMPHASIZES COORDINATED PROTECTION OF CROPS, ANIMALS AND FORESTRY

The Strategic Action Plan (1998)

The recent programme of action emphasizes antidesertification measures, coordinated protection of crops, animals and forestry, and of Lake Chad. Improvement in road and railway links between member countries is also a major concern of the Commission [1.9].

DATA ELABORATED FROM *LIVESTOCK ATLAS OF THE LAKE CHAD BASIN* [1.6]

MAP SHOWING THE HYDROGRAPHIC AND CONVENTIONAL BASINS OF LAKE CHAD

THE BASIN

The hydrographic basin of the lake extends over an area of about 2.4 million km^2, half of which is desert. This is shared by the four riparian countries, as well as by Algeria, the Sudan and the Central African Republic [1.7].

The conventional basin was established in 1964, by convention of the four riparian countries, as the area to be jointly managed by the Lake Chad Basin Commission. It covers an area of 427 300 km^2 which stretches from latitudes 10° to 16°N and from longitudes 9° to 18°E. Its hydrographic basin is composed of the Chari–Logone–El-Beïd and Komadugu–Yobé river systems [1.6]. The term "basin" used in this book generally refers to this area.

When the Central African Republic joined the Commission in 1994, the conventional basin was extended and it now covers an area of about 967 000 km^2. In 2000, the Sudan also joined the Commission.

PHOTO: COURTESY OF N.SCHAREIKA

USUALLY, 75 PERCENT OF THE ANNUAL RAINFALL IS CONCENTRATED IN JULY AND AUGUST

CLIMATE

Climatic zones in the Lake Chad Basin are mainly determined by rainfall levels, which range between less than 100 mm in the extreme north (Saharan zone), 100–400 mm in the central and largest part of the basin, including the lake (Sahelian zone), and 400 mm to as much as 1 000 mm in the southern edge of the basin (Sudanian zone). This variation greatly contributes to the diversity of vegetation types, agriculture, wildlife, livestock and all types of human activities in the basin.

The seasonal rainfall pattern depends on the movement of the intertropical convergence zone (ITCZ), which is defined as the boundary between the hot dry air masses originating from the north (harmattan) and the cooler damper masses originating from the south (monsoon). Between November and March the ITCZ is located far south of the basin, the harmattan prevails and the season is very dry. The ITCZ moves northwards in April, reaching its northernmost position, at about 20°N, in July to August, and starting its southward movement in September. Consequently, the first rains appear in May to June, are more consistent in July to August (about 75 percent of the yearly rainfall is normally concentrated in these two months), and decrease in September [1.10].
Temperatures reach their minimum values in December to January (about 14°C at Bol – monthly mean of minimum daily temperatures) and their maximum values in April to May (about 38°C at Bol – monthly mean of maximum daily temperatures) [1.1].
The combination of rainfall and temperature defines three main “seasons”: a cool dry season between October and February, a warm dry season between March and June, and a warm wet season between July and September [1.11].

The rainfall pattern is far from being constant in the different climatic zones of the basin and over the years. Especially in the drier areas of the north and in years of low rainfall it may be quite different; consequently the actual rainfall pattern for a single year is generally unpredictable.

A MAP PRODUCED IN 1653 BY P. DU VAL D'ABBEVILLE FOR THE KING OF FRANCE LOUIS XIV. LAKE CHAD IS SHOWN WITH THE NAME "LAC DE BORNO" [1.13]

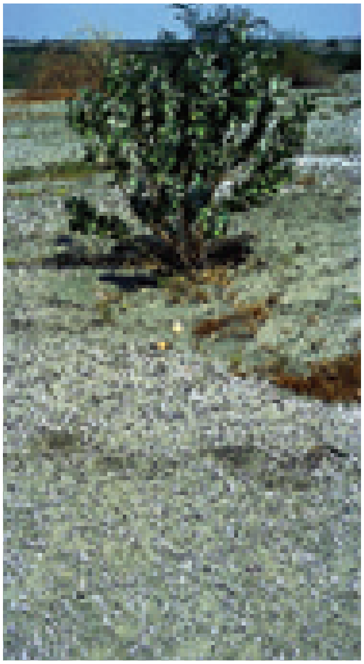
HISTORY

The Lake Chad Basin is a sedimentary basin formed in the Mesozoic era. Fluctuations are not new to Lake Chad. Fossils and the landscape of the area show evidence of wide fluctuations in the palaeoclimate, with periods alternating from very arid to very humid. During arid phases the lake dried out completely and dunes were formed.

During humid phases the lake extended over increasingly larger areas, to a maximum of about 400 000 km^2 (also known as Megachad). At least three such major cycles have been identified in the period from 55 000 to 6 500 years before present (BP) [1.12]. The current climatic arid phase started about 4 500 years BP. It is characterized by the presence of the Sahara Desert in the northern part of the basin and by a lake surface area not exceeding about 25 000 km^2.

The presence of prehistoric humans in the basin is well documented and is closely linked with these climate fluctuations, as these humans almost disappear during the most arid periods. Fossil evidence shows that populations relied on fish and other lake and river fauna for food.

Even in recent ages, geological data and historical records show how the alternation of humid and arid periods caused correspondingly wide fluctuations in the lake level. In the second millennium BC, the arid climate caused the population to concentrate in a few scattered oases and led to the development of nomadism.



EAST OF N'GUIGMI, THE NIGER

WIDE FLUCTUATIONS IN LAKE LEVELS HAVE BEEN DOCUMENTED THROUGHOUT THE AGES. THE CURRENT ARID PHASE STARTED ABOUT 4 500 YEARS BP

In the first half of the sixteenth century the lake almost disappeared but, by the end of the following century, the lake surface was about 25 000 km^2 in area. Another significant arid period was recorded in the first half of the nineteenth century [1.14].

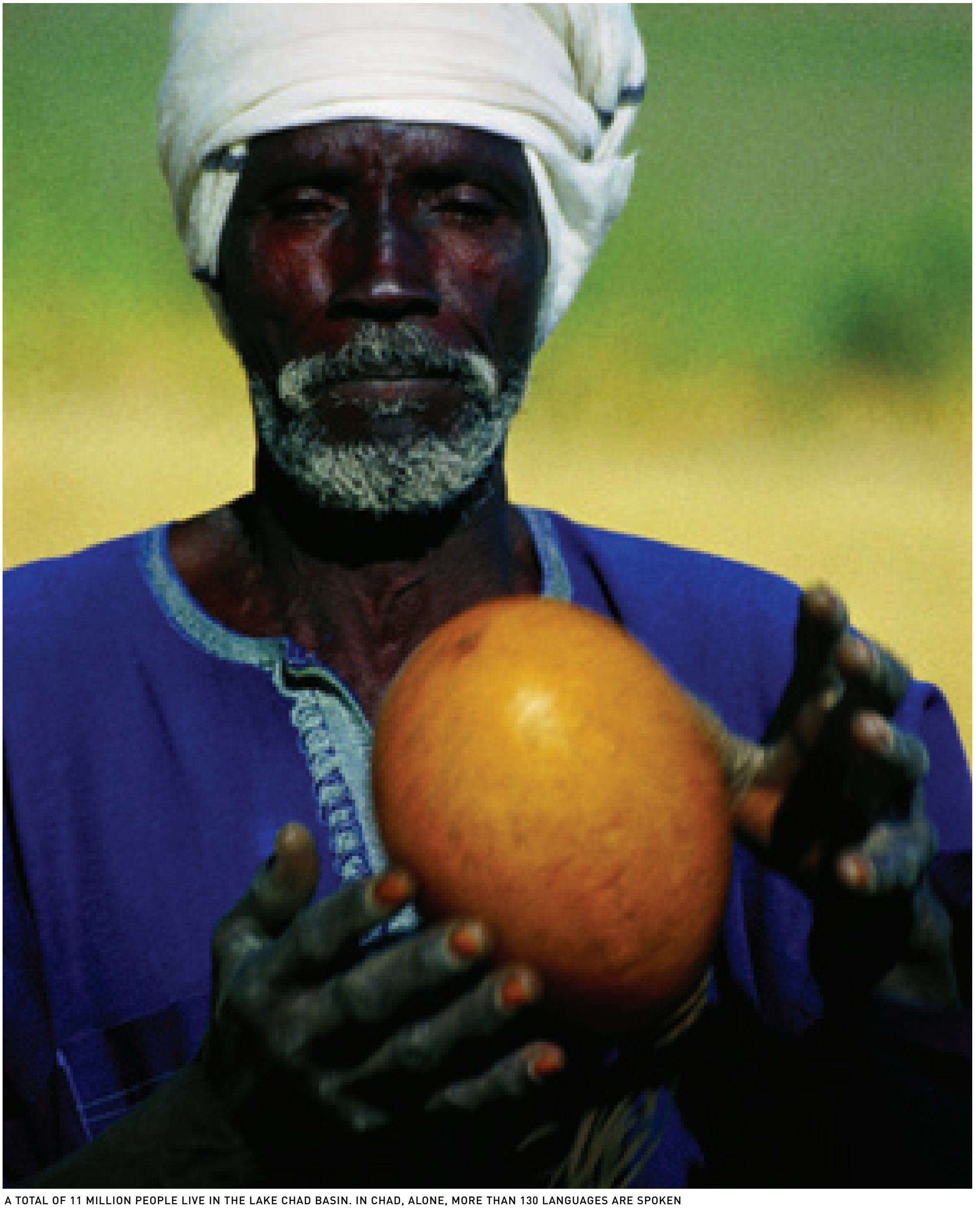
More precise data are available concerning the recent history of the lake, since the beginning of the twentieth century: the highest level was reached in the 1960s (a surface area of 25 000 km^2 in 1962/63), while the lowest levels were reached during the droughts of the 1970s and 1980s (less than 2 000 km^2 of open water surface area in 1990). In the last few years there has been evidence of a trend inversion [1.11], although the lake must still be considered as being in the Lesser Chad condition hydrologically.

As for the populations, during the first millennium BC the Sao and Daima civilizations were already present in the south of the Lake Chad Basin and Nok people were found in the southwest. Agriculture, fishery and pastoralism were the main activities.

According to legends, there was a flourishing civilization to the south of the Lake Chad Basin from 700 to 1050 AD. Textiles and pottery have been found, as well as defensive walls, built probably against the Kanembu. Trade flourished after the fourth century as a result of the introduction of camels, which enabled connections between the Mediterranean Sea and the Lake Chad Basin. The caravans used to carry products from the north, as well as weapons and precious fabric. On the way back, they would carry slaves captured in the southern part of the Kanem-Bornu kingdom. More recently, this trade continued with wheat and natron, etc.

A people called Zaghawa ruled Kanem until 1075, when the dynasty of Sefuwa became dominant. From 1210 to 1248, King Dunama Dibolami brought the Kingdom of Kanem to its peak. The kingdoms of Bornu and Kawar were unified under Kanem and trade was very active. Between 1382 and 1387, Kanem was annexed to the territories of Bulala, and the Bornu Empire dominated the region. Until the mid-nineteenth century, Kanem–Bornu remained a powerful state but, after European occupation, the population and its wealth decreased rapidly [1.14].

NEAR BOL, CHAD



A TOTAL OF 11 MILLION PEOPLE LIVE IN THE LAKE CHAD BASIN. IN CHAD, ALONE, MORE THAN 130 LANGUAGES ARE SPOKEN

THE LAKE CHAD BASIN IS A MOSAIC OF PEOPLE FROM DIFFERENT ETHNIC GROUPS, CULTURES AND RELIGIONS

PEOPLE

Today the Lake Chad Basin is a mosaic of peoples, each with different cultures, habits, skills and needs. For generations, farmers, pastoralists and fishermen have lived and worked in equilibrium with the fluctuations and uncertainties of their environment, developing a combination of different agricultural traditions, fishing skills and pastoral movements in order to make maximum use of the resources. Therefore, the peculiar biodiversity of the Lake Chad Basin ecosystem has been formed not only by its great variety of flora and fauna but also by the diversity of populations and their complementary skills.

People living in the Lake Chad Basin are drawn from several ethnic groups and tribes, such as the Kanuri, Mobber, Buduma, Haoussa, Kanembu, Kotoko, Shewa Arabs, Haddad, Kouri, Fulani and Manga. Over the years, interactions between these tribes and their cultures, their religions and the mobility of herders have led to a mixing of races and a blurring of roles. Herders have become farmer-herders and farmer-fishermen. Farmers have added fish to their diet and, in turn, gone on to become traders.

PASTORALISTS

Pastoralists and their cattle are a vital part of the ecosystem and often have a positive impact on the management and propagation of biodiversity and the maintenance of water resources. If sufficient resources are available, nomadic herding contributes to the sustainable use of grasslands and prevents the degradation and desertification of the region's poor and fragile soils.

Pastoralists fall into three main groups: the Toubou and Arabs, who are camel breeders and herders and sometimes agropastoralists; the Fulbe, including the Peul and the Woɗaaɓe (or Bororo), who normally do not farm but are nomadic herders; and the Buduma, who raise and herd the white Kouri cattle on the remote islands of the lake.

There are also agropastoralists or farmer-herders, including tribespeople from the Manga (the Niger) and Kotoko (Chad and Cameroon). These communities own relatively small herds of between ten and 30 head of cattle, and follow the transhumance routes of traditional herders.

However, even these ethnic distinctions are not definitive. Many of the farmers, such as the Manga or the Mobber, are also breeders, herders and agropastoralists, and some have settled on the edge of the pasture lands, where they coexist with the Peul and the Woɗaaɓe. By the same token, Fulbe tribespeople may also be farmers. Unlike their nomadic counterparts, they are sedentary and, most important, they drive herds that are not their own.

PORT OF BLANGOUA (KOUSSERI), CAMEROON

PEUL WOMAN AT THE MARKET TO SELL SOUR MILK


KABELEWA VILLAGE (N'GUIGMI), THE NIGER

WODAABE YOUTH AT THE WELL NEAR KABELEWA


TAL DESERT (N'GUIGMI), THE NIGER

ARAB PASTORALIST AT THE WELL NEAR LOWA

FARMERS

Almost all of the communities in the Lake Chad Basin grow crops to some extent. Among these tribes are the Haoussa, Mobber (Kanuri), Kanembu, Buduma, Shewa Arabs, Dadjo, Kouri and Sara.

Most farmers have limited land and labour. Soils are generally of marginal quality and rainfall is unpredictable. In addition, markets are scattered and difficult to reach and the population is scattered and mainly rural. As a consequence, farmers adopt subsistence strategies. Rather than looking for high yields, they select their seed according to its capacity to resist drought and disease, to produce on poor soils and to leave sufficient amounts of residues that can be used as animal feed or left on the ground to increase soil fertility. Market prices for agricultural products are generally low, so farmers have no interest in producing a surplus for sale at market, which would require additional input in terms of labour and fertilizers.

As a result, although there is great potential for increasing food production in the Lake Chad Basin, most of the production is still for household consumption, and only a small portion of the cereals produced in the area reaches the marketplace. Taste also plays an important role and most farmers select and grow cereals that best suit their processing and cooking habits.

The livelihood of farmers depends to a great extent on the crops that they are able to grow. At rainfall levels of 250–500 mm per annum, millet and sorghum are predominant. At rainfall levels of 500–750 mm, cereals, groundnuts and vegetables may be grown. Where levels reach 1 000 mm, cultivated crops include rice, wheat, maize, sorghum, groundnuts, cotton and forage crops.

DUMBA VILLAGE (BAGA), NIGERIA

KANEMBU WOMAN

DANOUWANE VILLAGE (N'GUIGMI), THE NIGER

ABOVE AND BELOW: SOME FARMERS PRODUCE MOSTLY RAINFED CROPS, WHILE OTHERS ARE ABLE TO GROW TWO OR EVEN THREE CROPS USING RECESSIONAL LAND

MALAM KOURNADI VILLAGE (DIFFA), THE NIGER

FISHERMEN

Around the islands of Lake Chad, people from communities such as the Buduma, Kanembu, Haoussa, Kotoko, Masa, Kanuri, Kim and Kabalay all make their living by fishing. There are estimated to be at least 20 000 professional fishermen in the lake basin, with the highest numbers concentrated in Chad and Cameroon, although over 300 000 people fish as a part-time activity. As well as in the lake itself, fishing is also practised along the Chari and Logone rivers and within the floodplain areas of the lake and rivers.

Many people fish the waters of the lake, the rivers and the wadis or pools for domestic consumption – fish is an important source of protein in the region. Fish is also an important trading commodity, and many people are involved at different stages of the fish marketing operations. So far, fishing has been practised according to seasonal fluctuations of the water basins, and there appears to be room for developing this important economic asset.

DORO LELEWA VILLAGE (N'GUIGMI), THE NIGER

FISH IS AN IMPORTANT SOURCE OF PROTEIN FOR THE INHABITANTS OF THE LAKE CHAD BASIN

BALATUNGUR VILLAGE (BOSSO), THE NIGER

FISH TRADER AT THE MARKET IN BALATUNGUR PORT

DORO LELEWA VILLAGE (N'GUIGMI), THE NIGER

OVER 300 000 PEOPLE FISH IN THE LAKE CHAD BASIN AS A PART-TIME ACTIVITY

People and societies of the Lake Chad Basin

by **Pierluigi Agnelli** *

Names of the people

The names given to different ethnic groups often reflect historical situations or how the groups are viewed by their neighbours. For example, the inhabitants of the islands, who used to hide themselves in the thick island vegetation to protect themselves from other groups, call themselves "Yedna" but are more commonly known as "Buduma", which in Kanembu language means "people living in water grasses". Mobber people – farmers who have settled in the Komadugu-Yobé area – are called "Doho", meaning "they have arrived and we have also arrived", by the Tumagri Kanembu of the Niger. Kotoko people make a distinction between Saway Arabs (*la gadi*, meaning "Arabs coming from the east") and Suwa Arabs (*saway gogi*, meaning "curdled milk Arabs" or "small Arabs"). The Kanuri are distinguished as "big Bornu" and "small Bornu"; the first term refers to those who live in Bornu, and the second to those who live temporarily in the Kotoko fishing zones.

Kanembu and Kanuri societies

These societies have only recently accepted state organization, and some aspects of the former Kanem–Bornu Empire social structure are still apparent.

In the Kanem (Chad) each member of the village obeys a village chief (*Marama* in Kanembu and *Buluma* in Arabic). His title is hereditary, but he is sometimes elected by the heads of families. A group of villages is ruled by the *Maï*, or *Chef du canton* (formerly called "sultan"), who is the representative of central administration. He is generally chief of an ethnic group, although a "canton" is not always ethnically homogeneous. Finally, at the top of the pyramid, there is the *Alifa of Mao*, supreme chief of the Kanembu people. He collects part of the village taxes and is the depositary of land titles for his territory.

In the Bornu (Nigeria) the village chief is also called *Buluma*, and a group of ethnically homogeneous villages is called a *Lawanat* and is ruled by a *Lawan* (race chief). A group of *Lawanats* is ruled by an *Adji* or *Adja* assisted by a counsellor. The *Adji* is nominated by the *Shehu* of Maiduguri who is the highest authority in the entire territory of the ancient Kingdom of Bornu. The authority of the *Shehu* is also recognized by other people. When the *Katchella* (chief) of the Mobber of Bosso pays a visit to the *Shehu*, he does not wear the traditional *boubou* but a goatskin on his shoulders as a sign of respect.

In Chad, the Haddad people are an example of what was once a caste. They used to be blacksmiths (*haddid* in Arabic means "iron"), but they now undertake a variety of manual jobs, forming socioprofessional rather than ethnic

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BLANGOUA VILLAGE (KOUSSERI), CAMEROON

HADDAD BLACKSMITHS IN THE MARKET AT BLANGOUA VILLAGE

GAOUI VILLAGE (N'DJAMENA), CHAD

THE HISTORICAL HOUSE OF THE KOTOKO SULTAN IN GAOUI

groups. They generally marry within their own group. Haddad people are shoemakers, hunters, farmers, natron extractors, butchers, *griots*, musicians, masons, and radio- and watch-repairers. In addition, Haddad women carry out artisanal work such as pottery making, *dihé* extraction and midwifery. All these jobs are often considered degrading activities, but this neglected group of people is now slowly gaining social recognition thanks to education and their highly prized work. Most of the Haddad people live in the areas of N'Gouri and Massakori.

Kotoko society

Kotoko people live in two large territories, Mandegé in the north and Lagwané, which lies south of a line from Kousseri (Cameroon) to Ndufu (Nigeria). The Kotoko developed an urbanized society because the villages in their territory were generally larger than those of their neighbours from different ethnic groups. The various Kotoko principalities are relatively independent. The main political power rests with the *Mé*, or prince. From the capital city, the *Mé* rules over several groups of villages, each governed by a *Mra*, who is selected directly by the *Mé*. Each village is ruled by a *Buluma*, who is nominated by the *Mra*. In the Mandegé region, the *Buluma* also takes the role of land chief (*Msitani*, or *Chef de terre*). The *Buluma* are elected by free men, grouped by age, and therefore their role is very important.

In the larger agglomerations (over 1 000 people), such as Makari and Goulfey, the class division is quite marked. At the top of the caste system are the *Fanawn* people, who are members of the prince's family and hold the political and economic power. They own large homes and horses, and wear expensive clothes. Then there are the *Mirwada*, or "land people", who produce goods for the city, and are responsible for the traditional religious ceremonies. At the lowest level are the *Furukay*, or "children from the west", who are descendants of slaves captured in the west (i.e. in the Mousgoun or Mouloui), and have the humblest jobs. This hierarchy, although not so well defined as in the past, still influences social relationships among people.

THE COUNTRIES

The four countries sharing Lake Chad, Cameroon, Chad, the Niger and Nigeria, are among the largest nations in Africa. Between them, they cover a total area of little less than 4 million km^2, i.e. 13 percent of the total surface of the continent [1.6]. Their total population of about 145 million people is not evenly distributed: about 77 percent live in highly populated Nigeria, 10 percent in Cameroon and the rest in the two northern and more arid countries, Chad and the Niger. The population in the Lake Chad Basin area is estimated at about 11 million people [1.6], [1.15].


NEAR BOL, CHAD

FOOD SECURITY AND POVERTY ALLEVIATION ARE IMPORTANT OBJECTIVES OF SUSTAINABLE DEVELOPMENT POLICIES IN LAKE CHAD BASIN COUNTRIES

TABLE 1 **POPULATION DATA OF THE COUNTRIES SHARING LAKE CHAD**

COUNTRY	Total population in 1999 (MILLIONS)	Population in the conventional basin in 1999 (MILLIONS)*	Annual population growth rate for 1999–2015 (%)	Adult literacy rate (%)	Population not using improved water sources (%)	Population without access to essential drugs (%)
Cameroon	14.6	2.9	2.1	74.8	38	34
Chad	7.6	3.8	3.0	41.0	73	54
Nigeria	110.8	3.7	2.5	62.6	43	90
The Niger	10.5	0.25	3.6	15.3	41	34
World	5 862.7	–	1.2	79.2	–	–

* 1999 population data extrapolated from 1992 data [1.6] by applying growth rates [1.15] in the four countries

Sources: UNDP, 2001 [1.15] and CIRAD/CTA, 1996, for population data in the Conventional Basin [1.6]

TABLE 2 **HUMAN DEVELOPMENT DATA OF THE COUNTRIES SHARING LAKE CHAD**

COUNTRY	Human Development Index (HDI)	HDI rank (out of 162 countries)	Gross domestic product per capita (PPP* US$)	Population below national poverty line (%)
Cameroon	0.506	125	1 573	40
Chad	0.359	155	850	64
Nigeria	0.455	136	853	34
The Niger	0.274	161	753	63
World	0.716	–	6 980	–

* PPP = purchasing power parity

Source: UNDP, 2001 [1.15]

Papyrus canoes on Lake Chad

9 March 2002
In open waters, Lake Chad

Returning to Bol by boat, we encounter on the way a number of fishermen. These days, their boats are all made of plywood, called madré; a factory-made material that comes from Nigeria. The famous papyrus canoes, *kadey* in the Buduma language, once the only mode of transport on the lake, belong to the past or probably to the poorest fishermen living on the most remote of the islands. From a distance, we make out the shape of just such a vessel on the shores of the island of Goergilom, half hidden by the reeds. It belongs to a very elderly looking fisherman, who, as we later find out, lives by himself in a hut a few metres from the lake shore.

The bearded old man moves very slowly and is helped by a young boy who looks about ten years old. Together, they prepare a fish for the market, splitting it down the middle and placing it over a rudimentary grill. Smoke rises slowly from the makeshift fire. It is all very simple, but it appears to be effective as well.

The "mythical" papyrus canoe turns out to be extremely small and very old. It is pulled up on the shore; we want to try it out, but it hardly floats any more. It is a far cry from the huge vessels that once took to the open waters, their great prows curved to look like an elephant's tusk. André Gide wrote about just such a boat in his *Voyage au Congo* and *Retour au Tchad* in 1925. "They don't use wood to build their boats. Using thick mats made out of papyrus, they make long rafts with a curved prow, a bit like a gondola," wrote the French author. "These extraordinary vessels are propelled by long poles, which are often imported from far away." Gide's travelling companion Allégret took a superb photograph of the vessel.

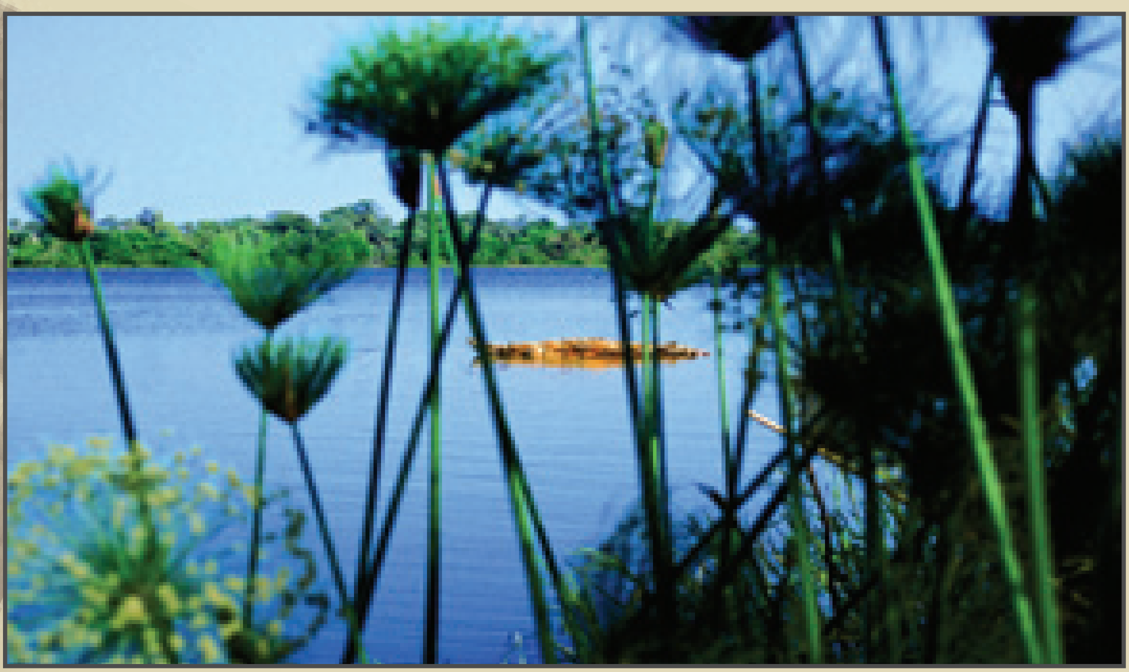
These papyrus boats are the same as the ones still found, even today, on Lake Titicaca in Peru and on Lakes Tana and Zwai in Ethiopia. They also bear a striking resemblance to vessels depicted in the paintings and bas-reliefs of the ancient Egyptians, more than 4 000 years ago. This was the method of transport used by the pharaohs. In fact it was believed that a crocodile would never attack a boat made out of papyrus, since this was the material used to make the boat in which the goddess Isis travelled, on her search to find the dead body of her beloved Osiris.

In spite of their apparent fragility, boats made from papyrus (*Cyperus papyrus*) were surprisingly strong and could be used on the high seas. This was amply demonstrated in 1970 by one of the greatest and most intriguing modern-day sailors, the Norwegian Thor Heyerdahl, who created the Kon-Tiki (built from balsawood) and later the Ra II, which was entirely made from papyrus.

Heyerdahl recruited Buduma fishermen from Lake Chad to build Ra II, and in the space of just a few months they had made a magnificent vessel, 12 m long. Heyerdahl used this vessel to cross the Atlantic Ocean, in an effort to prove his theory that ancient African sailors could have reached the coast of the Americas long before Christopher Columbus.

GOERGILOM ISLAND (BOL), CHAD

TRADITIONAL PAPYRUS CANOES ARE BEING REPLACED WITH BOATS MADE FROM IMPORTED PLYWOOD



GOERGILOM ISLAND (BOL), CHAD

ABOVE AND BELOW: DESPITE THEIR FRAGILE APPEARANCE, PAPYRUS BOATS ARE SURPRISINGLY STRONG. THE BOAT USED BY THOR HEYERDAHL TO CROSS THE ATLANTIC OCEAN WAS BUILT BY BUDUMA FISHERMEN

GOERGILOM ISLAND (BOL), CHAD

CHAPTER 2

GRASSLANDS

"You cannot show the stars to a person who lies on his back."

[Murum proverb from Chad]

GRASSLANDS

by
the **authors** and **Stephen Reynolds**[1]

2

GRASSLANDS PRODUCE FOOD, FIREWOOD AND MEDICINES, AS WELL AS MANY OTHER GOODS AND SERVICES

INTRODUCTION

The grassland ecosystem in the Lake Chad Basin plays a very important role in the everyday life of its inhabitants. Its area in the four riparian countries is more than half of the total land area (62 percent, corresponding to 2.5 million km^2). Just for comparison, the area dedicated to arable land and permanent crops in the same countries is less than 12 percent (0.46 million km^2) [2.1].

Grasslands provide feed for livestock, habitat for wildlife, and firewood and medicines for people. They also represent a genetic resource for crop improvement (many food grains such as wheat, rice and millet originated in grasslands), protect the soil against erosion, provide many other goods and resources, such as timber and energy, and act as a storehouse for carbon dioxide (helping to limit global warming).

Pastoralists have developed different ways of exploiting the grassland resources around Lake Chad. Some areas are grazed all year long, while others are used as a feed reserve, enabling transhumant herds to survive in the dry season. The expansion of agriculture in these areas is endangering the transhumant systems because it reduces the availability of feed resources. At the same time, the grasslands are under

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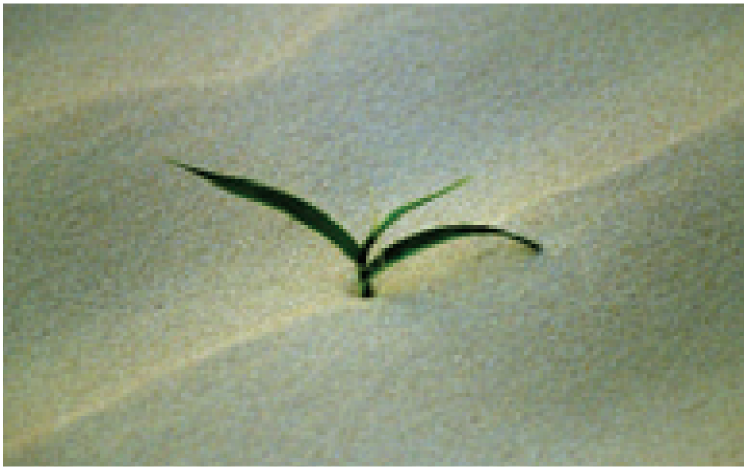
WAZA NATIONAL PARK, CAMEROON

KORRIGUM FEEDING IN WAZA NATIONAL PARK. THE NATURAL HABITAT OF WILDLIFE IS SUFFERING FROM ENCROACHING AGRICULTURE AND PRESSURE FROM INCREASING NUMBERS OF LIVESTOCK

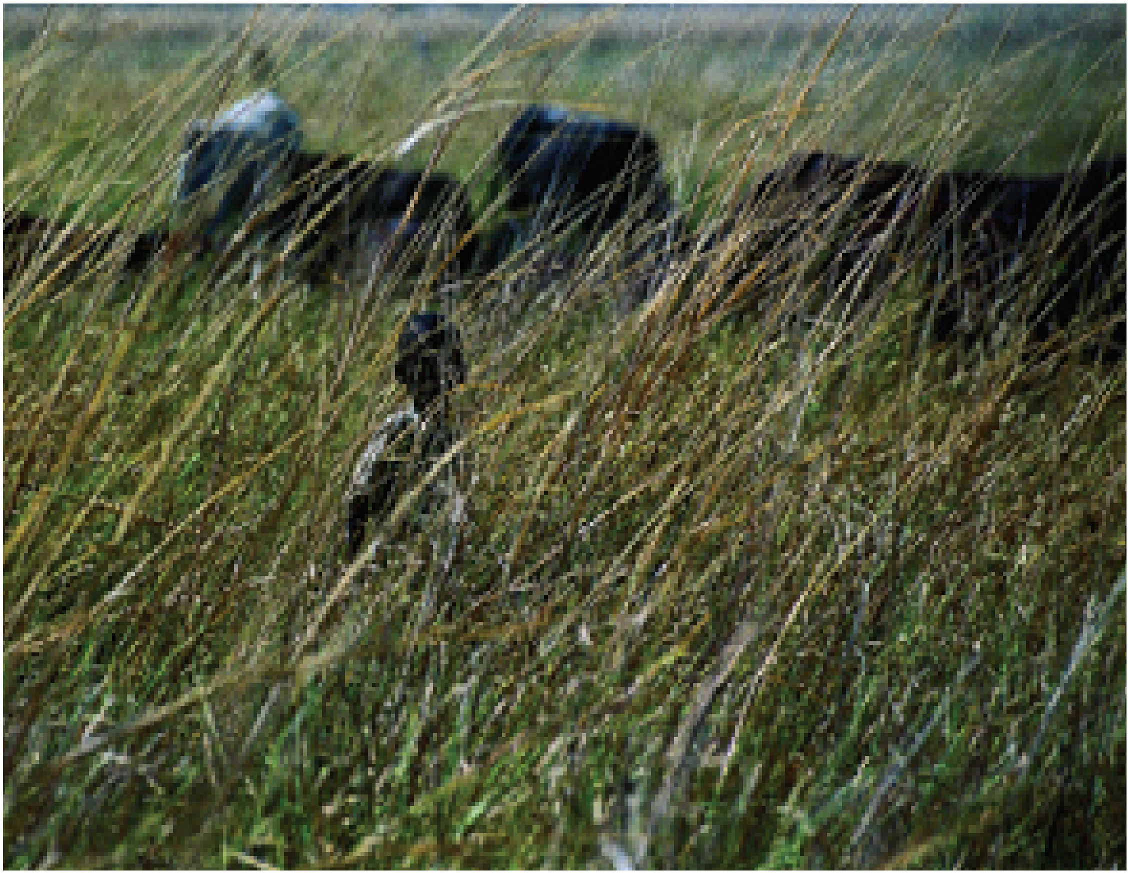
constant pressure to support a growing number of livestock. In the Sahel region as a whole, the numbers of livestock using pastures rose from 35 million in 1962 to 114 million in 2002 [2.1].

Soils of grasslands have generally poor levels of nitrogen (N) and phosphorus (P). Above 300 mm rainfall, these represent the main limiting factors to the productivity of grasslands, while below 300 mm rainfall, lack of water becomes the factor that limits grassland growth [2.2].



TAL DESERT (N'GUIGMI), THE NIGER

GRASSLANDS ARE A PRECIOUS SOURCE OF GENETIC DIVERSITY


NEAR LOGONE-GANA VILLAGE, CHAD

ABOUT 35 PERCENT OF GRASSLAND BIOMASS IS USED FOR ANIMAL FEED

PRODUCTIVITY

In Sahelian ecosystems grassland growth is rapid after the onset of the rains and young pastures are rich in protein, vitamins and minerals. Growth reaches its peak at the end of August and by that time the maturing herbage is already relatively fibrous and low in protein. As the standing herbage dries out, its feeding value falls. Herbage quality falls yet further through mechanical loss of the finer parts (leaves and seed heads) and bleaching by the sun, which greatly reduces the vitamin A content. During the dry season the nutritive value of these pastures is no better than poor-quality straw [2.3].

The production of biomass, which varies according to the types of grasses, soils and the amount of rainfall, ranges from 200–300 to 7 000–8 000 kg of dry matter per ha. The use of this biomass for pastoral animal feeding varies according to the composition of the pastures, pastoral management techniques, grazing efficiency (the proportion of the herbage that livestock can harvest) and the maximum proportion that can be grazed without causing grassland deterioration. Harris [2.4] suggests that for African rangelands the proper use factor varies from 30 to 40 percent (and even 45 percent in the dry season) of biomass.

Haymaking from natural grasslands

It is not certain whether hay from natural grasslands was traditionally produced to feed livestock from November to June, when mature and lignified grass has a quality no better than straw. However, there is evidence to suggest that hay from *Alysicarpus glumaceus* and *Rottboellia exaltata* was made on a regular basis and sold at very high prices on the market in order to maintain high value horses in good condition. Today, this traditional practice has spread and hay is collected from *Panicum laetum*, *Brachiaria ramosa*, *Pennisetum pedicellatum*, *Cenchrus biflorus*, *Andropogon gayanus*, *Zornia glochidiata*, *Alysicarpus ovalifolius*, *Echinochloa stagnina* and *Dactyloctenium aegyptium* in order to feed the dairy animals and small livestock that are kept close to farmers' houses throughout the year. Hay can be seen on roofs and in the markets, mainly close to large villages [2,3].

There is an increased demand for good quality hay and high prices can be obtained. This suggests that it is well understood that animals produce more if they are fed with good quality hay (young and leafy grasses). On the other hand, it is uncertain whether the producers know how to make good quality hay, i.e. to harvest it at a young stage and dry it rapidly. In most cases, hay still appears to be made at an overmature stage in order to maximize production. This results in a severe drop in quality, particularly of crude protein, because the cell contents are diluted by structural components. Consequently, the digestibility of the hay also decreases and animals produce less milk and meat.

NEAR MALAM MINOURI VILLAGE (DIFFA), THE NIGER

DEMAND FOR GOOD QUALITY HAY IS INCREASING

NEAR LOGONE-GANA VILLAGE, CHAD

TRADITIONAL HAY STORAGE FOR FEEDING ANIMALS IN THE DRY SEASON

Vegetation zones of Lake Chad

There are three main vegetation domains in the Lake Chad Basin: the Sahelian and Sudanian domains and the floodplains (*yaéré*) in the south. The boundaries between the different domains are not clear cut and are influenced by the combination of rainfall patterns, soil texture, topography, substratum and microclimate. For example, in the case of sand dunes with a high water infiltration capacity, stretching into a domain with 500 mm of annual rainfall, the dominant vegetation will be very meagre and characteristic of sandy soils. Often plants demanding over 700 mm of rainfall can be found beyond their climatic range if the soils have a high clay content or there is a higher water table in the vicinity of water ponds and wadis.

SCHOENEFELDIA GRACILIS [PLATE 1]

1. SAHELIAN DOMAIN

The Sahelian domain is situated between the 100 mm and 600 mm isohyets and can be divided into three subzones [2.5].

- The northern or desert Sahel, with an annual rainfall of 50–200 mm.
- The "true" Sahel, with an annual rainfall of 200–400 mm.
- The southern or Sudanian Sahel, with an annual rainfall of 400–600 mm.

Most rainfall is concentrated in the three or four summer months and is insufficient for permanent agriculture based on rainfed crops. Most of the Sahelian domain consists of a flat or gently undulating landscape below 600 m above sea level and contains about 1 200 species [2.6], of which probably only 3 percent are strictly endemic.

1.1 The northern or desert Sahel subzone

This region is characterized by sandy or sandy-loam soils and represents the northern limit of summer pastures. The most extensively occurring grasses are the annual species *Cenchrus biflorus*, *Schoenefeldia gracilis*, *Aristida stipoides* and the perennial species *Panicum turgidum* (which is much appreciated by animals), *Stipagrostis pungens* and *Aristida sieberana*. Other plants also display specific drought-resisting features, e.g. *Tribulus ochroleucus*, *Mollugo cerviana* and *Calligonum comosum*. Certain plants are evident only in years when rainfall is above average, e.g. *Colocynthis vulgaris*, which needs plenty of water to develop its fruits, which are 10–12 cm in diameter. The woody layer is characterized by the presence of Saharan species, e.g. *Acacia tortilis*, *A. laeta* and *A. ehrenbergiana*, *Commiphora africana*, *Salvadora persica* and *Leptadenia pyrotechnica*.

1.2 The "true" Sahel subzone

The "true" Sahel subzone receives enough rain to support grasses, but not crops, except in seasonally flooded areas. This area, which covers 300 km in latitude, is commonly called the Sahel. Soils are sandy with flat or dune-type landscapes. Depressions – wadis with clayed and sometimes salty soils – alternate with dunes and sandy soils. The area has a thorny scrub vegetation of the steppe type, which changes into a more dense vegetation when soils become clay. A sparse woody layer of trees (not exceeding 30 trees per ha in non-degraded areas) comprises *Acacia raddiana*, *A. seyal* and *A. senegal*, *Commiphora africana*, *Leptadenia pyrotechnica*, *Balanites aegyptiaca*, *Maerua crassifolia*, *Ziziphus mauritiana* and *Calotropis procera*. Grasslands are dominated by annual grasses in good rainfall years (*Cenchrus biflorus*, *Aristida mutabilis*, *Eragrostis tremula*, *Schoenefeldia gracilis* and *Tragus berteronianus*) and perennial species that form the bulk of livestock and wildlife feed throughout the year if water sources are available (*Panicum turgidum*, *Stipagrostis* sp. and *Cymbopogon schoenanthus*) [2.7], [2.8].

1.3 The southern or Sudanian Sahel subzone

This is a transition zone used by both pastoralists and farmers who grow millet and sorghum. Soils are sandy, with large depressions containing clay soils and water ponds. On sandy soils, steppe vegetation persists and the tree canopy reaches 10–20 percent. The woody cover is typically more diversified than in the northern subzones and includes *Acacia nilotica*, *A. senegal* and *A. raddiana*, *Piliostigma reticulatum*, *Terminalia avicennoides*, *Prosopis africana*, *Faidherbia albida*, *Combretum glutinosum*, *Ziziphus mauritiana*, *Balanites aegyptiaca*, *Hyphaene thebaica* and *Boscia senegalensis*, as well as characteristic species such as *Sclerocarya birrea*, *Bombax costatum*, *Sterculia setigera*, *Grewia bicolor* and *Tamarindus indica*. However, natural regeneration is rendered difficult by browsing, overexploitation and climatic changes.

Dominant grasses include *Aristida adscensionis*, *Schoenefeldia gracilis*, *Eragrostis tremula*, *Brachiaria xantholeuca* and *B. villosa*, and *Cenchrus prieurii*. In depressions, where additional water is available, and on clay soils, *Echinochloa colona* and *E. stagnina*, *Panicum laetum* and *Dactyloctenium aegyptium* are found. On saline soils *Guiera senegalensis*, *Ziziphus mauritiana* and *Acacia senegalensis* dominate, and *Aristida mutabilis*, *Schizachyrium exile* and *Panicum laetum* withstand human pressure and saline soils.

During the rainy season, and for some time afterwards, some grasses exceed 1 m in height (*Cenchrus biflorus* and *C. prieurii*), making walking difficult for the traveller when they are in fruit. Some Sudanian Sahelian annual plants, e.g. *Aristida stipoides* and *Tephrosia linearis*, can reach heights of 1.5 m. Some leguminous plants also push through at the end of the rainy season (e.g. *Indigofera* spp.). In the shelter of the trees, a true herbaceous flora can develop, including large-leaved grasses, such as *Urochloa latta*; compositae such as *Sclerocarpus africanus*; prostrate plants, such as several species of Convolvulaceae (e.g. *Ipomoea aitonii*), Commelinaceae or certain euphorbias.

2. SUDANIAN DOMAIN

The Sudanian domain is shared by Cameroon, Chad and Nigeria and is characterized by a savannah-type vegetation. Rainfall exceeds 800 mm. Maize, rice, cotton and vegetables are cultivated in a combination of many farming systems, and often more than one crop per year is harvested, thanks to the influence of Lake Chad.

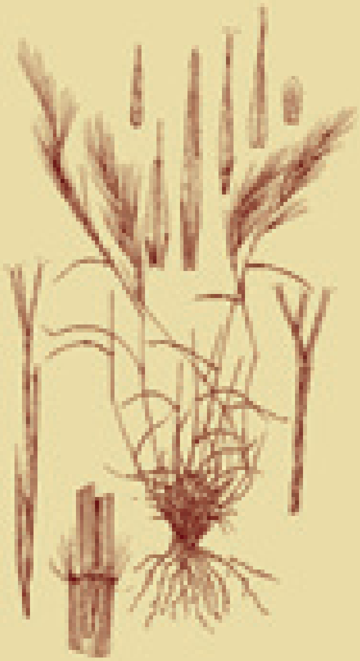
Among the many trees of the Sudanian domain, growing at different levels of density depending on soil types and land management (grazing, intensive agriculture and fallow, water availability), there are *Acacia* spp., *Anogeissus leiocarpus*, *Parkia biglobosa*, *Combretum* spp., *Vitellaria paradoxa* and *Terminalia* spp. Among the grasses are *Pennisetum pedicellatum*, *Brachiaria xantholeuca*, *Andropogon gayanus*, *Cymbopogon giganteus*, *Eragrostis tremula*, *Loudetia togoensis* and *Schizacherium exile*.

3. THE FLOODPLAINS (*YAÉRÉ*)

These areas are considered vital feed resources for grazing animals because they provide green feed reserves when the rest of the vegetation has already dried out. Some areas are under water for different periods of the year. This large ecosystem, which is based on the fluctuations of the lake, is the real asset of the Lake Chad Basin because both cropping and livestock systems do not depend exclusively on rainfall. Therefore one or more additional crops can be harvested and precious feed resources become available. The time and amount of the fluctuations are traditionally known by farmers and pastoralists, who have developed farming and grazing methods adapted to these water movements.

The vegetation of the *yaéré* is classified according to the duration of submersion. In descending order of flooding, this means grass savannahs, shrub savannahs with woody species withstanding partial submersion, and thorny shrub steppe with little tolerance to submersion.

Grassland species include *Aristida mutabilis*, *Echinochloa colona*, *Panicum laetum*, *Hyparrhenia rufa* (submerged for longer periods), *Panicum anabaptistum* and, on the water margins, *Echinochloa stagnina*, *Vossia cuspidata*, *Cyperus papyrus* and other *Cyperus* spp., *Cynodon dactylon* and *Phragmites australis*. Among the woody species, *Acacia seyal* and *A. ehrenbergiana* are present. Aquatic plants include members of the Cyperaceae, *Pistia* sp. and *Sesbania* sp., as well as *Phragmites mauritanus* and *P. australis* [1.3]. Noteworthy flora includes *Spirulina* sp., *Sporobolus* sp. and *Nymphaea* spp., as well as two interesting indigenous water legumes that form part of the Lake Chad ecosystem: *Aeschynomene elaphroxylon* and *A. crassicaulis*. The exotic *Prosopis juliflora*, which was introduced some 40 years ago, today forms thick forests around the lake border, mainly in the Niger and Chad, and is spreading into the best recessional land, where high-value agriculture is undertaken, causing many problems for fishermen trying to navigate the shallow waters of the lake [1.6], [2.9].



ARISTIDA MUTABILIS [PLATE 2]

VOSSIA CUSPIDATA [PLATE 3]

NEAR SELEYA VILLAGE (N'GUIGMI), THE NIGER

PASTORALISTS MOVE ACCORDING TO THE AVAILABILITY OF GRASSES AND WATER

>> RIGHT: NOMADISM IS AN EFFICIENT SURVIVAL STRATEGY IN FRAGILE AND DRY ECOSYSTEMS

PASTORAL MOBILITY

It is now well established that, in arid lands, nomadism is the most effective way of life, from both an economic and an ecological standpoint, because it follows the availability and seasonality of grassland growth. Nomads combine mobility with a deep knowledge of the ecosystem in which they live, and this represents the best solution to the unpredictable variations in the availability of feed.

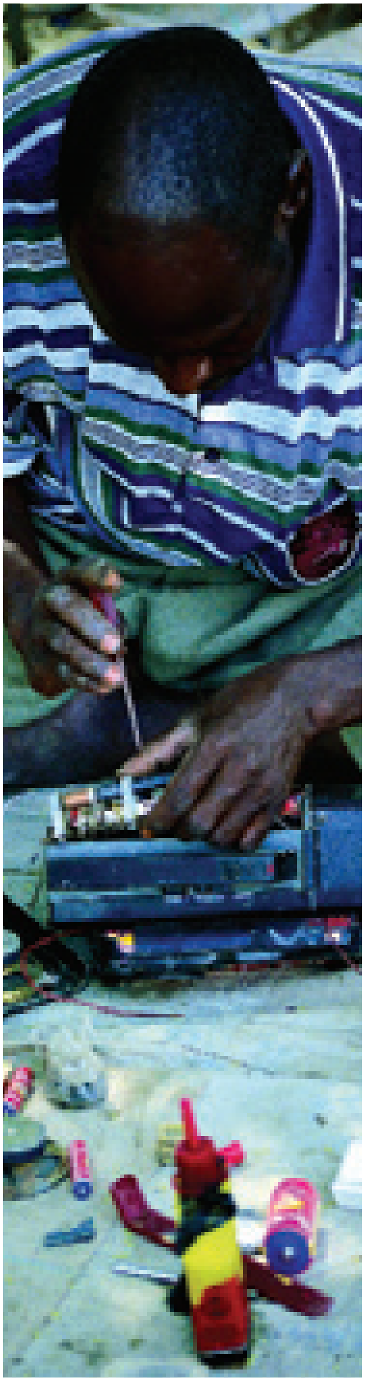
Nature itself offers countless examples of the need for mobility. Wild animals have always known that their survival depends on their ability to keep moving in order to find food and water. Plants have also developed mechanisms, such as winged seeds, in order to distribute themselves over vast distances by means of the wind. Many species distribute their seeds in the skin, wool or digestive tracts of animals and these mechanisms are facilitated by nomadic herding. Annual species need sufficient time to produce their seeds and should not be grazed before they set seed. Perennial species must be able to stock up their reserves of carbohydrates and if animals continuously graze the pasture this process cannot take place. Nomadism reinforces these natural strategies, enabling plants and animals, and the humans who depend upon them, to have a better chance of survival because it entails moving over large distances and thus covering a larger resource base.

NEAR MALAM FATORI VILLAGE, NIGERIA

TRADITION AND TECHNOLOGY

Arid and semi-arid ecosystems pose special challenges to which modern science has so far provided limited answers. They also offer considerable promise because of their special assets: space, air, sun, minerals and low population density. The skills and tools required to exploit these ecosystems are very different from those adopted by more intensively productive sedentary systems. Given the correct political, economic and social support, and by combining traditional systems with new legislation and technologies, the potential of these lands can be developed in a sustainable fashion, with nomadism and mobility at their core. Some examples of how this can be achieved are given below.

- Negotiation capacities of nomads should be supported so that their communities have a means of establishing political or family alliances for the management of herds, water, pastures and markets [2.10].
- Traditional monitoring abilities, which are related to water availability, the quantification and prediction of forage production, the prevalence of pests and animal diseases, and the predictions of seasons based on changes in plant phenology, time, intensity and distribution of rainfall, wind pattern and wildlife movements, should be combined with scientific and satellite information.
- Traditional communication methods used in meetings, fairs and ceremonies, such as the oral information exchanged among people from the same ethnic group about pasture conditions, water availability, and animal health and performance, should be enhanced by the use of modern communication tools, such as radios and mobile telephones.
- Oral education of young people should be reinforced by modern infrastructures which ensure that travelling schoolteachers and mobile facilities are adapted for the people at whom they are aimed.
- Traditional forms of payment for the use of water, pastures and veterinary services should be supported by adapted microcredit schemes, and traditional social insurance structures should be reinforced.
- Communal management of resources and traditional marketing systems should receive political support and be improved through the introduction of simple and safe processing techniques that ensure food quality and increased incomes for local communities.
- Simple tools based on renewable energy sources (basically solar energy) should be introduced. Photovoltaic generators could be used to power well pumps directly or, by means of batteries, to power communication equipment (radios and mobile telephones), torches, portable refrigerators for vaccines, etc. The key issue is the development of equipment that can withstand extreme environmental conditions, is simple to use and requires spare parts that can be made available on the local market. On the other hand, sophisticated performance and high efficiency, which are the most important market features in the developed world, are not a priority.
- Mobile medical assistance could be introduced to deal with emergencies in remote areas.
- Crops and cropping systems adapted to marginal ecological conditions, such as the production of *kreb* (see Chapter 4), should be revived.
- Cheap and transportable water-harvesting methods should be introduced, together with appropriate training for agropastoralists.



BALATUNGUR MARKET (BOSSO), THE NIGER

NEAR DOUTHY VILLAGE (DAMASSAK), NIGERIA

TRADITIONAL KNOWLEDGE DOES NOT DEFINE SEASONS RIGIDLY BUT ACCORDING TO DISTRIBUTION AND EFFICIENCY OF RAINFALL

THE SEASONS

The pastoral year does not simply consist of three seasons, i.e. a winter season, a hot dry season and a rainy season. Nomads recognize some eight different seasons [2.11] and they move their animals to different grasslands according to these seasons. Like their ancestors before them, the herders need flexibility in order to adapt quickly to seasonal, annual and interannual variations in climate, labour availability, security, family, and the size and health of their herds. Their movements are inextricably bound up with the conditions of the grasslands; the quantity, distribution and efficiency of rainfall; and the water levels in the ponds, wadis and wells.

NEAR MALAM FATORI VILLAGE, NIGERIA

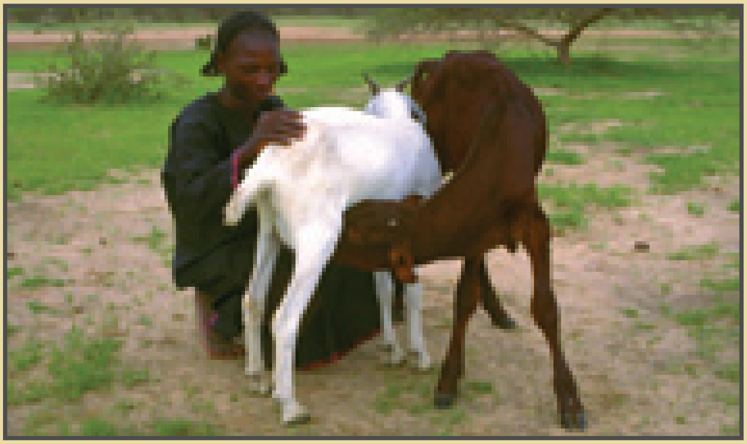
Nomadic cattle husbandry among the Woɗaaɓe in the Lake Chad Basin

by **Nikolaus Schareika** *

The Woɗaaɓe – a Fulani ethnic group – are spread out over many Sahelian and northern Sudanian regions in several West African countries. Those who live immediately to the west of northern Lake Chad, in the southeastern corner of the Niger, first began to arrive in the area in 1910. They came in a wave of migration (*perol*) from Damergu in central Niger and installed themselves in the clay plains of the region they call *Kawlaa*. The Woɗaaɓe are specialized herders of red Zebu cattle, which they keep supplied with grass and water by continuously moving both their herds and their families through the savannah land. Moving is the technique by which the Woɗaaɓe apply their sophisticated knowledge of nature and its processes to a specific task within their pastoral economy, i.e. to increase herd fertility. This goal is achieved by constantly optimizing the feed situation according to two related factors.

1. Seasonal variation in the resource potential of the Sahelian savannah.
2. Seasonal variation in the cattle's physical condition, which alternates from well fed to emaciated.

Soil quality is also a very important consideration in this pastoral strategy. At the beginning of the rainy season (*se'eto*), the herders move in a long seasonal migration (*ɓaartol*) from the clay plains (*karal*) in the east, where they spend the dry season, to the sandy dune areas (*ƴoolde)* in the west. They know that plants will sprout earlier and more quickly on sandy soils. To them, moving forwards in space is equivalent to moving forwards in time in terms of the availability of green fodder. With the first rains, the herb *Tribulus terrestris* (*tuppere*) appears, to relieve the exhausted animals from hunger. Next appears *Cenchrus biflorus* (*hebbere*). Once its shoots have "escaped from the ground", i.e. have become long enough to be bitten off without taking in sand, this species helps the cattle to regain weight after the privations of the dry season. The Woɗaaɓe state that, up to the stage of tillering, grass is much more nourishing than it is afterwards. Therefore they constantly follow the scattered rain showers in middle-range moves (*goonsol*) every two or three days in order to supply the herd with ever-fresh young shoots of *C. biflorus.*



A CALF THAT LOST ITS MOTHER IS FED WITH GOAT'S MILK. THE WODAABE HAVE AN INTIMATE RELATIONSHIP WITH THEIR ANIMALS

At the height of the rainy season (*ndunngu*, around the end of July) the nomads turn back east to the clay plains of *Kawlaa*. In a series of short- and middle-range moves they rove through various ponds (*weendu*) and floodplains (*karal maawam*), where the cattle build up weight with the by-now ripe grass species *Echinochloa colona* (*saɓeeri ngonngorsa*) and *Panicum laetum* (*kaasiyaari*). On elevated plains (*karal*) and flat sand layers (*ƴoolel)* people and animals find dry places to rest. Also growing here is *Chloris prieurii* (*geenal dimal*), which the Woɗaaɓe consider a delicious and nourishing fodder grass for cattle. Moving into the clay plains has at least three advantages.

1. The soil has a high content of salts and minerals, which cattle get directly from the plants. There is no need to feed natron (*kawwa*). The concept of "power" (*mbaawu*) refers to the particular nutritional value of plants on clay soil.
2. Grasses grow somewhat later and more slowly on clay than on sandy soils. Moving to clay therefore means that herds keep feeding on grass that has not yet come into ear. Moving backwards in space is now equivalent to moving backwards in time in terms of the availability of green fodder.
3. In the clay plains there are several herbs that supplement the grass. The Woɗaaɓe consider them *ballirɗum geene*, "something that helps the grass", and cite the following as interesting species: *Indigofera hochstetteri* (*jaa'oomaahi*), *Heliotropium ovalifolium* (*yaharehi*), *Cucumis melo* (*yamɓuruuwol*), *Colocynthis citrullus* (*layol gunaaru rimru*), *Ipomoea verticillata* (*amaseekel*) and *Corchorus olitorius/tridens* (*laalo*).

By the end of the rainy season the Woɗaaɓe achieve the balance of their herding success. The cows should be well fed and, as a consequence, ready to mate (*nagge ho'osa*). Every cow covered is registered as a bonus by its happy owner.

During the early dry season (*ƴaawol*) the Woɗaaɓe eagerly look for a special product of the clay plains: the reddish gleaming grass

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(called *kunɗeeri*) that withered at the stage of tillering, staying short and carrying no ear. The herders state that, in the case of *kunɗeeri*, a shortfall of rain prematurely interrupts the vegetative cycle of grass. Thus, before coming into ear and when still highly nutritious to cattle, it is preserved naturally to the pastoralists' benefit.

After the early dry season (at the end of October) the time of abundance comes to an end. The ponds dry out and the Woɗaaɓe have to resort to wells in order to supply herd and household with water. Protein-rich fresh fodder, or *kunɗeeri*, is no longer available and the animals have to live on dry grass. They first have to cope with periods of cold (*soorol* and *dabbunde*, from November to February) and then heat (*seeɗu* and *bajara*, from March to May). The herders' task shifts from getting their animals into shape – a precondition to mating – to getting them through the fodder-poor season (*feƴƴina na'i*) with the lowest possible weight loss. The nomads therefore limit the range of their movements in order not to exhaust the beasts. They exploit the pastureland around a well, moving in small stages (*sottol*) every seven to ten days. Only when the pasture is completely used up will they undertake a middle-range move (*goonsol*) in order to reach pasture around another well. During the cold period (*dabbunde*) the Woɗaaɓe look for woody depressions (*luggere*) to shield the herd from the chilly wind. During the hot period (*seeɗu, bajara*) they set up camp on open plains in order to catch any breath of fresh air.

The herders attach great importance to salty-tree browsing during the dry season. It is *ɗahatorɗum*, something that complements the staple food (*nyaamdu*) of cattle grass, just as a green sauce complements the millet porridge of humans. To the Woɗaaɓe, *Salvadora persica* (*kasassi*), which is widespread in *Kawlaa*, is the best tree for browsing. Other interesting *ɗahatorɗum* species that they mention are *Cadaba farinosa* (*karatiiyel*) and *Maerua crassifolia* (*senseni*). The disappearance of high-quality pasture is marked not only by the cattle browsing trees but also by the practice of watering the beasts only every second day (*degol e koorka*). At first the reduced water intake prevents the cold wind from "seizing" and "striking" the animals. Excessive intake of water would cause distension of the stomach and eventually lead to a loss of weight. During the hot dry season the Woɗaaɓe continue to water the herd only every second day and consequently accept lower milk yields. They say that in this way their cattle gain weight more quickly during the next rainy season.

By the end of the dry season (from May to June) pasture becomes very scarce (*meheri woodi*). There are some tree resources that can relieve the cattle's hunger, but they can never replace grass as a source of energy for any length of time: the young leaves of now-budding trees, such as *Boscia senegalensis* (*amjahi*), the fruits of *Maerua crassifolia* (*senseni*), the palm fronds of *Hyphaene thebaica* (*gellewol*), the flowers of *Acacia seyal* (*ɓulɓi*), the foliage and fruits of *Acacia albida* (*saski*) and the leaves of *Diospyros mespiliformis* (*nelɓi*). In the 1910s, when the Woɗaaɓe discovered *Kawlaa*, it appeared to be ideal bushland for cattle. Now a combination of reduced rainfall and intensive pasture usage by many different groups of herders has changed the situation (the Woɗaaɓe say *ladde waatii*, "the bush is dead"). Some highly valued grass species, notably *Andropogon gayanus* (*raƴƴere rimre*), have become extinct. Even more serious, in many years there is not enough grass for the herds to survive. Under such conditions it is of the highest priority for the nomads to have access to areas of retreat. These areas are the state of Bornu south of the Komadugu–Yobé in northern Nigeria, the dry Lake Chad Basin (*Saadi*) southeast of Bosso, and the dune valley Dillia (*Diriyaawol*), which stretches in a northwesterly direction from N'Guigmi to the massif of Termit [2.12], [2.13], [2.14].

Map projection: UTM, central meridian 12°E; Spheroid: Clarke 1880; from an original map by K. Vennemann, 1999

THE PASTORAL ZONE

Woɗaaɓe principles of animal nutrition and pastoral techniques

by **Nikolaus Schareika**

PRINCIPLES OF ANIMAL NUTRITION	PASTORAL TECHNIQUES
Fresh green fodder (*kessum*) is better than dry fodder (*jo'oruɗum*).	Lengthening green-fodder period (*ndunngu*); shift between sand dunes and clay plains by seasonal migration (*ɓaartol*).
Adjust the cattle's rumen from dry to green fodder at the beginning of the rainy season (*nagge horsina*).	Feeding natron, which has a laxative effect; looking for the leguminous herbs *Zornia glochidiata* (*dengeere*) and *Alysicarpus ovalifolius* (*gadaji'ire*) – these may provide the nitrogen that the rumen bacteria need for processing the now higher quantities of cellulose.
The nutritional value of grass is best before it has come into ear.	High frequency of middle-range moves (*goonsol*) on sandy soil following the rain (*tokka duule*). From sand back to clay (*ɓaartol*).
Look for what animals like and avoid what could reduce their appetite (particularly a bad smell of dirty grass).	High frequency of camp site transfers.
Successively exploit floodplains and ponds for *Panicum laetum* and *Echinochloa colona*.	High frequency of short-range camp site transfers (*sottol*).
Some species of herbs and creepers help grass to nourish the cattle (*ballirɗum geene*).	Staying on clay plains during the late rainy and early dry season.
Fodder plants of the same species can vary with regard to their nutritional value as determined by the content of minerals, salt and vitamins (*mbaawu*).	General choice of clay plain (*karal*) through yearly seasonal migration (*ɓaartol*) and historic migration from central Niger (*perol*).
Exploit dry but protein-rich short grass of the kunɗeeri-type on salt- and mineral-rich soil.	Middle-range moves (*goonsol*) between, and short-range moves within, pasturelands of the clay plains (*karal*).
Supplement dry and poor fodder grass by salt-rich trees (*ɗahatorɗum*), such as *Salvadora persica* (*kasassi*).	General choice of clay plain (*karal*) through yearly seasonal migration (*ɓaartol*) and historic migration from central Niger (*perol*).
Don't let animals be caught by a cold wind.	Camp site transfers (*sottol*) between woody depressions (*luggere*).
Adjust to poor fodder by reducing exertion for animals.	Short-range camp site adjustments (*sottol*) around a single well during the dry season.
Adjust quantity of water to reduced fodder quality and quantity, thereby preparing for fast weight gains during the rainy season.	Watering the animals only every second day (*degol e koorka*).
Cattle cannot survive for a long period without grass.	Being prepared to move to zones of retreat (Bornu, Lake Chad Basin) in case of drought.
There may always be a better pasture than the one being used at the moment. Constantly look out for the better.	Trying to get as much information on pasturelands as possible by first questioning any other herder and then personally inspecting promising areas (*seewtunde*).
Pasture quality can never be fully assessed by the herder's inspection.	Keeping herd and household mobile in order to judge pasture quality from the animals' reaction to it (milk production, coat, breathing, etc.).

>> RIGHT: PASTORALISTS HAVE A SOPHISTICATED KNOWLEDGE OF NATURE AND VEGETATION DYNAMICS

NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

THE NIGER


PHOTO: COURTESY OF N.SCHAREIKA

PASTORALISTS USE A COMBINATION OF TRADITIONAL AND MODERN VETERINARY PRACTICES

ETHNOVETERINARY REMEDIES

For centuries, pastoralists have observed the effects of treatments based on native plants and natural resources on their livestock when they fall sick. Today many of them use a combination of traditional and modern veterinary medicine, depending on the condition they are treating, their own financial situation and the availability of imported drugs.

It is a fact that ethnoveterinary remedies are often the only ones available in remote pastoral areas, where imported drugs either fail to arrive or are too expensive.

Statistical information on the percentage of pastoralists using ethnoveterinary remedies is not available, but there is no doubt that it must be very high, if only because, today in Chad, over 80 percent of the population still uses traditional medicine for human treatment. Although many pastoralists combine the use of traditional and modern drugs, collaboration between veterinarians and traditional practitioners is still erratic.

Since most information is transmitted orally to the younger members of the families, rather than being systematically codified in written form, and because the types of treatment may be very different according to animal breed, season and plant availability, it is quite difficult to collect information in a systematic way and to test the effectiveness of these methods scientifically.

Some efforts have been made to cross-reference traditional knowledge to scientific classification of diseases. For example, Maliki [2.15] has described three Woɗaaɓe disease categories: "hot", "cold" and "contagious". An animal with a "cold" disease stops grazing and does not gain weight, and Maliki suggests that this is because of parasites and nutritional deficiencies of pastures. On the other hand, diseases that the Woɗaaɓe call "hot" cause quick death and could be endemic, such as anthrax and blackleg.

Some 240 references related to ethnoveterinary medicine are listed in the annotated bibliography of Mathias-Mundy and McCorkle [2.16], many of them based on long years of activities with farmers and pastoralists. Descriptions of medicinal plants and their uses for traditional veterinary medicine in sub-Saharan Africa have been prepared by the International Prélude Network, Subnetwork "Health, animal productions, environment" [2.17], and a databank related to sub-Saharan Africa, with some 14 000 cards related to plant species, country, illness symptoms, recipes for the preparation and use of medicinal plants, and animals treated (cattle, camels, poultry, fish, pigs, etc.), is available on the Internet [2.18]. The information recorded comes from scientific articles, books and congress reports.

Ethnoveterinary medicine deals not only with drugs and treatments but also with folk beliefs, skills, methods and practices of health care of livestock. For example, Nigerian Fulani appreciate the role of insects in the spread of disease, correctly observing that *sammore* (trypanosomiasis) is linked to tsetse-fly bites [2.19]. They also wash their animals with an infusion of *Sesbania aculeata* before passing through a tsetse-fly belt. Fulani responses to foot-and-mouth disease are to move upwind in order to prevent the disease from spreading, or to move downwind in order to expose their animals to the disease so that they become immune [2.16]. The Fulani know that they must refrain from grazing on pastures infected with endemic diseases, such as blackquarter or anthrax, for two years.

It is important to note that many ethnoveterinary remedies are directed at prevention rather than treatment, evidencing good management of the herd and adaptation to environmental conditions.

As in Western veterinary science, not all ethnoveterinary practices provide effective solutions to animal health problems. Ethnoveterinary therapies are largely ineffective against infectious diseases such as rinderpest and foot-and-mouth disease. On the other hand, many ethnoveterinary techniques seem acceptable and may, on occasions, prove effective, even according to Western standards of medicine. These techniques include obstetrical measures (e.g. the Woɗaaɓe, using a razor blade, cut the perineum of an animal that is about to give birth if the birth canal is not sufficiently wide), rumen trocarization in cases of bloat [2.15], and lancing of abscesses, as well as anthelmintic treatments, correction of physiological malfunctions (such as pH imbalances in the rumen), wound care, basic surgery and treatments for skin diseases, nutritional deficiencies, respiratory illnesses and insect damage (e.g. fires are lit near the animals to control insects) [2.16].

All the experience related to traditional veterinary medicine cannot be simply ignored. Additional research and development in the field of ethnoveterinary medicine are recommended because they could well contribute to the enhancement of the value of grasslands and the promotion of low-input, sustainable agropastoral systems. The knowledge and use of ethnoveterinary medicine should be further documented and efforts made to evaluate traditional prevention and treatment practices scientifically and to combine them with the use of scientifically established pharmaceutical products.


BALATUNGUR MARKET (BOSSO), THE NIGER

TRADITIONAL MEDICINES FROM GRASSLANDS SOLD AT THE MARKET

How to treat cattle diseases

Interview with
Maï Inoussa Maï Manga *

"I own more than 500 head of Kanuri cattle, which I care for and vaccinate with traditional methods that give excellent results."

"For an animal with heart problems and internal haemorrhages caused by fights, we burn some natron (sodium bicarbonate) and stuff it deeply into the animal's nose, so that it breathes it in."

"For pneumonia, we have no vaccine. If an animal catches the disease, we kill it and remove the infected lung. The lung is soaked for three days before being cut into small pieces. Then the whole herd is vaccinated in the following way: a cut is made on the muzzle of the animal and a piece of lung is inserted in it and kept there for three days. The wound swells for a further three days. The piece of lung is then removed and the wound is cauterized with hot metal. If the piece of lung is not removed after three days, the animal's head swells, it goes blind and dies. My animals treated in this way are vaccinated against pneumonia."

"We also vaccinate animals against anthrax by cauterizing two parallel lines on their skins at the level of the kidneys, one on each side of the animal."

"To protect animals from pasteurellosis, we pound fresh garlic in a cup of fresh groundnut oil. This dose is enough for three adult animals. The oil and garlic mixture is diluted in hot water and the animals are made to swallow the solution – the animals' mouths are forced open and the liquid is poured into the back of the mouth. This treatment is repeated once a week for three weeks."

"If an animal gets a thorn (mainly from *Prosopis*) it should be treated with *Calotropis* milk. Three days later, the thorn comes out and leaves no infection."

DOUTHY VILLAGE (DAMASSAK), NIGERIA

HERDERS CARE FOR THEIR ANIMALS AND TREAT THEM WHEN NECESSARY IN ORDER TO PRESERVE THE HEALTH OF THE HERD

NEAR N'GUIGMI, THE NIGER

ACCORDING TO MAI INOUSSA MAI MANGA, PREVENTION IS BETTER THAN CURE

* Canton Chief of N'Guigmi, the Niger

KABELEWA VILLAGE (N'GUIGMI), THE NIGER

MOST INFORMATION ON ETHNOVETERINARY REMEDIES IS TRANSMITTED ORALLY, RATHER THAN BEING SYSTEMATICALLY CODIFIED IN WRITTEN FORM. THIS IS WHY IT IS QUITE DIFFICULT TO TEST THE EFFECTIVENESS OF THESE REMEDIES SCIENTIFICALLY

KABELEWA VILLAGE (N'GUIGMI), THE NIGER

TREATMENTS DIFFER ACCORDING TO THE BREED OF THE ANIMAL, SEASON AND PLANT AVAILABILITY

NEAR N'GUIGMI, THE NIGER

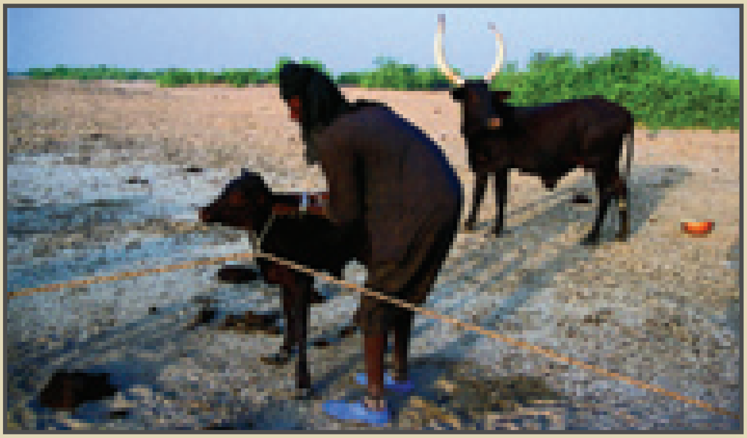
MANY ETHNOVETERINARY TECHNIQUES, SUCH AS RUMEN TROCARIZATION IN THE CASE OF BLOAT, SEEM ACCEPTABLE TO WESTERN VETERINARY SCIENCE

Notes from a journey

Making butter with the Woɗaaɓe

12 October 2001
N'Gortogol, N'Guigmi, the Niger

We arrive at the camp of a Peul Woɗaaɓe family before dawn; the air is cold and the light grey. We are led by Gorgio Birima, a well-known Woɗaaɓe guide, who settled down years ago in the nearby village of Kabelewa. At one point we left the asphalt and then, without a road, without a track, and with no apparent signs, we arrived at the camp. They are all sleeping except, of course, the mother of the family, who we see leading a calf in search of fresh foliage. Though Gorgio had previously made arrangements for us to document the preparation of butter, we do not wish to intrude. So we park at a distance, in order to allow the family members privacy and time to get ready at their own pace.


NEAR N'GORTOGOL (N'GUIGMI), THE NIGER

THE CALF IS BROUGHT NEAR ITS MOTHER IN ORDER TO STIMULATE MILK PRODUCTION

We notice that the camp is virtually divided into two sections: protected by a bushy sand dune is the area where the family lives, while facing it is the work area. The separation is marked by a long rope fixed to the ground, to which about ten calves are tied. In the middle are the smouldering remains of a minuscule open fire. The living area is defined by a bed with a canopy, where, on our arrival, the two younger children are asleep. The older members of the


NEAR N'GORTOGOL (N'GUIGMI), THE NIGER

VERY EARLY IN THE MORNING

NEAR N'GORTOGOL (N'GUIGMI), THE NIGER

IN WODAABE SOCIETY, MILKING IS PERFORMED ONLY BY WOMEN

family apparently sleep on mats next to the only bed. The father, as our guide points out, respects the space set apart for the older daughter. Only an invisible line separates the daughter's "room", but the father takes care never to step over it as he moves around. At the foot of the bed, piled up on a platform, are all the kitchen utensils for the production of the butter: mostly *calebasse* (gourds) of all sizes, many of them decorated, including the ladle, the vessel for milking, and the gourd with a stopper of woven fibre for storing the milk.

The father gets up from his "bed": one animal skin as a mat, another as cover. Next to him, with other hides for covers, lie the two older sons. The man puts on his clothes and comes to greet us; his name is Buba and, like most nomads, he is tall and lanky. We get acquainted. His wife's name is Suri; her noble, dignified face, softened by a shy but lively look, is thrown into relief by the black of her clothing. There are four children: the first, about ten years old, is named Peruji (as we will learn only later, since tradition forbids pronouncing the name of the first-born until adulthood); next come the two girls, Bamo and Tobo, and finally the youngest, one-year-old Bandi.

The older boy goes to fetch the cattle, which have been left grazing nearby during the night. The mother, Suri, continues to look after the calves;

NEAR N'GORTOGOL (N'GUIGMI), THE NIGER

DAUGHTERS HELP IN BUTTER PRODUCTION

Notes from a journey

Bamo and Tobo keep warm by the small fire; Buba, the father, prepares tea; and Bandi sleeps peacefully in his bed. In the soft, golden light which slowly floods over us, the small family seems to exist in a dream-like, happy limbo.

As the herd returns from the pasture, the cows approach spontaneously. Suri unties the calves one by one, in order of arrival, and lets them join their mothers to suckle. After a few pulls at the udder to suck a drop of milk, the calf, gently but firmly, is pulled away by Suri. She ties a rope around the cow's hind legs and begins milking, crouched at the side, almost under the belly of the animal, holding the large gourd tightly between her legs. With rapid movements of her hands, Suri deftly squirts the milk into the waiting calabash: it seems like a miracle, even though the quantity, compared with what we are used to, is quite meagre. To help her mother, Bamo keeps the cow calm by scratching it under its tail. One after the other, Suri milks all the cows, using the same ruse with each calf, which runs to suck a drop of milk and thus prepares the udder for milking.

After receiving milk from about ten cows, the calabash is full. It may contain 4 or 5 litres, which includes the yield from the previous evening as well. Some of it will be drunk right away: the gourd is passed from mouth to mouth. This is often all the family will have in the way of sustenance until evening. The remainder is poured into another vessel, which is closed with a stopper and placed firmly on the sandy ground. For a good 20 minutes, the gourd is shaken back and forth with a rhythmical movement, until the milk, as if by magic, solidifies into creamy white butter. Carefully kept in the calabash, the butter will later be taken by Suri to the nearest market, where it will be bartered for millet or another cereal. Meanwhile, with the last traces of butter that have remained at the bottom of the calabash, Suri oils her daughter Bamo's hair, leaving the small plaits soft and shiny.

NEAR N'GORTOGOL (N'GUIGMI), THE NIGER

A STAGE IN BUTTER PREPARATION. THE BUTTER WILL THEN BE SOLD OR EXCHANGED AT MARKET TO BUY CEREALS AND OTHER GOODS

NEAR N'GORTOGOL (N'GUIGMI), THE NIGER

BANDI, THE SMALLEST CHILD, HOLDS HIS PASTORALIST'S STICK

CHAPTER 3

LIVESTOCK BREEDS

"With this drought,
cows no longer
produce milk
and hunger has arrived
in our encampment.
But the market
is killing our animals,
and not the drought."

[Fulani pastoralist, near Diffa, December 1984]

LIVESTOCK BREEDS

by
Dominique Planchenault[1]

3

THE BEST WAY FORWARD IS A BALANCE BETWEEN DEVELOPMENT OF THE ANIMALS AND MAINTENANCE OF THE ECOSYSTEM

INTRODUCTION

The impact of human beings on the environment, and the consequent modifications of the genetic structure of animal populations, should be seen as part of the development and evolution of a given breed[2]. It is not a question of answering for, or justifying, the negative impact of human behaviour on the environment. It is more a question of remembering that human beings, animals, plants and the environment are all inextricably linked, and that the wisest option is to manage all of them in the best way possible, given the knowledge and information that we have at our disposal. What is vital is that animal breeds be allowed to develop on the basis of the needs of human populations, taking into account the constraints of the environment in which they live.

Conservation[3] by management means submitting a sample or the whole of an animal population to controlled genetic modification with the aim of maintaining, using, restoring or improving the animal's genetic resources to meet specific production goals. In fact, the most effective way of conserving genetic resources is often to help farmers develop their breeds and make fuller use of them. Generally, in the case of Africa, the criteria for improvement will be quantitative, since animal productivity remains weak and the imperative is to provide food rather than to satisfy demands for a particular taste or fashion. Criteria for quality which may be valid in the developed countries – such as the composition of milk or percentages of fat in meat – are currently of no interest because such values have no commercial application.

On the other hand, some features must be preserved[4] during genetic improvement if the products are to have any commercial prospects. That goes for the colour of *Tabaski*[5] sheep as much as for the chickens that are used in

1 Based on work done for the *Centre de coopération internationale en recherche agronomique pour le développement* (CIRAD). Today Dominique Planchenault is the Director of the *Bureau des ressources génétiques*, Paris, France.

NEAR DOUTHY VILLAGE (DAMASSAK), NIGERIA

HUMAN BEINGS, ANIMALS, PLANTS AND THE ENVIRONMENT ARE ALL INEXTRICABLY LINKED

sacrifices. When it comes to breeding for meat production, the build of the animal is of prime importance, since it determines how its meat will be cooked and eaten. In cultures such as those of most European countries, where time is of the essence and meat is often served grilled, it is useful to breed animals with well-developed muscles so that the meat will be tender. In Africa, however, where food is generally cooked for a much longer time, the criteria for selection will be very different.

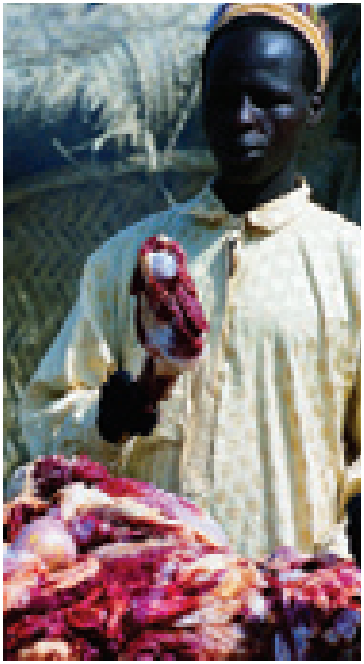
In all cases, the physical environment and the economic, social and cultural context must guide the choices made about conservation. It is clear that, in an economic system where there is very little input from the outside, the herder is alone in deciding upon his objectives when it comes to maintaining and developing his animals' genetic resources. When a country or a region has a very weak agricultural information exchange system (i.e. no means of rapid communication and no organized marketing network that would enable producers to learn about consumer needs outside the immediate area), it is quite natural that animal populations should develop according to the needs, habits, constraints and specific circumstances of the environment in which they are reared. Taking into account the major differences that can exist between habitats, climates, breeding and production systems and sociocultural conditions, the best way forward is to find as effective a balance as possible between the development of the animal and the maintenance of the ecosystem on which it depends.

2 In this chapter, the word "breed" will be taken in its broadest sense. It may refer to isolated breeds that have been well studied and documented. Alternatively it may be used to describe populations, families or subfamilies that appear in very few documents because work on their classification has yet to be completed or, in some cases, has not even started. Are the goats kept by Arab, Moorish Tuareg, Sahelian and Kanem herders all different? And what about the Logone pony? For the sake of clarity, the word "breed" will be used to describe all of these.

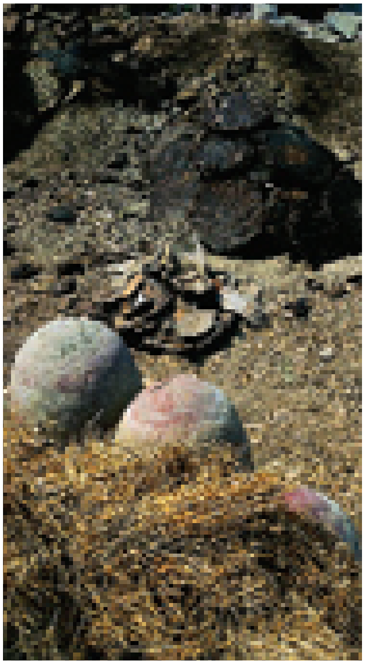
3 As far as the term "conservation" goes, we are using the definition given in the *World Strategy for Conservation*, which was prepared by the World Conservation Union (IUCN), together with the United Nations Educational, Scientific and Cultural Organization (UNESCO), FAO, the United Nations Environment Programme (UNEP) and the World Wide Fund for Nature (WWF). In this context, conservation means the management of the biosphere, with the aim of extracting the maximum advantage for the present generation, while being careful to maintain its potential, so as to be able to meet the needs and aspirations of future generations. Conservation is therefore a positive concept, which includes the preservation, maintenance, sustainable use, restoration and improvement of the natural environment.

4 Strictly speaking, "preservation" means isolating a sample of animal genetic stock and maintaining it in an environment in which there can be no risk of human forces making any irreversible genetic changes. This process can be undertaken *in situ*, when the animals are alive and living in their natural habitat, or *ex situ*, when the specimens are, for example, preserved cryogenically. The latter is a far more static concept than the former, which requires isolation but does not rule out changes through development or evolution.

5 *Tabaski* is a Muslim feast that commemorates the biblical episode of Abraham's sacrifice. God had told Abraham to sacrifice his son Isaac in order to test his faith. He was just about to do this when an angel appeared and ordered him to kill a ram instead. The feast is held two lunar months and ten days after the beginning of Ramadan.



DORO LELEWA VILLAGE (N'GUIGMI), THE NIGER



GAOUI VILLAGE (N'DJAMENA), CHAD

N'GUIGMI MARKET, THE NIGER

IN PASTORAL SOCIETIES, IN CONTRAST TO THE SITUATION IN THE GLOBAL MARKET, IT IS NOT ONLY MEAT AND MILK BUT ALSO BY-PRODUCTS SUCH AS DUNG AND SKIN THAT PLAY A MAJOR ROLE IN THE SELECTION OF A BREED

<< LEFT: THE FOOD SECURITY OF PASTORALISTS IS CLOSELY LINKED TO MILK PRODUCTION

THE ENVIRONMENT

The diversity of animal types used for livestock rearing depends to a large extent on the different ways in which people use the animals and their products. Today, most non-food animal products play only a minor role when it comes to global markets. Most energy comes from oil or coal, while most fertilizer is made from chemicals and most fabrics are of vegetable or chemical origin. In some countries, however, these non-food products are still highly important – dung, skin and wool are all significant by-products from livestock and have considerable value for their owners. Animals also represent an important capital resource in countries where a reliable banking system is often non-existent.

Foodstuffs obtained from animals – such as meat, milk and eggs – have no chemical or industrial substitutes, and these tend to constitute the main products used by livestock rearers. In some cases, they can be partly replaced by vegetable products, but consumption levels will vary widely according to income, availability and customs. In sub-Saharan Africa, most livestock breeding is aimed at providing a combination of products at any one time – such as meat and milk, meat and labour, meat and eggs, or meat and hides – to which must be added the social and capital value of the animal.

In all cases, soil remains a determining factor when it comes to choosing a production system. In the Lake Chad Basin, there are two distinct systems: a dune system and an island system.

NEAR CHARI RIVER, CHAD

AFTER THE MORNING MILKING, THE HERD IS MOVED FOR GRAZING. AT NIGHTFALL, IT IS GATHERED TOGETHER, A FIRE IS LIT TO WARD OFF INSECTS AND THE ANIMALS ARE LEFT TO GRAZE ALL NIGHT

>> RIGHT: THE WET ENVIRONMENT OF THE LAKE SHORE IS A PRECIOUS SOURCE OF FORAGE FOR ANIMALS ADAPTED TO ITS PARTICULAR CONDITIONS

THE LAKESHORE ENVIRONMENT

Herders make good use of the pastures that are adapted to the particular conditions of the Lake Chad area. Livestock are moved here mid-morning and left to graze around the edge of the lake for the rest of the day. Before nightfall, the herder lights a fire and gathers his animals around it in order to ward off insects. When night closes in, the herd moves off again to graze until dawn. In the morning, when the herd returns, the herder milks the cattle. This method of nocturnal grazing is also found in the Sahelian zone during the hot dry season [3.1].

The livestock system used by herders depends to a great extent on the availability of grazing or agricultural by-products, as well as on the constraints imposed by the environment – such as insects and the existence of islands. There are three main types of traditional livestock-rearers in the region.

1. **Pure pastoralists**, mainly Buduma, who practise transhumance on the islands, most notably with Kouri cattle, which can be considered a pure breed.
2. **Semi-transhumant agropastoralists**, who leave their families behind in the villages and accompany their animals as they move in search of pasture.
3. **Sedentary agropastoralists**, who live on the mainland and own herds that are mainly made up of zebu cattle and a few Kouri cross-breeds.

NEAR SELEYA VILLAGE (N'GUIGMI), THE NIGER

THE WELL OF KABELEWA VILLAGE (N'GUIGMI), THE NIGER

WODAABE MAN WITH HIS HERD. THE WODAABE ARE NOMADS AND ARE PART OF THE FULANI ETHNIC GROUP

On the islands, the main breeders and conservers of the distinctive Kouri cattle are the Buduma. These people actually come from villages on the islands, a factor which places them in a unique position when it comes to rearing the Kouri and keeping the breed pure. However, mention should be made of other ethnic groups living on the edge of the area, most notably the Fulbe and the Gorane who, in different ways, may have an impact on the future of Kouri cattle. The way in which Kouri cattle are reared is strongly influenced by the environment. The presence of water and the availability of pasture on the islands and around the lake have all led to the development of a particular system of transhumance, generally with the following patterns.

- During the cool dry season and after the harvest, the cattle graze in the village fields on the shores of the lake.
- During the hot dry season, they search for grazing on the islands.
- During the rainy season, the herds graze away from the fields on the dunes and on the mainland.

One distinctive feature of Kouri cattle is the way that they move from one island to another by swimming – a striking sight. Each community of herders owns a small number of islands and a parcel of land on the shore, and they rotate the use of pastureland between them.


NEAR TAL DESERT (N'GUIGMI), THE NIGER

IN THE INLAND DRY ENVIRONMENT, HERDS ARE CONTINUOUSLY MOVED IN SEARCH OF FORAGE

THE INLAND ENVIRONMENT

A number of different ethnic groups live in the region around the lake: Arabs, Kanembu, Kanuri, Gorane and Fulbe. Some of them have always lived here, while others pass through with their animals as part of a nomadic pattern.

Those who are exclusively herders are mainly Fulani, although the Gorane and Arabs may also fall into this category. These tribespeople do not practise farming as such because they are constantly on the move in search of new and better pastures. The Fulani raise M'Bororo cattle and small ruminants. The Gorane have cattle, small ruminants and a few camels. However, they do not breed camels on anything like the scale of some of the Arab ethnic groups [3.1].

To these should be added other transhumant pastoralists, the Kanembu, who pass along the southern shores of Lake Chad. They come from the Massakori region (Dum Dum, Mourzougui) and arrive on the shores of the lake later in the dry season. Their herds contain large numbers of Kouri cross-breeds.

Arab agropastoralists are almost entirely sedentary and live on the mainland. Their production system is dominated by agriculture, most notably the cultivation of maize, sorghum, millet and gombo. Their herds are smaller and groups of livestock belonging to several different owners are sometimes managed together. Many of their animals, especially goats and poultry, are fed on household scraps, such as fruit and vegetable skins, or crop residues, such

KALGAMA ISLAND (BOL), CHAD

PEUL FAMILIES CONSTANTLY MOVE BETWEEN WET AND DRY ECOSYSTEMS

as straw, hay and bran. Rearing animals is therefore a subsidiary activity that utilizes the by-products of the main activity, which is crop production. As a result, these animals incur a virtually negligible production cost and their development depends directly on that of the farming system which supports it. If crop production becomes more intensive, so does the production of animals, and vice versa.

For this reason, periods of low livestock production are unlikely to have a direct effect on a household. By the same token, the development of breeds able to adapt to catastrophe is relatively unimportant.

In spite of this, it is more than likely that these agropastoralists have the ability to select the breed of any species according to their own particular needs, although it remains to be seen why the selection of breeds has not been stabilized in the area. The truth is most probably that this is a highly complex process, with one group of herders responsible for the conservation of a breed that is adapted to a natural system while other pastoralists are introducing a farming system aimed at maximizing the production of crops rather than animals (in which case local breeds disappear and new breeds are introduced that maximize the utilization of crop by-products). Sometimes it must be accepted that there are no animal breeds that are perfectly adapted, or able to adapt, to all the constraints of the environment.

NEAR LOGONE-GANA VILLAGE, CHAD

SHEWA ARAB SEDENTARY AGROPASTORALISTS LIVE ON THE MAINLAND. THEY ARE MAINLY FARMERS AND OWN SMALL HERDS, WHICH OFTEN FEED ON CROP RESIDUES AND AGRICULTURAL BY-PRODUCTS

NEAR LIWA, CHAD

AGROPASTORALISTS TEND TO SELECT BREEDS ACCORDING TO THEIR SPECIFIC NEEDS, BUT THE PROCESS IS COMPLEX AND DYNAMIC

NEAR SELEYA VILLAGE (N'GUIGMI), THE NIGER

KOURI CATTLE ARE A UNIQUE BREED WELL ADAPTED TO THE SEMI-AQUATIC ENVIRONMENT OF THE LAKE

THE ANIMALS

The modifications of the natural environment, through desertification and fluctuations in the water levels of the lake, have had a tremendous impact on the farmers and herders of the Lake Chad Basin. These modifications have, quite naturally, led to changes in the way that the lake dwellers live their lives and use their animals.

CATTLE

Kouri cattle

The environmental and climatic conditions of the Lake Chad Basin are not well suited to an extensive pastoral system based on the Sahelian zebu, but pastoral production can rely on Kouri cattle, a unique breed adapted to these conditions. Also known by a variety of local names (Kuburi, white cattle of the lake, Buduma, Bahari, Baré, Borri and Dongolé), the Kouri is one of Africa's most ancient breeds and is perfectly adapted to its semi-aquatic habitat. However, changes in the landscape and in the rearing practices of local herders have led to an increase in cross-breeding between Kouri cattle and local breeds of zebu, such as the Arab and the M'Bororo zebu.

The Kouri belongs to the species *Bos taurus* and is a member of the cattle group that has long horns but no hump. Its natural habitat is the islands and shores of Lake Chad. It is characterized by its large size – from 140 to 150 cm high at the withers and with a thoracic circumference of 170 to 190 cm – and by the striking white colour of its coat. Its head is long, wide and thick, and its ears are medium-sized, but wide and set horizontally.

The Kouri has a massive build with a well-developed bone structure. Sexual dimorphism is very pronounced in this breed, most notably in the horns. These are large, white and tipped with black, lyre-shaped and carried high above the head, or wide and crescent-shaped. Near the base, the horn is hypertrophied and porous. Here, it can measure as much as 80 to 100 cm in circumference. On the islands, there is more variety in the shape of the horns, the

NEAR N'GUIGMI, THE NIGER

CHANGES IN THE ENVIRONMENT AND IN REARING PRACTICES HAVE LED TO AN INCREASE IN CROSS-BREEDING BETWEEN THE KOURI AND THE ZEBU

onion-shaped ones being the most spectacular. Contrary to popular belief, the horns of the Kouri do not help the animal to keep its head afloat while it swims between the islands. In fact, the cattle keep their horns out of the water as they swim and, because of their cumbersome weight and shape, they are poor swimmers. Animals with well-developed horns are believed to have a shorter lifespan. By the same token, cows with short horns are believed to be better milkers.

Kouri cows have a remarkable reproductive capacity, given their habitat. They first calve at around 36 months of age, with an average interval of 16 months between each subsequent birth. Given that the average lifespan for this breed is 12 years, a cow can easily produce between six and eight calves during her lifetime – a figure that underscores not just the ability of this breed to make the best advantage of an extremely harsh and difficult environment, but also the extent of the work and knowledge invested in the Kouri by local herders.

NEAR SELEYA VILLAGE (N'GUIGMI), THE NIGER

THE KOURI HAS A REMARKABLE REPRODUCTIVE CAPACITY

At birth, a male calf will weigh around 25 kg and a female 22 kg. Growth continues until the age of five years, when an adult male will weigh between 400 and 700 kg and a female between 350 and 400 kg. Growth rates vary according to environmental conditions but, in traditional surroundings, can be as much as 450 g per day up to the age of two years. Average daily weight gains of 635 g have been observed over a period of 140 days in intensively reared Kouri cattle of an average age of three years.

Milk yields range from 4 to 6 litres daily. The lactation period varies from six to ten months, with an average annual milk production of around 1 300 litres. Natural weaning usually occurs at seven to eight months, when the mother's milk dries up. The Kouri cow is a better milker than the Arab zebu, which accounts for around 90 percent of the cattle population of Chad as a whole but which only produces between 2 and 3 litres of milk per day. In the 1960s, breeding centres at Maiduguri in Nigeria and at Matafo in Chad managed an output of 1 200 litres of milk per lactation, with a record of 2 440 litres and a lactation period of 314 days. Regrettably, these centres have since been abandoned, as a result of various events and circumstances that have shaken the region.

The most striking feature of Kouri cattle is the way in which this breed has managed to survive and evolve and be so successful, despite living in a particularly difficult habitat, with problems including the presence of the islands, the floating vegetation and a high level of parasites (such as tsetse fly). That this has happened is due, in part, to the skills of local herders, who, down the years, have learned to make the utmost of the characteristics and aptitudes of this breed. As far as anyone is aware, Kouri cattle do not exist anywhere else in the world. It would be interesting to learn why this particular breed has been able to establish itself so successfully in the region, when other races, especially the zebu, have found it much more difficult.

Defining Kouri cattle: the great debate

The study of this breed, which is found only in Chad and around the lake, is a fascinating one – but not everyone agrees on the animals' make-up. The Kouri is striking for the unusual shape of its horns and for the fact that it thrives in such a difficult habitat, producing good quantities of milk in spite of the constraints. The Kouri is undeniably a taurine because it has no hump and it possesses the Y chromosome common to all *Bos taurus*. As far as the herders of the region are concerned, it also has the gait and bearing of a taurine, rather than that of a zebu. However, researchers say that the breed's autosomal markers suggest that the Kouri is more closely related to the zebu than to the taurines.

In Africa, the concept of breed is a fluid one. A breed is seen as a grouping of animals that satisfies the needs of a group of herders, who identify themselves in relation to this particular animal. A breed is not a fixed entity, to be managed according to a particular standard or to any stud book. In its classic form, the Kouri is white, with lyre- or crescent-shaped horns that are thick and bulging. However, herders also readily accept cattle with brown coats, since parent animals with white coats can produce descendants with different coat colours.

Researchers use different criteria to characterize this breed. A study using 14 microsatellite markers to examine two populations of Kouri – one of which was typical and presumed to be pure, and the other of which had some coloured components and was presumed to be mixed – showed that the variability in the number of alleles was lower in the cattle thought to be of mixed breed than it was in those deemed to be pure. If homogeneity is a criterion for defining a breed, then it would seem that the herders' vision is the correct one.

This brief sketch serves to show that only the people who live with – and off – a breed can really be in a position to define it. What is needed is an understanding of their objectives so that they can be helped to get the best out of the breed in the given circumstances. That is the type of assistance that African herders really require from researchers.

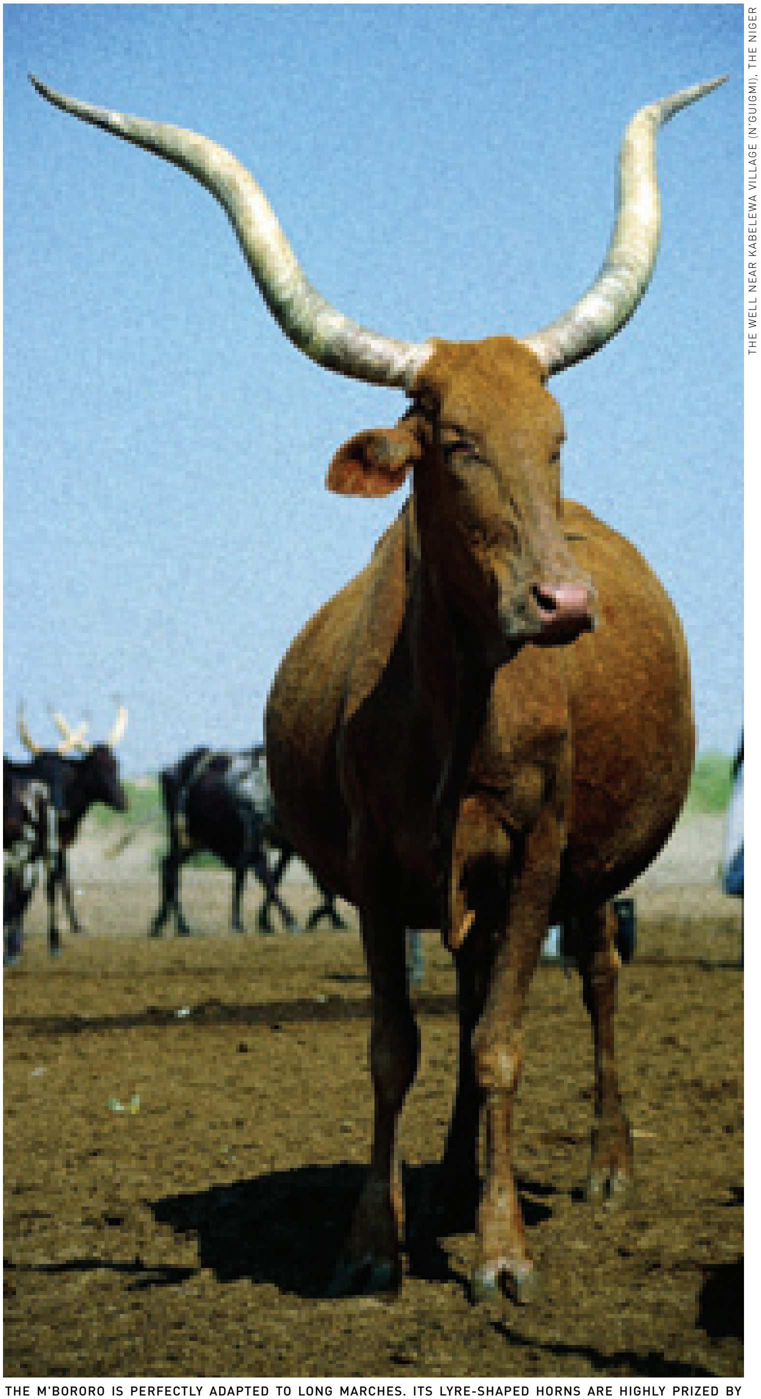
NEAR SELEYA VILLAGE (N'GUIGMI), THE NIGER

M'Bororo cattle

The M'Bororo zebu is only present in the region on a temporary basis, because of transhumance, and is found mainly in the central-western and southwestern regions of Chad. This animal – whose local names include Bororo, red Peul zebu, red Fulani, Djafoun, Rahadji, Fellata and Foulata – is finely built but very large, measuring between 140 and 150 cm at the withers. It is perfectly adapted to long marches, and therefore to transhumant pastoral systems. The dewlap hangs low and the horns are carried high, in a lyre shape, reaching between 0.8 and 1.2 m in length. The skin is a uniform red colour. At birth, both male and female calves weigh between 15 and 20 kg and, under natural conditions, the adult weight ranges from 400 to 500 kg for males and 350 to 450 kg for females. Weights vary widely according to the seasons and to the amount and quality of fodder available.

The M'Bororo zebu is a hardy breed that adapts well to different climatic conditions. In Chad, it can be found in the hot dry regions as well as in the wet regions with trypanosomiasis. The animal is the major capital resource of many herders in the region. M'Bororo cattle have a high value as a form of capital accumulation. Taking mortality into account, and usage to supply household needs, these herds have an annual capital growth of between 3 and 5 percent. This is comparable to the interest rate paid on an average bank account and, in the absence of any reliable banking system, is a more than acceptable return.

M'Bororo cows do not have a very high reproductive capacity or a high milk yield. Instead, these herds form part of a complex economic system that also involves sedentary farmers and that is not easy to quantify. On fields left fallow, the cattle supply dung, which is needed for the subsequent



THE WELL NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

THE M'BORORO IS PERFECTLY ADAPTED TO LONG MARCHES. ITS LYRE-SHAPED HORNS ARE HIGHLY PRIZED BY THEIR OWNERS year's crop. They feed on crop residues, such as straw and bran, and also play a role in a social context, bestowing status on their owners and supplying meat for special occasions, a modest amount of milk on a daily basis, and hides to make tents.

Fulani cattle

The Fulani zebu, also known locally as the Fulbe, Peul, white Fulani and Akou, is found in the Mayo–Kebby region to the west of the River Logone, where it was introduced in 1915 by the Peul, who had emigrated from Cameroon. Today, the breed is reared extensively by sedentary and semi-nomadic Peul, especially on the outer edges of Chad. A white coat is the dominant characteristic of this zebu. Its horns are lyre-, cup- or crescent-shaped. The adult male has an average height of between 125 and 140 cm at the withers.

The Fulani is closely related to the M'Bororo zebu. It has the same easy speed of animals accustomed to covering long distances and a very fine coat. However, its hump is better developed and is often lopsided, especially in the female. Its rump is more rounded and well developed, making this zebu particularly sought after by herders who are rearing cattle for meat. One interesting trend, which merits further attention, is the increasing tendency for herders to abandon the M'Bororo in favour of the Fulani breed as they concentrate more on meat production.

Arab cattle

The Arab zebu – whose local names include Choa, Shewa and Wadara – is not widely found in the lake region. Traditionally, this breed can be found between 11º and 13ºN in the Sahelian–Saharan and Sahelian–Sudanian zones, although there is an increasing tendency for populations to spread further south.

NEAR DOUTHY VILLAGE (DAMASSAK), NIGERIA

ZEBU ARE A MAJOR CAPITAL RESOURCE FOR HERDERS

Average to small in size, the Arab zebu has a straight nose, a wide muzzle and a squat frame that is well fleshed. The hump is pronounced in the male, much less so in the female, and the limbs are short but fine. The horns are generally short and point outwards. The coat is usually dark red or dark brown, although some animals are black and white or red and white in colour. This breed has a sound capital value since it fetches a good price once butchered.

Kilara cattle

The Kilara zebu is generally considered to be a different-coloured variety of the Arab zebu, although no studies have been carried out on its provenance and characteristics. To the Kilara should be added the variety known as Wadara by the Arabs of Chari–Baguirmi, in central–western Chad. By rights, the term "breed" rather than "variety" should be used to describe these zebu cattle, which are linked to a region or an ethnic group. However, in the absence of any conclusive studies on the animals' identification and traits, the usual term has been adopted, although this does not mean that they might not, in fact, be breeds.

Toupouri cattle

This breed, whose local names include dwarf Logone cattle and Massa cattle, is the smallest found in Chad. Its height ranges from 110 to 120 cm at the withers for animals aged four years and over. Its weight varies between 100 and 150 kg. Its main quality is its resistance to trypanosomiasis, which is the major reason why it has acclimatized so well to its habitat. The breed is becoming increasingly dominant in areas where the Arab zebu is traditionally found. However, pure breeds have become rare, which means that this is an endangered breed.

THE WELL NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

SMALL RUMINANTS REPRESENT A FLEXIBLE, MINIMAL CAPITAL INVESTMENT AS WELL AS PROVIDING A SUPPLY OF FRESH MEAT

SMALL RUMINANTS

Sheep and goats are hardly ever reared on their own in the region, but are almost always mixed in with herds of cattle, or even camels. It is not easy to define which breeds are raised by which pastoralists because this often depends on the availability of animals. There are three types of small ruminant pastoralists in the areas around Lake Chad.

- **Agropastoralists who are comfortably off and who also own cattle and horses.** These are mainly Arabs from the Oulad Issé ethnic group. Their flocks consist mainly of goats and number no more than 20 animals, with at least one horse, which indicates the social status of the owner. There are few sheep in the flocks, since lamb and mutton are only used on special festive and religious occasions. More than 75 percent of flocks consist only of goats. Most of them do not even have a male for reproductive purposes, since the pastoralists do not select and breed their animals but rather keep and use them with very little investment.
- **Agropastoralists with more modest revenues.** These people have fewer cattle, and their sheep and goat flocks represent a more significant investment. The people grow maize during the rainy season, using the residues to fatten their animals. They sell milk and butter and will generally send five sheep or goats to market in any one year. These are the region's real breeders of small ruminants, which represent a significant source of revenue. The flocks, together with breeding males, are kept collectively.
- **Lakeshore dwellers who grow maize and millet and keep small flocks, mainly of goats, on a casual basis.** These are users of small ruminants, rather than breeders in the strict sense. Because these people have no facilities for keeping food fresh, having a small flock of animals is the only way of ensuring a supply of fresh meat.

Arab sheep

The Arab sheep – whose local names include black Moor and long-haired Moorish sheep – is a large animal, the male of which stands 80 cm high and the female 70 cm. The coat is black and fawn in colour and the hair is generally long. The horns are smaller in the females. Their ears are often pendulous and floppy rather than upright. This breed produces excellent meat and fattens easily on crop by-products. Their meat is used for feasts such as *Tabaski*.

Peul sheep

The Peul sheep, also called the Bororo sheep, can be found during transhumance migrations and is the largest of the sheep breeds in Chad. The male has an average height of 85 cm, while the female generally reaches 80 cm. The distinguishing feature of the Ouadah variety is its two-tone coat, which is black or brown in front and white behind, with the two colours meeting halfway along the body. The Waïla variety differs in having a coat that is uniformly white. The Peul breed is short-haired and has long, pendulous ears. A high percentage of the females have horns. Dewlaps are rare, but long – up to 15 cm. The nose is straight, strongly hooked in the case of the male, while the tail is relatively thin and ends at the hocks.

Kababich sheep

The Kababich sheep is the same size as the Peul sheep, but its rump is low, ending in a tail that is thicker near the base, where it may have a circumference of up to 30 cm. The tail is also very long, always extending below the hocks and sometimes reaching the ground. The distinguishing trait of this breed is its fawn coat, although it is sometimes fawn and white. Local names include Kababish and Sudan desert sheep, and it is often called the Peul sheep.

Mayo–Kebby and Kirdimi sheep

The Mayo–Kebby sheep is sometimes found on the shores of Lake Chad and is very similar to the Arab sheep. It is known locally as the western sheep and as the Poulfouli, but its presence in the region is due entirely to trading.

Also coming from southern Chad is the Kirdimi sheep, the smallest of the sheep breeds found in Chad. Its local names include southern dwarf sheep, Kirdi and Djiallonké. The Kirdimi has as many varieties of coat colour as the goat breeds, the most common being all-black or black with a red belly.

Sahel goat

The lake region is dominated by the Sahel goat, whose local names include Arab goat and Sahelian goat. However, herders also make use of a variety of other breeds, depending on the location, the purpose and their ethnic group.

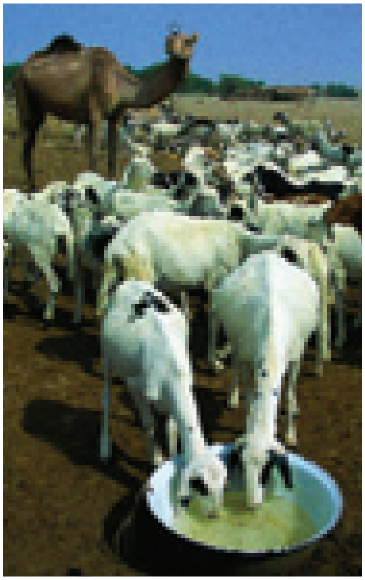
- The Moussouro or Kanem goat is small, between 45 and 55 cm in height and from 20 to 30 kg in weight.
- The nomadic Arab goat is large, between 75 and 85 cm in height and from 35 to 40 kg in weight.
- The western goat is about 69 cm in height and from 25 to 30 kg in weight.
- The Baguirmi or Massakori goat is a cross between the Sahelian breed and the southern breed.

Without a detailed study (inventory and breed characteristics), it is difficult to say how many breeds actually exist, especially when names have been given by the pastoralists without linking them to specific forms of utilization.

Kirdimi goat

The Kirdimi goat is reared by the sedentary populations of the south. Known locally as the southern dwarf goat, Kirdi and Djallonké, this goat, like the Kirdimi sheep, is found on the shores of the lake, aided, no doubt, by its well-known resistance to parasites. In the south, this goat represents the sole source of meat in the tsetse-fly (trypanosomiasis) zones although, unlike the Sahelian breed, it is not kept for milk. Around Lake Chad, where trypanosomiasis is not a major problem, there appears to be no justification for its use.

This small goat has short, coarse hair that is white, yellow, brown, or sometimes black. It varies in height from 45 to 55 cm, and its weight ranges from 15 to 25 kg. The meat is used for everyday consumption. The animal does not appear to be especially well adapted to its surroundings and people use it on an opportunistic basis rather than attempting to develop it into any particular breed [3.2].



THE WELL NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

SHEEP AND GOATS ARE GENERALLY MIXED WITH CATTLE, HORSES AND CAMELS

NEAR LOGONE-GANA VILLAGE, CHAD

THE HORSE IS A SYMBOL OF POWER AND PRIDE

PACK ANIMALS

In the case of both horses and camels, there is no particular species endemic to the Lake Chad Basin. Around the lake, during certain times of the year, more or less all the species found in the rest of Chad can also be seen, depending on migration and transhumance patterns and, in the case of horses, on an owner's desire to make a statement about his social position. Of the two, the dromedary is more extensively used as a pack animal and has been more thoroughly studied, but the horse has an undeniable social role.

Horses and ponies

The equine population of the region is very diverse and appears to be the result of random cross-breeding. However, three different morphological types can be distinguished, and these are used by various ethnic groups.

1. The Dongola horse, which is believed to exist in a relatively pure version in the Bahr-el-Ghazal region, is a light, finely built animal that weighs just 350 to 400 kg. Its coat is generally dark, with extensive


MATAFO VILLAGE (BOL), CHAD

THE RELATIONSHIP BETWEEN ANIMALS AND PASTORALISTS DEPENDS NOT ONLY ON ECONOMIC FACTORS BUT ALSO ON SOCIAL ISSUES

white patches on the extremities. It has large white socks, a broad blaze, broad white patches on the belly, hairless patches around the nose, and often different coloured eyes.

2. The Berber Arab horse is found almost everywhere. Bay is the dominant colour, with chestnut being rare in the lake region.

3. The Logone pony is very rare in the area around the lake. Traditionally, this breed, which is also known as Sara, Lakka, Kirdi, Mbaï, Kabia pony and Hoho pony, is reared on either side of the River Logone in southern Chad. It is extremely hardy and robust, with excellent powers of endurance, and is capable of bearing heavy loads. It is an animal well suited to difficult conditions although, since the end of tribal conflicts and the introduction of measures to ban traditional hunting, its use has been much reduced. This has almost certainly led to it becoming a species in danger of extinction. More information is required in order to establish any effective conservation programme.

The disappearing Logone pony

The Logone pony was once a familiar sight in wide tracts of Chad. At the beginning of the twentieth century there were some 40 000 examples of this breed in the country. The ponies were found between the lower reaches of the Tanjile, an affluent of the Logone River from which the animal takes its name, and the Kabia, which flows into the Fianga. The raising of this breed was essential to a whole range of ethnic groups, including the Marba, Kolon, Nancere, Musey, Lele, Mesme and Monogoy tribes.

For a long time, the Logone pony was an integral part of daily life in a wide variety of social settings. It was used as a cavalry horse, as a packhorse, for transport and for reasons of social prestige. However, the end of tribal conflicts, together with a greater use of cattle as draught animals, the banning of traditional hunting, profound social changes and the exclusion of the pony from dowry settlements, all led to a decline in the fortunes – and hence the numbers – of this hardy local breed. Today, just a few hundred of the ponies remain. Sentiment aside, the disappearance of the Logone pony from the Lake Chad Basin – a genuine prospect given the dramatic fall in numbers – represents a major loss to the genetic heritage of the region.

Donkeys

Only one breed of donkey is found in Chad, but it is relatively homogeneous. It is a short, hollow-backed animal of small stature, standing between 90 and 110 cm at the withers, and is mainly found in the Sahel. Its coat is grey, with a cross-shaped black stripe on the back. Over two million donkeys are estimated to exist in the four riparian countries, mainly owned by small farmers and pastoralists. The animals are rustic and can feed on poor grassland, and they are well adapted to rough tracks.

Very few studies have been carried out on this animal, which is widely used for transport and especially for carrying water. Unlike horses and camels, donkeys are pack animals with no status, and it is quite common to see women riding them.

NEAR BOL, CHAD

DONKEYS ARE THE CHEAPEST MEANS OF TRANSPORTATION

THE WELL NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

FOR CENTURIES, DROMEDARIES HAVE BEEN USED FOR TRANSPORTING GOODS ACROSS THE DESERT. THEY ARE ALSO GOOD MILK PRODUCERS

Dromedaries

The first studies on the dromedaries found in Chad were carried out by the veterinary services of the then French colony at the beginning of the twentieth century. These animals are often used by nomads for transporting merchandise and camping materials, especially in Chad's Sahelian zone. They also produce milk. Three breeds of dromedary can be distinguished.

1. The Kanem dromedary is the smallest of all the breeds in the region. The hair of the coat is short and the most common colours are light fawn or white mixed with grey. This animal has the long neck found in camels used for riding, and it is accustomed to both *had* (*Cornulaca monocantha*) and saltwater. This type most closely resembles the dromedaries used by the Tuaregs of North Africa. Its habitat is the Kanem region of northwestern Chad.

2. The Mahamid or Arab dromedary is a pack breed, large in stature, measuring between 1.85 and 2 m at the withers, and is found in eastern and central Chad. Its coat is whitish grey to fawn in colour. The hair is quite long and slightly wavy. This dromedary is bred by the nomadic Arab tribes, the Batha and Ouaddaï, from the Sahelian zones.

3. The Gorane dromedary is reared by the Sahara's Toubou and is more accustomed than the Mahamid dromedary to harsh conditions, *had* and saltwater. It is a finely built animal, with a short, light head, and is excellent for riding over the rocky terrain, to which it is well accustomed.

Village dairy production around Lake Chad

The transformation of milk into other dairy products is carried out entirely by women, mainly during the rainy season, when milk fetches a lower price of 125 CFAF * per litre or less [3.3]. The three main dairy products are milk, curds and melted butter. Fresh milk is usually consumed in the morning, generally with added sugar and accompanied by bread or cake. It can also be used to prepare dishes. Curds, which are separated out during churning, are mainly used in the preparation of cereal-based dishes, to which millet or rice flour and sugar are added. These are the main dishes eaten by Muslims during Ramadan. Curds may also be used to accompany the traditional millet porridge. Eaten on their own, curds – or *rayib* – are consumed with sugar, rather like yoghurt. Melted butter is used widely in cooking, with two or three tablespoonsful being added to each dish. The people of the Lake Chad region, who are mainly Muslim, consume large quantities of fresh milk and curds and are also the major consumers of fresh camel's milk. Turning milk into cheese is a traditional and inexpensive method of conserving milk, which would otherwise be difficult to market. *Tchoukou*-type cheese is a dry cheese to which commercial rennet is added, although this can be replaced by locally available vegetable coagulants. The cheese is made into round or rectangular forms, each weighing around 100 g, which are dried for 24 to 48 hours in the sun. It takes 1.5 litres of milk to make 100 g of cheese. Each form sells at 250 CFAF, which is equivalent to 166 CFAF per litre of milk – an increase on the seasonal average. Cheddar-type cheese is pressed and warmed, and keeps well in village conditions, although making it requires a greater initial investment, since it requires a small dairy. It takes 10 litres of milk to make 1 kg of this type of cheese [3.3].

NEAR KANIRAM VILLAGE (MALAM FATORI), NIGERIA

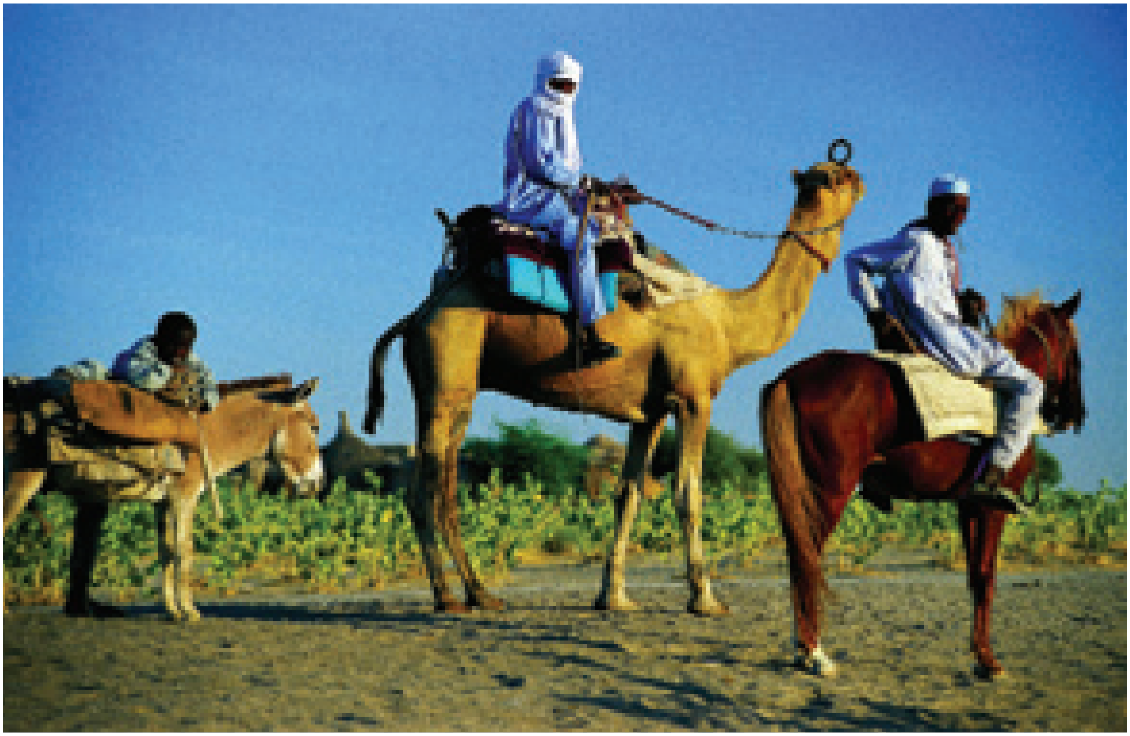
PEUL WOMEN WITH MILK ON THEIR WAY TO THE MARKET

* 1 000 CFAF are equivalent to 1,52 euros.

N'GORTOGOL (N'GUIGMI), THE NIGER

BREEDS BECOME ESTABLISHED AND WIDESPREAD NOT NECESSARILY BECAUSE OF THEIR PRODUCTION LEVELS BUT AS A CONSEQUENCE OF THE DYNAMICS OF THEIR HERDERS. M'BORORO CATTLE, FOR EXAMPLE, ARE WIDESPREAD AMONG WODAABE NOMADS, DESPITE THEIR LOW MILK YIELD

NEAR BOL, CHAD



DIFFERENT ANIMALS SUIT DIFFERENT TRANSPORT NEEDS

BREEDING PRACTICES AND OBJECTIVES

The types of animal that farmers and herders in the region choose to rear depend largely on the purposes for which they are required. Geography is certainly an important factor when it comes to the creation and maintenance of animal breeds. As different tribes moved into the region, they brought their livestock with them. These animals have often taken both the names of the areas from which they originated and those of the ethnic groups that introduced them. It is remarkable to see how the Kouri or Buduma herders have managed to develop breeds so superbly adapted to their habitat, and the cattle have generally taken the name of the tribes. Heavily built breeds are not suited to travelling long distances, so they are useful for communities who have to some extent become sedentary. At the same time, there has been no parallel creation of specific breeds of sheep or goats, although various breeds occur at random, such as the Peul sheep.

All the breeds are related to the environment and have been modified by, or have adapted to, the systems used by the farmers and herders. Factors such as whether the system was intensive or extensive, or whether it was sedentary, nomadic or based on transhumance, have had a strong influence on the development of breeds. Having said this, it is hard to say whether the existence of a certain breed has forced herders to adopt a particular management system or whether the breed has been forced to change in order to fit in with a particular environment. Only careful phylogenetic research will provide the answer.

The same question mark hangs over the issue of determining the aptitudes of certain races. In Africa, this is often not so easy, unlike the situation in Europe, where specific traits, such as good milk or meat production in cattle, are clearly defined. However, that should not lead immediately to the assumption that the majority of cattle breeds in Africa are of mixed origin.

In fact, the specific traits displayed by a breed are already an indication that human beings have intervened with a genetic improvement programme, whether in a systematic, organized fashion or in a more empirical way.

Birth weight is one example of a selection criterion. In the case of animal growth performance, the selection criteria and the objective are the same and, for reproduction purposes, the herder will use males with the best growth performance given the feed resources available. He therefore combines his objectives with the environmental and herd situation.

The definition of a selection criterion is far more complicated when direct measures of the animal in question cannot be taken, or when the selection is directed at animals from another generation. Scientists carry out sophisticated selection programmes, using ascendants, descendants, collaterals and multiple selections. The breeder who wants to improve his milk production will choose a bull whose mother is a good milker. He will check the descendants and then give the go ahead for new mating. The desired objective dictates the choice of criteria and progressively shapes the species.

NEAR BOL, CHAD

MOST BREEDS REPRESENT THE BEST RESPONSE TO THE DEMANDS OF HERDERS IN A GIVEN ENVIRONMENT. THE SELECTION CRITERION OF THE KOURI BREED IS ITS ADAPTATION TO THE ISLAND ECOSYSTEM

BREEDS IN EVOLUTION

It could be argued that the ancestors of African livestock breeders did not have the advantage of the selection methods that we use today. However, it would be wrong to assume that they were unable to identify those selection criteria that responded to their objectives. Around Lake Chad there is living proof that these African herders were able to create a cattle breed that was perfectly adapted to both the particular conditions and the needs of the people who lived there. Meat and milk were equally required, in an environment that was especially difficult. With no sophisticated knowledge of genetics, the local herders almost instinctively responded to the challenge by creating the Kouri breed. The physiognomy of this breed is therefore based not on the characteristics found in literature, such as large horns, white coat and large size, but on the adaptation of the breed to the island environment. As a result, the breed represents a combination of genes best suited to the environment: a breed in evolution.

By the same token, it should be remembered that, in an African context, selection criteria are more complex. In Africa, it is not simply a question of economics, of developing breeds that produce more milk or more meat. Other factors need to be taken into consideration, such as the capacity of an animal to thrive on poor pastures and resist certain diseases, make the most of certain difficult habitats, retain a capital value for the household or a dowry, or be suitable for use in social and religious rites.

Perhaps we should ask ourselves how effective our own methods would be in responding to demands such as these.These aspects are often neglected because there is a lack of information, but these selection criteria are certainly behind the creation of many breeds.

BREEDING AND SOCIAL STRUCTURES

For most of us, a breed consists of a grouping of animals that we recognize as belonging to that breed. The principle of belonging may be based on inherited phenotypical criteria, such as the size of an animal's horns, the colour of the coat or the type of fleece, or it may be based on the animal's performance. The diversity of breeds existing at any one moment will depend on the constraints encountered in rearing them. Moreover, this diversity has increased over time, because the weight of history has forced each animal population to evolve according to the social relationships developing among peoples and to the environment. This is what happened with the widely distributed Peul zebu. Therefore, the existence of certain "varieties" cannot be called into question.

However, while there may be homogeneity when it comes to the criteria of belonging, different breeds of animals may be heterogeneous when it comes to other criteria. That, after all, is what makes it possible to improve average production and for breeds to evolve in response to changes in environmental or socio-economic conditions. Conserving biodiversity is as much about preserving the different breeds as it is about preserving diversity within each breed.

GENE BIODIVERSITY

In this context, cross-breeding does not undermine biodiversity unless the relative importance of one of the breeds declines over the years, and unless the genes present in that breed do not occur in other breeds. On the contrary, in certain cases, cross-breeding can actually preserve genes, either because a new breed has been created, or because the maintenance of the parent breeds, as a source of the cross-breeds, has an economic benefit.

It is therefore possible to think of livestock breeds as socially created phenomena that have been constructed according to a range of constraints imposed by the rearing system together with a range of objectives based on the intended use of the animal. Breeds that have become firmly established and geographically widespread do not owe their success simply to biological factors, such as high production levels and the ability to adapt to the most common livestock-rearing methods. They also owe it to the dynamics of the particular human group, be it a collective of livestock rearers or a private firm that has organized the selection of the animals, mastered their genetic potential, taken care of the promotion and sale of the reproductive stock and been responsible for sharing out the profits among the various participants. All of this strongly suggests that it should be possible to find just as many good qualities in other breeds as in the so-called "improved races", provided that a social grouping is prepared to take on the long and arduous job of organizing all that this entails.

However, breeds evolve naturally under the pressure of change, both from rearing systems and production objectives. This evolution can be achieved either by the grading of reproductive stock within the breed (selection) or by introducing reproductive stock from outside (cross-breeding). In practice, most breeds represent the best response by an animal population to the demands of herders in a given environment.

This line of reasoning leads to the logical conclusion that there is no such thing as a pure breed. No breed is "pure" in the sense that it has not been mixed.

BREEDS AND THE MARKET

It is important to look at breeds in an economic context. No livestock farmer will invest time and money in developing a breed unless it has something particular to offer, either directly, e.g. by providing meat or milk for the household, or indirectly, e.g. by producing items that fetch a high price at market. In both cases, humans and animals are sharing a common space and the resources of the land. Cattle breeds that are adapted to an extensive pastoral system are neglected in favour of crop growing when populations increase demands or when this kind of activity is more profitable. The system has to be flexible; the farmer may abandon certain breeds of domestic animal and concentrate on developing other breeds that are better adapted to a new set of circumstances. He may also modify a previously used breed in order to respond to changing demands in the marketplace. The examples that have been given of animal populations around Lake Chad show how this is happening.

The conservation of a breed in a static form can only happen in a relatively closed environment, where the product or the service is exclusively aimed at domestic consumption. In any case, animals always evolve in response to the needs of those who keep them. What is needed is a system that allows the animal to develop on the understanding that it is the animal adapting to human beings. It is nonsensical to think that this process can be halted, and much better to try to manage it and minimize the losses. Conservation initiatives will only work if they are undertaken within a well-defined economic context in which the farmer has a good chance of making a profit, and in circumstances that are socially acceptable. The pros and cons need to be carefully weighed up before embarking on such a process.

THE WELL NEAR KABELEWA VILLAGE, THE NIGER

CONSERVATION INITIATIVES WILL ONLY WORK IF THE PASTORALIST CAN MAKE A PROFIT AND IF CIRCUMSTANCES ARE SOCIALLY ACCEPTABLE

CONCLUSIONS

It seems that the primitive concept of existing species and selected breeds being invariable can be easily replaced by a much more evolutionary idea. That static and fixed notion has led to the universal adoption in most production systems of a few so-called "superior" or "improved" breeds. It has also led to the development of cross-breeding programmes and to the sale of improved reproductive stock and artificial insemination. But it has often failed in environments that are either unsuited to these breeds or that are in a state of evolution. If one focuses not on the animal but on the environment, which evolves in response to human actions, then it is possible to view the animal as a grouping of genes that are organized to take the best advantage of a temporary situation. The only problem lies in managing the time span. The very notion of "breed" is inextricably linked with the environment.

As far as the evolution of an animal is concerned, a species or a breed develops when it is isolated. Most frequently, this isolation is geographic, although it may sometimes be behavioural. This is confirmed by the observations on animal breeds living around Lake Chad.

It therefore seems paradoxical that, in many countries, a clear distinction and a sharp separation are made between livestock breeds and the environment. This situation is the fruit of history, but it cannot be supported any longer. Both domestic and wild animals have an impact on the environment and on human ability to manage it. It is the common evolution of animals, environment and human beings that must be always considered.

Notes from a journey

Peul/Buduma agreement

December 10, 2002
Kalgama island (Bol), Chad

We leave Bol early in the morning and reach the island of Kalgama after more than four hours of navigation, hindered by a myriad of floating islands; driven by a northeast wind, they force us to change course over and over again. We are going to meet Moussa Bukar, a Peul family head (*Chef de famille*), a herdsman and a nomad: 45 years old, two wives, eight children. We are accompanied by Idriss Issaka, a splendid figure of a man, a breeding extensionist (*Technicien de l'élevage*) at the service of the herders. He tells us the origin of the name Kalgama: it means "Grain island" because as recently as 80 years ago the whole island was cultivated. Now the drought has forced the last of the farmers to abandon these lands; the nomads take advantage of it, driven by the same drought to find new territories. The problem, however, is not that simple: the Peul herds are not comfortable in water. While they are hardy walkers, the Peul zebus swim with some difficulty and the islands can only be reached by swimming. This is where the Buduma poeple come in, expert as they are in the customary transhumance of their Kouri herds from island to island. The agreement provides for "technical assistance" until the new grazing lands are reached.

Moussa Bukar receives us seated with great dignity on the big *natta* woven of dum palm leaves, in the light shade of acacia trees. After the usual polite remarks, there can be but one topic of conversation: the drought, which every year modifies the habits and the itineraries of the nomads. It has been 15 years since they have had to go so deeply among the floating islands, so far from solid ground.

On the islands the pasture is good, but the transfer from one to the other is costly: one must rent pirogues for the members of the family and the household goods, while for the herd, which must swim across, there is always the risk that some of the animals will disappear in the dark waters of the lake. For this task the Peul turn to the more experienced Buduma for help. Today, too, they are ready. We are going to give them concrete assistance by putting at their disposal our large motorized pirogue. In this way we will be able to document the whole enterprise: the transfer from the island of Kalgama to the island of Kafia (which takes its name from a plant that colonized it, the *Maerua crassifolia*, traditionally used as a remedy for pulmonary diseases).

The go ahead for the operation is given. While the females, all of them, from five-year-olds up, work rapidly loading donkeys and zebus with the household goods, the men gather the remaining animals, about 30. In half an hour or so all is ready, and no trace is left of the camp. We are on our way. Soon we arrive at the shore. All the belongings are transferred on to the big pirogue, along with the smaller animals, a few calves and an old donkey loaded and tied like a sack of potatoes. Then it is the turn of the people, especially the young women with their youngest tied on their shoulders. In a short while, with three or four trips, they will all be on the new island. Now it is time to cross with the herd: Moussa Bukar gets into a small canoe with his oldest son, while the other Peul herdsmen drive the reluctant animals into the water. Four Buduma will go alongside the animals, prodding the laggards, guiding the leaders in the right direction. Suddenly there is a great churning of water, a tangling of long horns, a roaring of bellowing animals and goading shouts, a spectacular tumult that we follow with great anxiety: all efforts and hopes are aimed at keeping the animals under control. After about ten minutes, which seem endless, the bulk of the herd arrives on the new land. They stop, disoriented, gasping for breath. Then the horses arrive, a few at a time and, last of all, the donkeys. Some of the exhausted animals are unable to make it ashore. The Peul jump into the water and drag them forcibly on to the land. Now it is all over; silence descends and dissolves the tension. The crossing was quite a feat, but not a single animal was lost.

Chef de famille Moussa Bukar is drenched from head to toe after having floundered in the shallow water near the shore to help the horses, donkeys, cows and calves to reach land.


KALGAMA ISLAND (BOL), CHAD

BUDUMA PEOPLE HELP PEUL HERDERS REACH THE ISLANDS

KALGAMA ISLAND (BOL), CHAD

ABOVE AND BELOW: ZEBU CATTLE ARE HARDY WALKERS BUT SWIM WITH SOME DIFFICULTY. THE JOURNEY IS NOT SO EASY

KALGAMA ISLAND (BOL), CHAD

Notes from a journey

KALGAMA ISLAND (BOL), CHAD

TRANSHUMANCE IS GENERALLY REGULATED BY PERSONAL AGREEMENT RATHER THAN BY ANY CODE OF LEGISLATION

KALGAMA ISLAND (BOL), CHAD

NOMADS' BELONGINGS ARE VERY BASIC, BECAUSE THEY MUST BE PACKED OR UNPACKED IN A FEW MINUTES

KALGAMA ISLAND (BOL), CHAD

DECISIONS ON HOW, WHERE AND WHEN TO MOVE ARE TAKEN BY THE *CHEF DE FAMILLE*

KALGAMA ISLAND (BOL), CHAD

WOMEN ARE RESPONSIBLE FOR THE WHOLE HOUSEHOLD

Laughing, he tells us, “I was about to die with my eyes full of water . . .”, and he seems unwittingly to paraphrase another more famous nomad, Dayak, who wrote, “I was born with my eyes full of sand . . .”. Certainly, from the sands of the desert to the waters of the lake is a long distance to cover, mental as well as physical.

Although soaking wet and out of breath like his animals, Moussa Bukar appears to be in high spirits: no losses and a rich new pasture for his herd. We say goodbye with warm handshakes, while all the women, from five-year-olds up, have already set up the new camp: yellow rows of calabashes are neatly piled up on their trestles and the mortars are already at work, with their usual muted and regular rhythm. Tonight, too, there will be curdled milk and millet to eat.

On the way back, in the reddish light of the sunset, we encounter another small group made up of a pirogue with two Peul herdsmen on board and three Buduma in the water, who are driving four recalcitrant zebus. The Buduma swim close to the four animals, prodding them with shouts and blows. It does not seem to be an easy job. Idriss Issaka explains that they are going to Bol for the following morning’s market. He adds that the Buduma are usually willing to take the Peul animals across, in those rare instances when the nomads, out of need, decide to sell some of their zebus. To get to the market, they often have to cross five or six islands, with as many stretches of water to swim across. The distance between islands can be as much as a kilometre. For such a service the Buduma usually charge 5 000 CFAF *, (but with two or three trips they might earn as much as a teacher).

By now we are navigating in complete darkness. The moonless night has brought to a close a difficult day full of risks, with Peul and Buduma as protagonists in the arduous but somehow harmonious arrangement between nature and the calm and resolute human will to survive.

* 1 000 CFAF are equivalent to 1,52 euros.

CHAPTER 4

KREB

"If the grasshopper harvests,
the ant will pay
the debt."

[African proverb]

INTRODUCTION

HISTORY

BENEFITS

HARVESTING AND PROCESSING

DESCRIPTION OF GRASS SPECIES

THE NEED FOR MORE RESEARCH

THE FUTURE

KREB

THE NIGER PHOTO: COURTESY OF N.SCHAREIKA

KREB HAS BEEN THE STAPLE FOOD OF NOMADS AND THEIR HERDS FOR CENTURIES

4

INTRODUCTION

Kreb is the name given to the mixtures of grains from a dozen or more of the wild grass species that grow in the semi-arid environments of the Lake Chad Basin and the whole of sub-Saharan Africa; these are harvested to produce food for humans and feed for animals. The mixture may vary from place to place and from year to year, according to the species of grasses that are available.

Kreb used to be the traditional cereal source for pastoralists, who would protect grasslands to ensure seed production, harvest the grains and then allow their animals to graze the grasslands. In this way, agriculture and pastoralism were combined in a productive system that was well adapted to the fragile ecosystem of the area.

However, the immense potential of *kreb* has been sorely neglected in recent years as populations have been encouraged to discard it in favour of cultivated crops and specialized agricultural and pastoral production. There is now a real danger that this once-prized foodstuff will be lost forever as oral traditions of how to harvest and prepare it die out. There are already signs that the use of *kreb* is becoming more and more sporadic.

HISTORY

A NOBLE PAST

Derisively dismissed in recent times as "famine food", *kreb* has, in fact, been a staple food for centuries in much of the Sahel and other parts of sub-Saharan Africa. It was traditionally harvested from natural grasslands by nomadic herders for their own consumption and was highly relished for its culinary merits [4.1] [4.2]. There is evidence of traditional pastoral grassland management systems that promoted the production of *kreb* and grass. Under herding and nomadic grazing systems, chieftain elders used to forbid grazing in certain pastures in order to allow the plants to seed. If camels were found grazing in the forbidden area, the chief pastoralist could demand a camel in compensation. If any goats were found in these areas, ten goats could be claimed in compensation for the loss of grain.

ERAGROSTIS TREMULA [PLATE 4]

N'DJAMENA, CHAD

KREB, A MIXTURE OF GRAINS FROM WILD GRASSES, IS STILL USED AS HUMAN FOOD

NEAR MALAM FATORI, NIGERIA

KREB IS IN DANGER OF OBLIVION BECAUSE THE NUMBER OF PEOPLE COLLECTING IT IS DIMINISHING AND THEIR TRADITIONAL KNOWLEDGE IS BEING LOST

REASONS FOR THE DEMISE OF *KREB*

With the advent of the colonial powers came prejudice and the introduction of new types of crops. As a result, the huge potential of wild grasses was largely ignored. Moreover, a combination of decreased nomadic movements and local conflicts has reduced access to available *kreb* sources in remote areas. Also, continuous grazing around villages and water points has resulted in grassland degradation, leading to the disappearance of species suitable for *kreb* collection, because wild fodder plants cannot complete their life cycle and produce seed under conditions of continuous grazing.

Also contributing to the recent decline in the use of *kreb* is the fact that nomadism itself is on the wane. In the past, the two have always gone hand in hand, but the sedentary lifestyle being adopted by an increasing number of people encourages the replacement of *kreb* collection with cropping of introduced cereals [4.3].

BALATUNGUR (BOSSO), THE NIGER

BENEFITS

A BOON TO FOOD SECURITY

Kreb is an extraordinarily versatile food source, making it a particularly valuable tool in the struggle for food security. There is no hard-and-fast rule as to what goes into *kreb*: its composition varies widely according to what is available at a particular time and in a particular region. In the Sahel, the grains of *Cenchrus biflorus* (*cram cram*, or Sahelian sandbur) are widely used [4.4]. In more humid regions, *kreb* is likely to consist of grain from between three and 15 different species, which can vary from year to year and from place to place, according to soil differences and climatic conditions.

History shows that the harvesting of *kreb* in the grasslands is one of the most sustainable and organized food production systems in the world. In the last century, a single household could harvest 1 000 kg of *kreb* per season. Similarly indisputable is the fact that the grains used in *kreb* are highly nutritious, comparing very favourably with many cultivated crops. Studies show that the percentage of protein found in these wild grasses is often higher than that found in farmed cereals, reaching levels of 17–21 percent [4.3]. The grasses are also especially rich in amino acids, which are generally lacking in sorghum and other common staples.

CENCHRUS BIFLORUS [PLATE 5]

KALGAMA ISLAND (BOL), CHAD

HARVESTING OF *KREB* IS ONE OF THE MOST SUSTAINABLE AND ORGANIZED FOOD PRODUCTION SYSTEMS IN THE SAHEL

THE NIGER

PHOTO: COURTESY OF N.SCHAREIKA

NOMADS AGREE THAT SOME AREAS SHOULD BE PROTECTED FROM GRAZING SO THAT GRASSES CAN PRODUCE SEED FOR *KREB* HARVESTING

A SAFEGUARD FOR THE ENVIRONMENT

As well as providing food and forage, the wild grasses used to make *kreb* play a significant role in protecting the environment. Perennial grasses anchor the soil, protecting it from wind erosion, and facilitate the infiltration of water, improving fertility and reducing runoff. Food security aside, there is a sound argument for returning to the practice of harvesting these wild grasses because of their potential contribution to halting desertification caused by overgrazing. *Kreb* grasses grow with no external input and form a stable and cheap barrier against desertification.

THE NIGER

PHOTO: COURTESY OF N.SCHAREIKA

KREB SPECIES ARE AN IMPORTANT GENETIC RESOURCE THAT SHOULD BE MAINTAINED. THEY ARE RESISTANT TO DROUGHT, THRIVE IN WATERLOGGED AREAS AND SALINE SOILS, ANCHOR THE SOIL AND FACILITATE INFILTRATION OF WATER


THE WELL NEAR KABELEWA VILLAGE (N'GUIGMI) THE NIGER

PASTORALISTS ARE THE CUSTODIANS OF *KREB* AND GRASSLANDS GENETIC RESOURCES

A VALUABLE GENETIC RESOURCE

The grass species used to make *kreb* are an invaluable genetic asset because their genetic make-up is closely linked to the particularly harsh conditions in which they thrive. Whereas the annual grasses harvested for *kreb* produce large quantities of grain and grow quickly during the rains, perennial grasses have a longer life cycle in order to ensure the reproduction of their species under difficult conditions. The additional solar energy used by many Sahelian grasses, classified as C4,[1] produces a good grain yield. Such wild grasses can grow and produce grain in arid situations, in the presence of grain-eating birds (such as *Quelea quelea*) or hungry insects, on poor and sandy soils, and in waterlogged environments, i.e. in circumstances that would render the cultivation of other cereals impossible [4.3].

The species used for *kreb* also have an international value as a genetic resource. Some are related to species used as food and forage crops. Therefore the genes that enable these wild grasses to resist heat, drought and disease, and to grow on shifting sands or saline soils, may be of use in the development of superior varieties of cultivated crops.

1 C4 is a type of photosynthesis, technically known as the C4 carbon fixation pathway, which is especially efficient at high temperatures and in bright sunlight

A POTENTIAL MARKET RESOURCE

Although *kreb* is mainly harvested for household consumption, a proportion is sold on local markets. While visiting various marketplaces in Chad, the authors noted that its price varies from half the price of wheat to the same or double the price of millet, or even more, depending on the time of year, the price of other cereals and the proximity of large cities (prices are much higher in markets close to large cities). In monetary terms a 100 kg sack will fetch between 15 000 and 80 000 CFAF *.

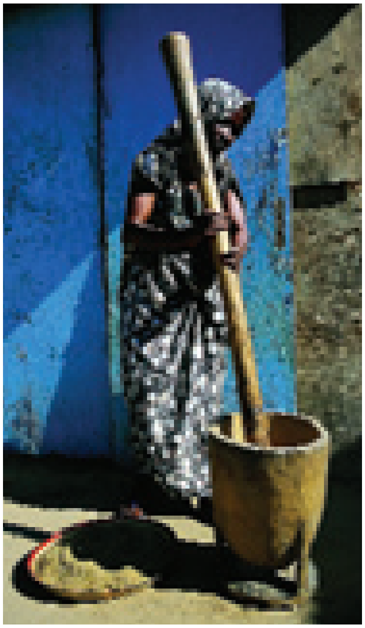
This would confirm that there is a genuine market for *kreb*, and that there is an interesting potential to develop it further: as a replacement for other cereals and as a delicacy, to be sold as a "niche" product to the peoples who use *kreb* in their traditional recipes.

HARVESTING AND PROCESSING

The gathering of wild grass seeds and their preparation as food are processes that have changed little over the centuries. In the dry season, whole families, mostly women, harvest the wild edible grains from grasses to make *kreb*. Sometimes these grains are the only nutritious cereal available. When there is plenty of choice, larger grains are favoured, but the harvest is never selective because the different grasses grow alongside each other.

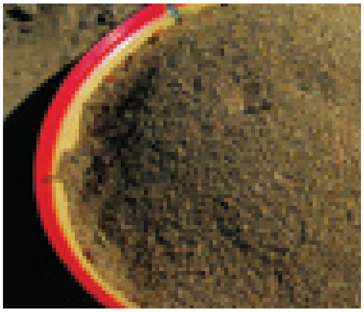
The most common device used for collecting the grain is a basket, known in Chad as a *sossal*. Conical in shape, it is made of sliced and woven dum palm leaves, with its pointed end pushed in to form a "navel" at the bottom. The wooden rim has a rope handle and the basket has a lid like a spider's web to stop the chaff and leaves from falling into the basket with the grain. When the seeds are ripe and ready to drop, the basket is swept through the grasses. As the basket fills up, the seeds are poured into a sack, which is carried by the harvester. The grain is then laid out to dry on dum palm mats before being eaten, either whole or pounded into flour, cooked or raw, depending on the type of grains forming the *kreb* [4,5].

While the grasses are still damp, they are scythed, dried, threshed and winnowed like a cultivated cereal. This leaves a stubble on which cattle or small ruminants can briefly graze. Sometimes when the seeds have already ripened and fallen, the grasses are cut or burned and the grain is swept up. This spoils the taste and allows sand and grit to become mixed with the seeds, which is a disadvantage, but still a viable option in hard times. Occasionally, in periods of severe drought, the women dig out seeds from ant hills or termite mounds, raiding the underground storehouses of these insects.

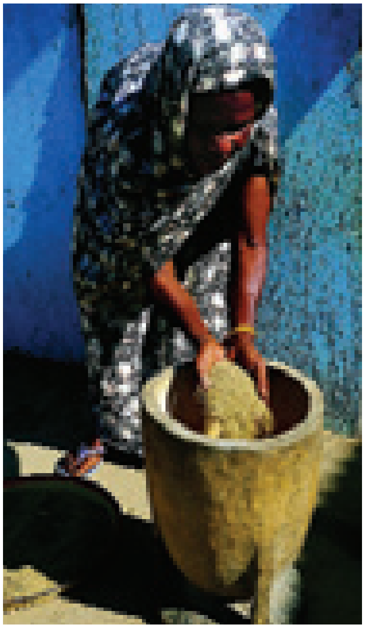


N'DJAMENA, CHAD

KREB IS MAINLY COLLECTED FOR DOMESTIC CONSUMPTION BUT IS INCREASINGLY SOLD IN MARKETS, ESPECIALLY AROUND LARGE CITIES



N'DJAMENA, CHAD



N'DJAMENA, CHAD

A SINGLE HOUSEHOLD ONCE HARVESTED 1 000 KG OF *KREB* PER SEASON

* 1 000 CFAF are equivalent to 1,52 euros.

N'DJAMENA, CHAD

Tef and fonio: two examples of small cereal domestication

by **Alessandro Bozzini** *

In the semi-arid sub-Saharan areas, two species, with physiological and morphological features similar to the species involved in *kreb* harvesting, have been domesticated. These are tef (*Eragrostis tef* (Zucc.) Trotter), which is cultivated nearly exclusively in Ethiopia, and fonio (or *acha*) (*Digitaria exilis* Stapf.), which is cultivated in the dry savannahs of West Africa (Burkina Faso, Mali, Senegal, Guinea, Togo, Benin and Nigeria). Both have very small seeds and have been domesticated and cultivated as a staple food by the local populations for millennia.

ARSI REGION, ETHIOPIA

TEF AND FONIO ARE AMONG THE OLDEST AFRICAN CEREAL CROPS

Fonio is one of the oldest African cereal crops, along with sorghum, pearl and finger millets, African rice and tef. It is also considered to be one of the world's best-tasting cereals and one of the most nutritious of all the grains, containing 8–11 percent protein, with a high content of essential amino acids (except lysine).

Fonio is cultivated in difficult soils (some 300 000 ha), and some cultivars or populations are very early: they can complete their cycle (seed to seed) in six to eight weeks. The grain is made into porridge and *cuscus*, ground and mixed with other flours to make bread and pasta, and brewed for beer. The straw is used as animal feed and mixed with clay for making bricks.

Tef most probably derives from the wild *Eragrostis pilosa* (L.) Palib., which spread from Egypt into East Africa, into the Sudan and

* Professor of Genetics

WOLLO REGION, ETHIOPIA

TEF MOST PROBABLY DERIVES FROM THE WILD *ERAGROSTIS PILOSA*. TODAY IT IS THE MOST IMPORTANT STAPLE FOOD FOR ETHIOPIANS


ARSI REGION, ETHIOPIA

TEF IS NOW CULTIVATED IN MANY PARTS OF THE WORLD AS A SOURCE OF GRAIN AND FORAGE

Ethiopia. Nowadays, tef cultivation covers about half (1.5 million ha) of the area devoted to cereals in Ethiopia and is certainly the most important staple for Ethiopians.

Tef flour makes a very particular type of bread, called *injera*, a kind of flat pancake, spongy, moist and elastic, produced after special fermentation and cooking. It contains no gluten and is therefore gaining the interest of people affected by coeliac disease (gluten intolerance). Several Ethiopian restaurants in the United States and Europe are now serving *injera*. Tef is also baked in cakes and used to prepare homemade beverages. The use of the straw mixed with clay, to make bricks for building, dates back to ancient Egypt.

The seed is white, red, brown or black and larger than the seed of its ancestral species (*E. pilosa*); the plant is also larger – a clear result of the domestication process, which includes resistance to seed shattering.

Tef grains are reported to contain 9–13 percent protein, have high digestibility and are well balanced in essential amino acids and several microelements. Therefore tef appears to be similar to wheat in food value. Recently, tef has also been cultivated in other areas (e.g. South Africa, India, the United States and Australia), both for grain and production of forage of good quality.

DIGITARIA EXILIS [PLATE 6]

DESCRIPTION OF GRASS SPECIES

This section includes short descriptions of grasses that are of special interest to scientists, particularly in the context of desertification control and biodiversity; all are found in the Lake Chad Basin. Other species collected for *kreb* in different ecological conditions include: *Eragrostis pilosa* (wild tef), *Setaria sphacelata*, *Cenchrus leptacanthus* and *C. prieurii*, *Echinochloa stagnina* and *E. colona*, *Tribulus terrestris* and *Oryza breviligulata*.

LOCAL NAMES

The grass known in Arabic as *drinn* (*Aristida pungens*) was once the foremost wild grain found in the northern Sahara [4.3]. *Panicum turgidum* (*afezu*, or *altumam* in Arabic) was a very important perennial grass adapted to very dry conditions with a rainfall as low as 250 mm per year and much collected for *kreb* production. Table 3 lists a selection of *kreb* species with their Arabic and botanical names.

It is interesting to note that local names often refer to the typical use of the plants, thereby highlighting the links between the environment, the people and the ways in which they use the plant. For example, the Peul use the following words:

- *fagg* (to collect, to put aside)
- *hudo* (herbs) refers to all grasses with the exception of cereals
- *lekki* (tree) refers to all other phanerogams
- *pagguri* refers to all grasses used for *kreb* production
- *pagguri-jaawle* (famine grass) refers to *Brachiaria* sp.
- *pagguri-gertoodè* (famine grass) refers to *Setaria sphacelata*.

More examples of the links between local names of plants and their appearance, qualities, uses, origin and biotope are given by Tourneux and Seignobos [4.6]. For example:

- *haako-ndiyam* (water vegetables) refers to *Amaranthus caudatus*
- *li'eere-leeno* (local cotton) refers to *Gossypium hirsutum punctatum*
- *sawru-gawri* (millet guardian), so called because it is not removed from millet fields, refers to *Amorphophallus aphyllus*
- *senkello-bafeere* (black-soil *Alysicarpus*) refers to a combination of *Alysicarpus* spp.
- *senkello-yoolde* (sandy-soil plant) refers to *Alysicarpus vaginalis*
- *tuppe-degol* (weed from General de Gaulle) is the Peul name for *Achantospermum hispidum,* which was introduced by animals migrating from the north after the war with General de Gaulle in the 1950s.

ALYSICARPUS VAGINALIS [PLATE 7]

CENCHRUS PRIEURII [PLATE 8]

ECHINOCHLOA STAGNINA [PLATE 9]

TABLE 3 **ARABIC AND BOTANICAL NAMES OF *KREB* SPECIES AND THEIR PREFERRED SOIL TYPES**

ARABIC NAME	TYPE OF SOIL			BOTANICAL NAME
	BLACK	CLAY	SANDY	
abu asabé (father of fingers)		X	X	*Dactyloctenium aegyptium* Wild.
abu bélilé		X		–
abu layo (father of porridge)		X	X	–
adar (pond shores)	X			*Sorghum sudanicus* (wild sorghum)
al fula (pond shores)	X			*Echinochloa pyramidalis*
am dijankga			X	*Eragrostis tremula*
am sakiné (knife mother)	X	X		*Echinochloa stagnina*
am surmo (swamp)				–
ascanit abu shock (spiny *cram cram*)		X	X	*Cenchrus catharticus*
diffré		X		*Urochloa* sp., *Echinochloa colona*
kalassindra		X		*Eleusine indica*
kamdallah		X		*Brachiaria regularis*
timan (twins)		X		*Panicum turgidum*, *Panicum laetum*

Source: P. Créac'h, 1993 [4.5].


ELEUSINE INDICA [PLATE 10]


SETARIA SPHACELATA [PLATE 11]


ERAGROSTIS PILOSA [PLATE 12]

SELECTED GRASSES IN LAKE CHAD BASIN ECOSYSTEMS

Panicum laetum

Known as *baya* in Haoussa and *timan* in Arabic [4.5], [4.8], this plant is found in a broad swathe across sub-Saharan Africa, from Mauritania to the Sudan. It is an annual that frequently grows in black clayey soils in areas that are seasonally flooded.

Its seeds are relatively easy to harvest and are used as the basis for porridge. The seeds are eaten in Kano state, northern Nigeria, and in central Chad.

The plant is also particularly appreciated by animals and is well suited to the production of hay and silage.

PANICUM LAETUM [PLATE 13]

TABLE 4 ***PANICUM LAETUM***

CEREAL	Protein content*	
Panicum laetum (mixed with *Echinochloa colona*)	11.10	
Wheat	9.85	
Oat	9.70	
AMINO ACID**	*Panicum laetum*	Wheat
Valine	4.49	5.1
Isoleucine	3.75	3.7
Leucine	7.96	6.8
Phenylalanine	4.59	4.5
Methionine	1.78	1.45

* % of dry matter
** g for 100 g protein

Source: FAO, 1997 [4.7]

PANICUM TURGIDUM [PLATE 14]

Panicum turgidum

This perennial grass is known as *afezu* or *markouba* in the Sahel and *taman* or *tuman* in the Sudan and grows as dense bushes up to 1 m tall. It bends over and roots at the nodes, the leaves are few and the stems hard and bamboo-like.

The grass grows from Pakistan west through the Arabian peninsula to northern Africa largely within the 250 mm isohyet. These remarkable drought-tolerant plants survive by dissociating themselves from one another rather than growing in association.

The root hairs bind particles of fine sand by the extrusion of a glue that allows them to absorb more moisture from the soil. *Panicum turgidum* is usually found on deep dune sand, but will grow well in wadis.

It grows where few crops can and is a good colonizing species that is extremely useful for erosion control because it spreads by long stolons building up mats of vegetation. Young leaves and shoots are very palatable; even in the dry state the plant is still eaten by camels and donkeys. It produces large quantities of seed that closely resembles *proso* millet; the Tuareg inhabitants of the Ahaggar Mountains in the central Sahara eat it ground into a flour and made into porridge. The ashes are added to tobacco for chewing, and the powder from ground stems is used for healing wounds.

Cenchrus biflorus

This annual, also known as *cram cram* [4.9], is particularly well adapted to sandy soils. Its Latin name comes from the Greek word *kengchros*, meaning “millet”. In the past, it was the main cereal of the Sahel and the Sahara.

Cram cram is harvested slightly differently from other *kreb* grasses: the ears are cut off with a knife instead of being swept up in a basket. The seeds are then dried, threshed and winnowed like other *kreb* grasses.

The grains contain over 10 percent crude protein [4.10] and are mixed with *bajra* (millet)

TABLE 5	***CENCHRUS BIFLORUS***
COMPOSITION*	
Energy (kcal)	325.0
Protein (g)	19.2
Carbohydrate (g)	56.0
Fat (g)	2.9
Fibre (g)	2.3
Ash (g)	10.2
AMINO ACID CONTENT**	
Cystine	1.7
Leucine	15.5
Phenylalanine	5.2
Lysine	1.1

* per 100 g seed
** g for 100 g protein

Source: NRC, 1996 [4.3]

for making bread and also eaten raw. In the Sudan (Kordofan, Darfur), the grains are removed from the husks by rubbing the seed heads between two pieces of leather. They are then pounded and either eaten raw or made into porridge. They may also be mixed with other foods. A thin bread (*kisra*) is also made from the seeds. In Kano state, Nigeria, seeds are only occasionally eaten.

CENCHRUS BIFLORUS [PLATE 15]

Dactyloctenium aegyptium

The name of this plant comes from the Greek word *dactylos*, meaning "finger", and *ktenion*, "a little comb", and alludes to the digitate inflorescences. Soil types favoured by the plant include clayey soil, sandy soil and the black soil along the borders of ponds, swamps and bogs.

An excellent food and feed resource [4.11], the rugose grains are either cooked into a thick porridge or the husked seeds are boiled in water to a thick mush. Mixed with semiground *Phaseolus aconitifolius*, the grains are used to prepare a dish called *keech*. They are also reportedly mixed with *bajra* (millet), and other grains (for making bread).

Church [4.12] reports two grain samples, each from a different area, which he states are identical but that have different vernacular names: *anchu manchu* and *mali* or *manebhi*. The first is described as unsavoury, causing constipation and urine retention. The second is made into bread and much appreciated.

In central Chad, grains are eaten. In extreme famine conditions the grain, which is also collected by ants, has been dug from the ground and eaten [4.13].

TABLE 6	***DACTYLOCTENIUM AEGYPTIUM***
COMPOSITION*	
Energy (kcal)	323.0
Protein (g)	11.8
Carbohydrate (g)	65.0
Fat (g)	1.7
Fibre (g)	4.0
Ash (g)	7.5
AMINO ACID CONTENT**	
Isoleucine	4.8
Leucine	9.9
Phenylalanine	6.8
Valine	5.8

* per 100 g seed
** g for 100 g protein

Source: NRC, 1996 [4.3]

DACTYLOCTENIUM AEGYPTIUM [PLATE 16]

Using grasses for food and fodder in the Sudan

by **Mahgoub Zaroug**, **Babo Fadlallah**, **Ali Hasab-Alkarim** and **Jadkareem Madibo**, 2002

Kreb is also harvested in other sub-Saharan regions, including the Sudan. Here, several grass species are used as traditional and emergency food. These include *Brachiaria obtusiflora* (*umchir*) and *B. xantholeuca* (*abugigra* or *kereib*), *Cenchrus biflorus* (*haskaneet khishin*), *Dactyloctenium aegyptium* (*abuasabee*), *Echinochloa colona* (*diffra* or *kereib*), and *Oryza barthii* and *O. breviligulata* (*ruz*). Grains of some of these grasses are collected from ant hills or termite mounds, or from the ground where they have fallen; others are harvested manually from standing grasses, which are dried and threshed.

Kereib is the name given to grasses such as *Brachiaria* spp. and *Echinochloa colona*. In most cases, these grasses are associated with areas that are temporarily flooded and are found in shallow rainwater pools and depressions, known in the Sudan as *rahads*. These species are forage plants and their grains may be used as emergency food. In the Buram and Al-Dein provinces of southern Darfur state, in the Sudan, grains are collected from partially submerged plants in a basket with a special opening. The basket is dragged through the grass stands with a beating rhythm and the grains fall into the basket. The dry grains are then ground and the resulting flour is used for the preparation of a kind of porridge, called *madida*, which is eaten with milk, ghee and sugar, or sometimes with cooked meat.

Ruz (wild rice) is the name given to *Oryza* spp., which are associated with swamps and seasonally flooded areas in western and southern Sudan. *O. barthii* grows in the beds of *raqabas* (local natural water channels)

ORYZA BARTHII [PLATE 17]

BRACHIARIA XANTHOLEUCA [PLATE 18]

while *O. breviligulata* grows at a medium depth in *rahads*. There are two ways of harvesting the grains of *ruz*.

1. When seed heads mature they fall on to the surface of the swamp. They are collected, dried and threshed, and the grains are stored for subsequent use.
2. Some people use small boats to move through the swamps where the wild rice plants grow, shaking seed-bearing culms on the side of the boat. When the boat has a full load of grains it is moved to the edge of the swamp, where it is unloaded; the trip is then repeated. Collected grains are dried and stored for subsequent use. Some surplus grains are marketed locally. The grains are cooked with milk and consumed by pastoralists and other local communities.

Abuasabee is the name given to *Dactyloctenium aegyptium*, an annual forage species, which grows on *atmur* soils in the Kass and eastern Zalinji provinces of Darfur. *Atmur* is the slightly elevated area of stabilized sand dunes. Seed heads are cut manually when they turn yellow, which indicates maturity. The harvested material is left to dry, then threshed by beating it inside a wooden container, or *funduk*. The seeds are cleaned and mixed with millet (two parts of *abuasabee* to one part of millet) and the mixture is ground to produce flour. This flour is used during emergency periods to prepare a porridge called *asida* and, on occasion, to make the traditional thin bread known as *kisra*. Pure *abuasabee* flour is used to treat diarrhoea.

THE NEED FOR MORE RESEARCH

The evidence so far points strongly to the value of *kreb* as a foodstuff, a forage source and a way of protecting the environment. However, more investigation is urgently needed in order to obtain scientific information about its benefits so that promotion can begin in earnest. Without this, there is a serious risk that this exceptional resource will be lost to future generations.

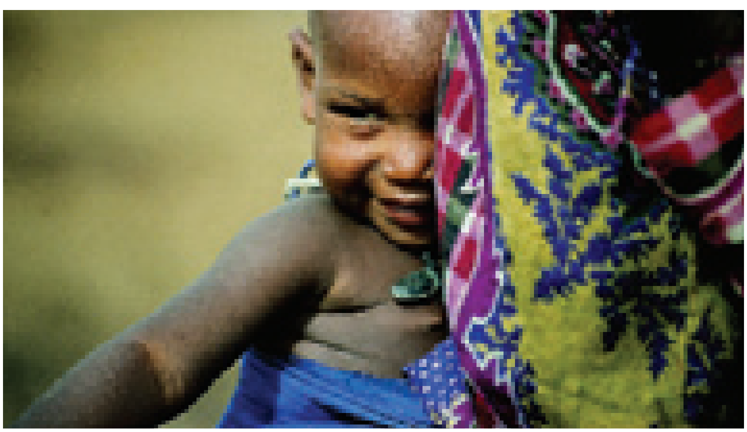
Much more needs to be known about the nutritional properties (e.g. the quality and quantity of starch and protein) of the different wild grasses that make up *kreb*, as well as pest and disease control and resistance, resistance to drought and salinity, and geographic adaptability. *In situ* and *ex situ* collections should be made in order to preserve genetic diversity for the future.

Evaluations, tests and studies should include germplasm evaluation, cytological studies and the production of tetraploid specimens in order to increase the size of the seeds. The different germplasms should be characterized and their important qualities noted, such as variation in colour, sensitivity to day length, uniformity of maturation, susceptibility to pests, yield, and adaptation to heat and cold. If the grasses are to be selected for food production, characteristics such as non-shattering and easily husked seeds are desirable. Seed shape and seed coat, preferably inelastic, should be defined and selected. Genetic research will enable efficient plant-breeding strategies to be set in place.

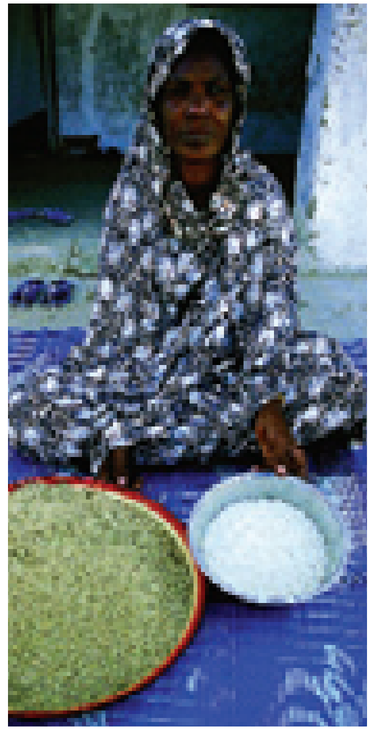
As far as germplasm collection is concerned, particular attention should be paid to collection in harsh environments, where many relict cultivars are present and could be threatened. One basic need is for ethnobotanical investigations related to plant production and uses. The range and ecological requirements of the plants must be studied to enable the identification and protection of the different types of germplasm.

Agronomic analyses need to be carried out in order to determine cultural practices, plant behaviour, population dynamics, plant density and sequences. Crop-handling studies should focus on harvesting, cleaning, storing and processing methodologies.

THE WELL NEAR KABELEWA VILLAGE, THE NIGER



THE PROTEIN CONTENT OF GRAINS IS OFTEN HIGHER THAN THAT FOUND IN FARMED CEREALS



N'DJAMENA, CHAD

SCIENTIFIC METHODS SHOULD BE COMBINED WITH ORALLY TRANSMITTED KNOWLEDGE

THE FUTURE

It is most important that any future benefits from the use and improvement of *kreb* are returned to the people who have used and preserved it for centuries.

These people who, through observation, experience, agreement and error, have developed techniques of harvesting *kreb* and maintaining the grasslands for their animals, must remain the direct beneficiaries of their knowledge and work.

Analysis of *kreb* species

by **Attilio Lovato** and **Enrico Noli** *

A sample of *kreb* collected around N'Djamena by a woman from the Ati tribe was brought to Italy where it was analysed at the LaRAS in April 2003. The results are given below.

COMPOSITION OF *KREB* SAMPLE

SPECIES	% OF SAMPLE
Echinochloa colona (L.) Link	79.4
Panicum coloratum L.	10.7
Panicum antidotale Retz.	0.5
Cyperus sp.	0.2
Eragrostis abyssinica Link	0.2
Impurities	9.0

In this case the dominant species were *Echinochloa colona* and *Panicum coloratum*. These two species should receive special attention in future activities related to the breeding of grasses for food production.

Nutritional analysis of *kreb*

by **Marina Carcea** **

A sample of *kreb* collected in Chad, near N'Djamena, by local women, was analysed at INRAN on 2 July 2003 with the results given below.

NUTRITIONAL ANALYSIS OF *KREB* SAMPLE

CONSTITUENT	% OF SAMPLE	
Water	12.00	
Protein	8.80	
Ash	0.95	(dry matter)
Lipids	1.43	(dry matter)

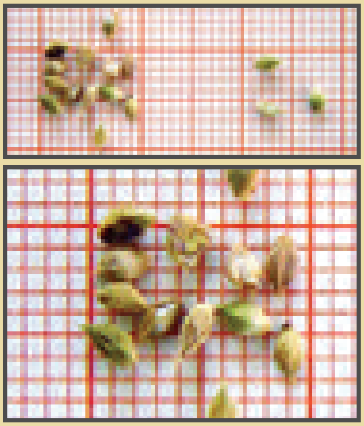
This analysis confirms the good protein content of *kreb*.

* Laboratorio di Ricerca e Analisi delle Sementi (LaRAS), Bologna, Italy, 2003

** Istituto Nazionale di Ricerca Alimentazione e Nutrizione (INRAN), Rome, Italy, 2003

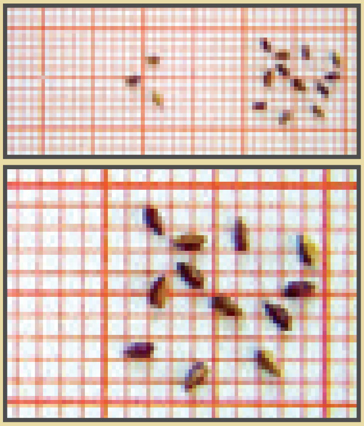
ECHINOCHLOA COLONA [PLATE 19]

PANICUM COLORATUM [PLATE 20]



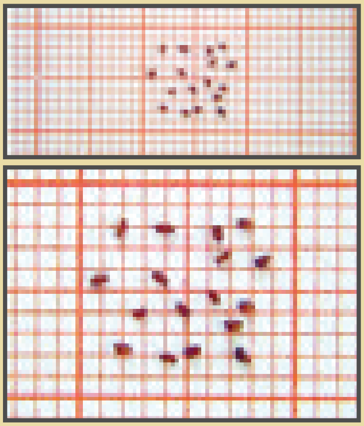
PHOTOS: COURTESY OF E.NOLI

ECHINOCHLOA SEEDS



PHOTOS: COURTESY OF E.NOLI

CYPERUS SEEDS



PHOTOS: COURTESY OF E.NOLI

ERAGROSTIS SEEDS

Notes from a journey

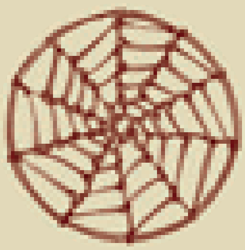
An annual miracle

14 December 2002
N'Djamena, Chad

It was a surprise to find *kreb* right here in N'Djamena since, as far as we knew, this cereal belonged more to the northern culture of the Sahel. However, in N'Djamena we meet Madame Fatimé Mahamat Terap, who annually repeats the ritual of gathering *kreb*. The mystery is explained when we learn that Madame Fatimé belongs to the Ati ethnic group; as an "immigrant" from the northeast she brought the tradition with her.

With great courtesy and patience, Madame Fatimé explains all she knows about *kreb* and, what's more, she presents us with a small bag of it, which we will later have analysed by a specialist laboratory.

So we begin to verify what very few books report exhaustively.



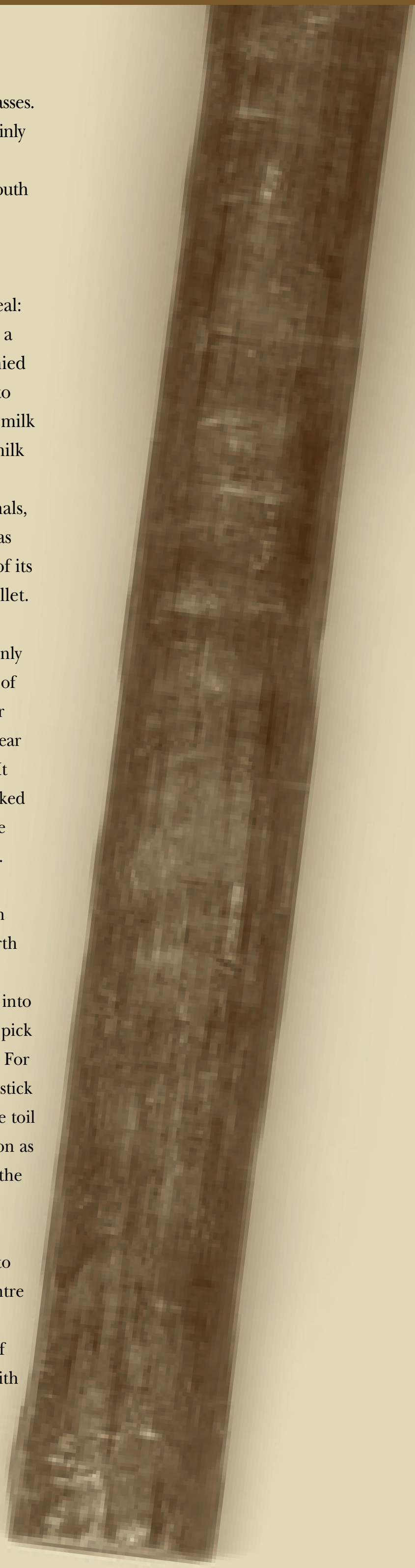
>> RIGHT: BASKET AND STICK ARE STILL THE TRADITIONAL TOOLS USED SPECIFICALLY FOR *KREB* COLLECTION

- *Kreb* is a mixture of grains from wild grasses.
- Its use is very ancient and widespread mainly in the northern villages of the Sahel. The Kanembu, for example, who live to the south of the Sahel, rarely consume or gather it.
- *Kreb* is not cultivated, but grows spontaneously.
- It may be substituted for any other cereal: cooked, it can be eaten like *cuscus* with a sauce or, as a soup, it can be accompanied by any condiment. It can also be used to make *basisa*, a kind of pasta eaten with milk and sugar, or *bouillie*, also mixed with milk and sugar and accompanied by *polenta*.
- It is a choice food for all kinds of animals, including birds. Even the bird known as the *mange-mille* (millet-eater), in spite of its nickname, prefers *kreb* to cultivated millet.

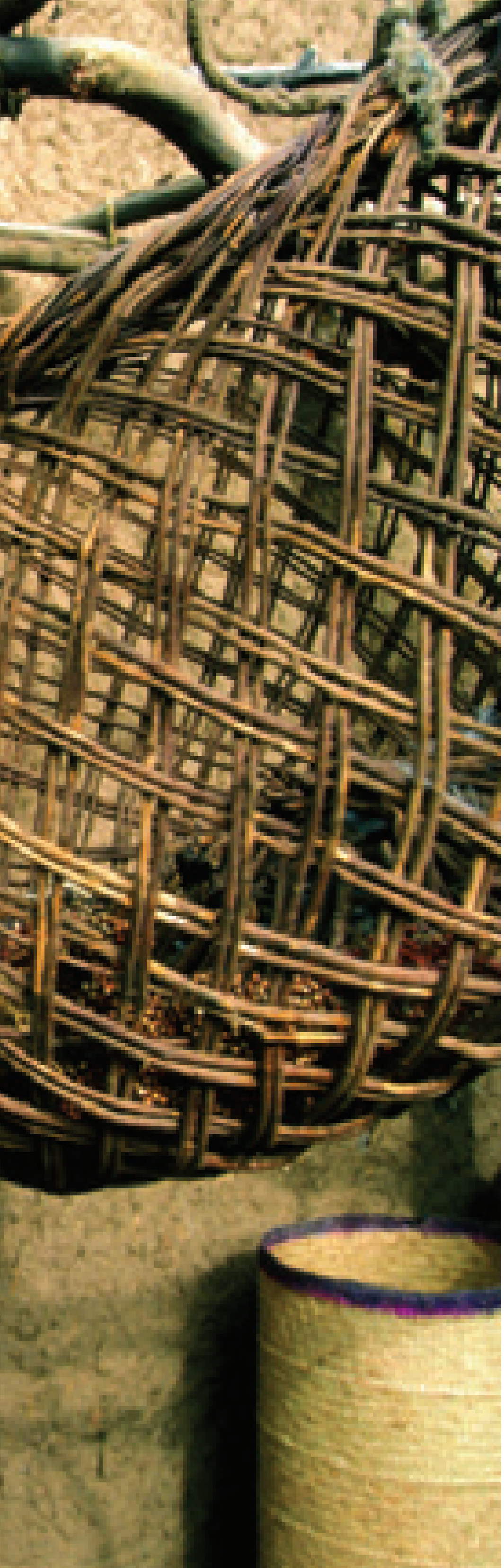
Kreb is found at the market in N'Djamena only during the harvest season, towards the end of September, at the price of 2 000 CFAF * per *coreau*, the equivalent of 1.5 kg. In a given year Madame Fatimé may gather a *coreau* a day. It takes eight *coreaux* to produce 1.5 kg of husked *kreb*. But it is difficult to calculate an average yearly yield; it depends on too many factors.
To gather *kreb*, Ati women use a basket especially made for that purpose. Held with one hand, the basket is swung back and forth under the ripened spikes, shaking the dry grass. If the *kreb* is ripe, the seeds fall easily into the basket. Many will fall to the ground; to pick them up, small as they are, is no easy work. For support each woman leans on a decorated stick traditionally made for that purpose. But the toil is worth it: *kreb* provides a source of nutrition as well as extra cash for the household, since the surplus is sold at the market.

Later we will also go with Madame Fatimé to her "field" of *kreb*, about 6 km from the centre of N'Djamena. At the time of our visit, in December, the area is a desolate expanse of land, punctuated by a few mud huts. But with the first rains, the grasses will grow again, renewing this annual miracle.

* 1 000 CFAF are equivalent to 1.52 euros .



N'DJAMENA, CHAD



CHAPTER 5

FARMING SYSTEMS

"To work with a farmer,
you have to start
to know his life,
his knowledge,
what he can do,
what he wants to do."

[Proverb from the Niger]

FARMING SYSTEMS

5

NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

THE CHALLENGE OF MODERN FARMING SYSTEMS IS TO CREATE A BALANCE BETWEEN INTENSIFIED PRODUCTION AND MAINTENANCE OF THE ECOSYSTEM

INTRODUCTION

For centuries human beings have been the builders of their environment. The large savannah ecosystems of the Lake Chad Basin, dominated by *Acacia* trees, have been managed by people through fire and movements of livestock, which transported seeds and grazed the grasslands selectively, and also through the collection of fruit, wild vegetables, tubers and cereals, and the use of wood and water resources. To protect livestock against predators and thieves, pastoralists tended to plant spiny trees, such as *Ziziphus* and *Commiphora*, around settlements [5.1].

Human beings have also modified the environment through the introduction of agriculture and, in the Lake Chad Basin, which is part of the larger Sahelian zone, several important crops have been domesticated. These include millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*), water melon (*Citrullus lanatus*), jute (*Corchorus olitorius*), cowpea (*Vigna unguiculata*) and *gombo* (*Abelmoschus esculentus*) [5.2].

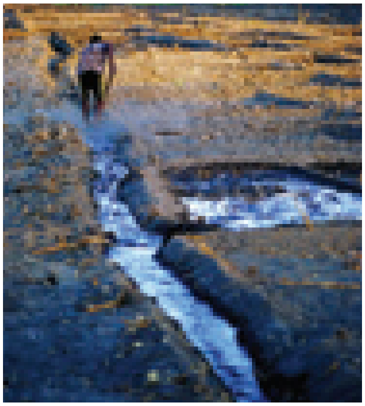
Recurrent droughts and conflicts have caused people to move over large

NEAR DIFFA, THE NIGER

THE LAKE CHAD BASIN HOSTS A MOSAIC OF CROPS, RANGING FROM THOSE CULTIVATED FOR DOMESTIC CONSUMPTION TO CASH CROPS

distances, bringing with them their domesticated crops, cultivation practices, food habits and preferences, religious beliefs and social organizations. In the Lake Chad Basin all these different practices and requirements, combined with local soil types, water regimes and existing indigenous vegetation, have resulted in a mosaic of different agricultural systems, each specific to an ethnic group and ecosystem. Traditionally, all these systems have the following features in common.

- **Mobility**: to avoid overexploitation of poor soils and search for water.
- **Integration with pastoralism**: to obtain manure and produce meat, milk and skins.
- **Integration with natural vegetation**: to collect food, medicines and materials for the construction of houses, canoes and mats.
- **Integration with fisheries**: in rivers, lake and ponds.
- **Wise use of water fluctuations**: to crop in recessional land and obtain additional food.



BOL, CHAD

TRADITIONAL WATER MANAGEMENT TECHNIQUES SUPPORT MANY FARMING SYSTEMS

ISSEIROM VILLAGE (DUM DUM), CHAD

FARMS ARE GENERALLY SMALL, AVERAGING FROM 0.25 TO 2.5 HA IN AREA AND EMPLOYING UP TO FIVE PEOPLE. MANY FARMERS COMBINE AGRICULTURE WITH FISHING AND LIVESTOCK PRODUCTION

AGRICULTURAL SYSTEMS

Today, growing populations and the consequent need to expand the limited amount of land available for agriculture and to increase production per land unit have put more pressure on agriculture and natural resources. Shorter fallow periods and encroaching agriculture have reduced the area of available grasslands, overexploited soils are degrading and water is becoming increasingly polluted and scarce.

Conflicts between farmers and pastoralists have increased because they are competing for natural resources.

At the same time, the variety of agricultural crops has increased and currently includes crops for domestic consumption (sorghum, millet, maize, *gombo*, pepper and wheat) and cash crops (cotton, peanuts, vegetables, rice, etc.). The cultivation of these crops on different soil types (ranging from sand to clay) and in areas of different water availability (rainfed, irrigated and recessional lands) has resulted in a mosaic of traditional and new farming methods and cropping calendars. Socio-economic factors, such as labour availability and farm size, also play their part in determining the cropping system. An average farm in the Niger part of the Lake Chad Basin has an area of 0.25 to 2.5 ha and employs five people [5.3].

Traditional farming systems are therefore undergoing a transformation towards intensive systems, although they still consist mostly of a combination of traditional subsistence cropping, fishing and livestock production with the production of cash crops. Examples of this evolution in four different ecosystems are described in the following pages.

NEAR MALAM FATORI, NIGERIA

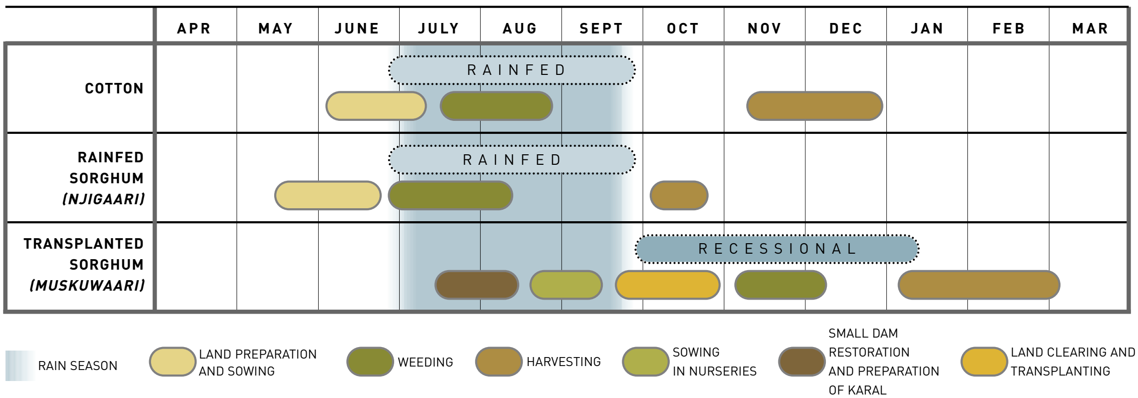
ABOVE AND BELOW: THE SUSTAINABILITY OF IRRIGATED AGRICULTURE MUST BE CAREFULLY EVALUATED, BOTH ECONOMICALLY AND ENVIRONMENTALLY

NEAR MALAM FATORI, NIGERIA

1. Subsistence and market farming

At Balaza, (Cameroon) domestic consumption is based on a combination of short-cycle rainfed sorghum (named njigaari) and of transplanted sorghum (muskuwaari) which is cultivated in clay soils at the end of the rainy season; rainfed cotton is cultivated as a cash crop. The trend is to increase cotton production instead of rainfed sorghum in order to guarantee a regular income, and maximize the cultivation of transplanted sorghum to ensure subsistence.

TABLE 7 **COMPLEMENTARITY OF COTTON, RAINFED SORGHUM AND TRANSPLANTED SORGHUM**

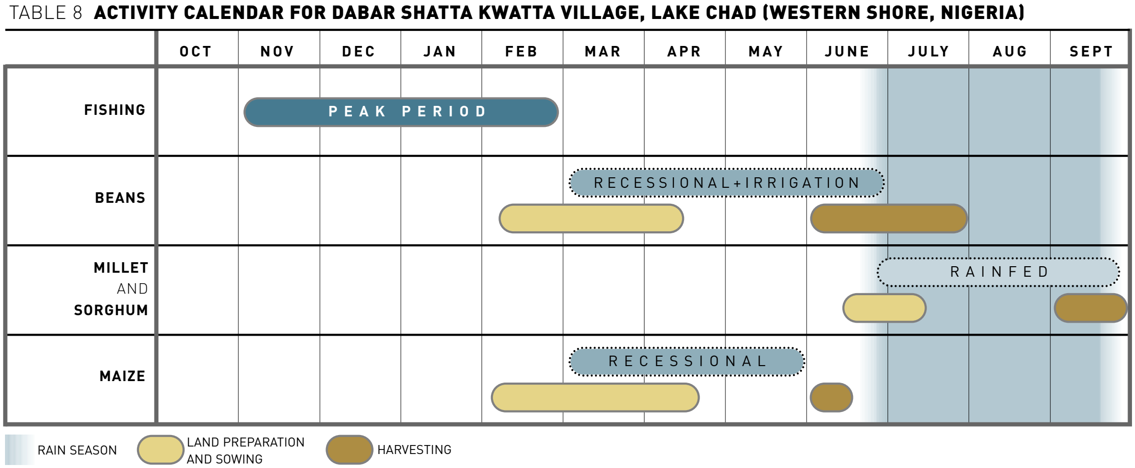


Source: extrapolated from B. Mathieu 2002 [5.4]

2. Farming and fishing

The activity calendar for Dabar Shatta Kwatta village, Lake Chad (western shore, Nigeria) shows the integration of fishing and the agricultural system, and the efficient use of the lake's fluctuations in order to provide for both domestic consumption and the market. Furthermore, this arrangement enables the harvest to be distributed evenly over the year in order to best meet domestic and market demands.

TABLE 8 **ACTIVITY CALENDAR FOR DABAR SHATTA KWATTA VILLAGE, LAKE CHAD (WESTERN SHORE, NIGERIA)**

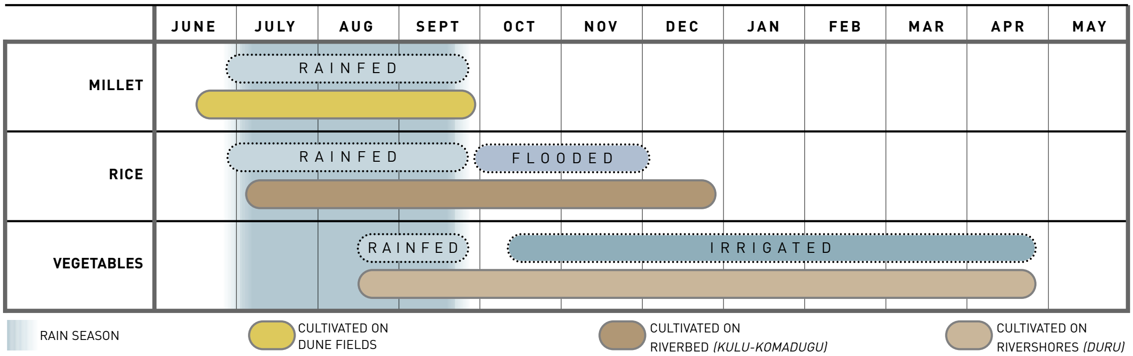


Source: extrapolated from A. E. Neiland *et al.*, 1994 [5.5]

3. Complementarity of wet/irrigated and dry ecosystems

From the end of June until the end of December, the Mobber people of the Komadugu–Yobé have an intensely busy agricultural calendar because they have to work in two different environments: the river shores and sandy dunes. Rainfed millet is cultivated on sandy dunes for domestic consumption. Rice is sown in July-August on dry soils for domestic and market consumption. Rice rises with rainfall and is subsequently flooded by the river and is harvested in December. Mobber people used to fish from October to January but recurrent droughts and the additional request for rice have reduced fishing activities. Vegetables are cultivated on the rivershore from August, using irrigation after the end of the rains.

TABLE 9 **AGRICULTURAL CALENDAR OF THE MOBBER PEOPLE IN KOMADUGU-YOBÉ**

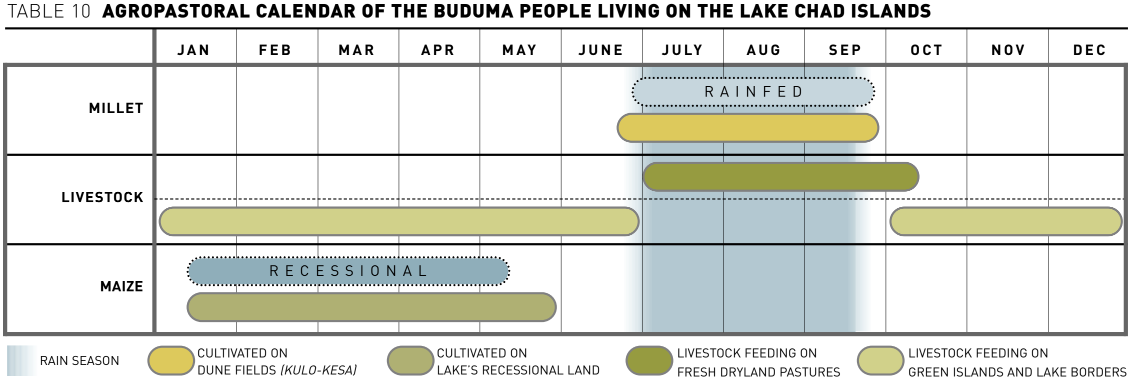


Source: extrapolated from C. Bouquet, 1990 [1.5]

4. Agriculture and pastoralism

Buduma agropastoralists from the Lake Chad islands have adapted their calendar to fulfil both agriculture and pastoral requirements. They also combine fishing but this will be left out from the scheme below. At the onset of the rainy season, when the presence of insects forces livestock towards drier environments, millet is grown on sand dune soils for harvest at the end of the rainy season. Animals are also kept around the dunes, grazing on fresh dryland pastures. From October, after the harvesting of millet and drying of natural grasslands, the animals return to the islands, and lake fluctuations allow maize cropping in recessional land. The wet island environment produces additional and very precious green feed for livestock from February to June. This corresponds to the difficult hot dry season of the ecosystem around the Lake Chad Basin, when animals suffer from lack of fresh forage.

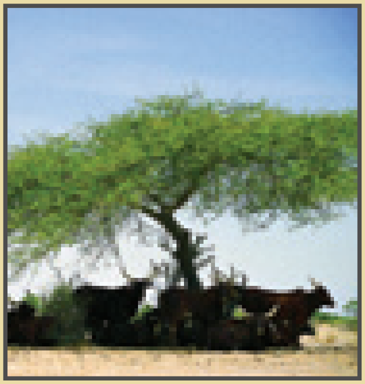
TABLE 10 **AGROPASTORAL CALENDAR OF THE BUDUMA PEOPLE LIVING ON THE LAKE CHAD ISLANDS**



Source: extrapolated from C. Bouquet, 1990 [1.5]

The fallow system

Farmers in the Lake Chad Basin have traditionally used the fallow system, allowing cultivated land to rest for several years before each new planting. In the region, where land has always been plentiful – unlike water and good soil, which are both in short supply – this technique was important for allowing regeneration of soils and vegetation. However, pressure on the land from the growing population means that this system is now being practised on a much-reduced scale, as more intensive farming takes over. The fallow system has a role to play in preserving biodiversity because, on land that is left fallow for more than four years, plants, soil organisms, insects and small vertebrates start to develop, and these species support birds and rodents. These, in turn, attract predators, such as jackals, owls and birds of prey, and the entire wildlife habitat is maintained. Native grasses allow grazing of wildlife and livestock, and shrubs and trees protect soils from erosion and provide timber, firewood and shade.



THE WELL NEAR KABELEWA VILLAGE (N'GUIGMI), THE NIGER

DIFFA, THE NIGER

FALLOW PERIODS ARE PROGRESSIVELY REDUCED TO INTENSIFY AGRICULTURAL PRODUCTION, BUT IN THE LONG TERM THIS CAUSES LOSS OF BIODIVERSITY AND LOSS OF LOCAL RESOURCES SUCH AS FIREWOOD

TRADITIONAL CEREALS

The main traditional cereals cultivated for domestic consumption are millet and sorghum, although wheat, rice and maize are increasingly replacing them, mainly because they are consumed in towns and cities and their preparation is often easier and quicker. The Peul use the word *gawri* for both millet and sorghum.

MILLET

The millets (meaning "small seed") are a group of various millet species that produce small seed. They comprise a dozen crop species belonging to different genera. Statistical documentation for millet is generally poor since most national statistics do not distinguish between the various botanical species. Among them, pearl millet (*Pennisetum glaucum*) and finger millet (*Eleusine coracana*) are the major millets and West Africa minor millets are fonio (*Digitaria exilis*), black fonio (*Digitaria iburua*) and guinea millet (*Brachiaria deflexa*). Some 20.6 million ha were sown with millet in Africa in 2002, with a total production of 13.6 million tonnes; it was the third most widespread cereal, after maize and sorghum, and before rice and wheat [5.6]. Pearl millet, like all other millets, is adapted to arid and semi-arid conditions and to sandy soils with very low fertility. It tolerates downy mildew, stem borer and head caterpillar. Production rates are very low (around 400–500 kg per ha in the Niger and Chad, and 900–1 000 kg per ha in Nigeria and Cameroon) but it gives the farmers a chance to survive in very arid environments and also provides some fodder for the animals, which feed on stalks after the harvest [5.7].

KOURNADI VILLAGE (DIFFA), THE NIGER

MILLET IS PERFECTLY ADAPTED TO ARID CONDITIONS AND SANDY SOILS OF LOW FERTILITY

Pearl millet has a long growing season which, although agronomically inefficient, allows the grains to dry well after the end of the rains, thus reducing the risk of moulds forming during storage [5.8].

As they do for their livestock, farmers maintain a high level of heterogeneity in their seed stock. They traditionally perform what scientist call "population breeding", a technique of maintaining a cluster of genotypes to ensure that the population has as many different genes as possible. In this way, it has the plasticity to respond and produce in varying conditions (droughts, pest attacks, wind and floods).

NEAR DANOUWANE VILLAGE (N'GUIGMI), THE NIGER

FARMERS GROW SORGHUM, DESPITE ITS LOW PRODUCTIVITY, BECAUSE IT HAS GOOD RESISTANCE TO DROUGHT: THIS REPRESENTS A LOW-YIELD, LOW-RISK STRATEGY

SORGHUM

Sorghum (*Sorghum bicolor*) has adapted well to local conditions down the years, achieving a good balance between production and sustainability. Some varieties of sorghum are cultivated as a rainfed cereal while others are transplanted on to recessional land. There is evidence to suggest that *durra* varieties were already being eaten in Egypt as early as 4000 BC. Chad and eastern Nigeria form a centre of diversity for the *caudatum* variety [5.2]. In 2002, 23.6 million ha of sorghum were cultivated in Africa, with a total production of 20.3 million tonnes. Together with millet, sorghum represents the main source of calories for people living in the world's semi-arid tropical regions. Sorghum is rich in carbohydrates but contains relatively little protein.

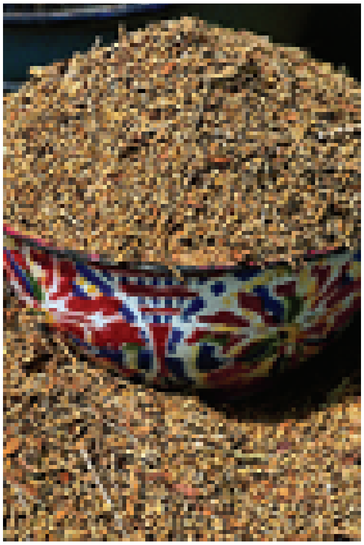
Yields vary greatly according to the conditions in which it is grown. In the United States, the yield may be as high as 4 tonnes per ha, while the average harvest in developing countries is just 1 tonne per ha. In Chad, the average falls even further, to 0.6 tonnes per ha, while in the Niger it is around 200 kg per ha [5.6].

The reason for such large differences lies partly in the varieties that are cultivated and in the low-input cultural practices of the Sahel. However, it is mostly because, in areas of low yield, sorghum is mainly grown on marginal soils where rainfall is unreliable and often inadequate, and diseases (smuts) and bird attacks are frequent. In such hostile conditions, it is often better to sacrifice high yields in favour of balance and food security. Therefore low-yield, high drought-resistant varieties are used. In some cases, the straw is even more important than the grain because it is used as construction material.

Another consideration is the relatively low market price of this crop. For this reason, farmers in the Lake Chad Basin have little interest in producing any more than they need for themselves, given the extra effort, cost and stress on the land that this would entail. Only 15 percent of total sorghum production in the region is sold on the open market.

With this in mind, farmers in the Lake Chad region select seeds that will keep risks to a minimum, favouring those that have a good flavour, adapt well to difficult conditions, are resistant to drought and disease, and produce sufficient residues to feed their animals. A high yield is not the prime objective and, therefore, is generally not an overriding criterion when it comes to selecting a new variety. When farmers do need to increase their production of sorghum or millet, they tend to extend the cultivation of existing varieties into more marginal lands, rather than opting for a more intensive production on land already in use [5,9].

N'GUIGMI, THE NIGER



15 PERCENT ONLY OF SORGHUM PRODUCTION IS FOR THE MARKET

DANOUWANE VILLAGE (N'GUIGMI), THE NIGER

SORGHUM AND MILLET REPRESENT THE MAIN SOURCE OF CALORIES FOR PEOPLE LIVING IN THE WORLD'S SEMI-ARID TROPICAL REGIONS

The farmers' treasure trove

by **B. Mathieu**, **N. Perrot** and **S. Gonne***

Farmers own and cultivate their local varieties of transplanted sorghum (*Sorghum bicolor* (L.) Moench, *durra* or *durra-caudatum* varieties), which have become adapted to the different ecological and social conditions of the Lake Chad Basin. These dry season sorghums have different generic names according to the production area: *berbere* in Chad, *muskuwaari* in Cameroon and *masakwa* in Nigeria.

The production cycle on recessional land starts at the end of the rainy season and develops during the dry season with the use of soil-water reserves. This allows extra cereal production at a time when most other food reserves have already been exhausted (between December and March, depending on the variety). In Cameroon, transplanted sorghum was introduced during the Bornu Empire by the Kanuri. The nomadic Peul populations, who progressively settled in northern Cameroon, have contributed to the spread of *muskuwaari* since the sixteenth century [5.10]. Today, the production of transplanted sorghum ranges from 500 to 1 500 kg per ha.

Cultivation techniques vary widely from country to country, depending on labour availability, soil types, the growing period of the selected varieties – ranging from 90 to 150 days – and the dominant grass types that spring up during the rainy season, including *Loudetia togoensis*, *Setaria* spp., *Echinochloa* spp. and *Oryza* spp. [5.11]. The skills and knowledge of farmers are important, including the building of small dams so that rainwater is retained and infiltrates the soil; the coordination of the agricultural calendar by adjusting the production in nurseries to the transplantation period, which is governed by the predicted end of the rains and the withdrawal of water from the flooded lands; managing the clearing of grasses; and the use of low-cultivation density, not exceeding 10 000 holes per ha. For example, farmers from the Diamaré Plain (region of Maroua, Cameroon) have developed a technique for rehabilitating degraded soils that combines the development of a close network of small dams with the use of pioneer varieties well adapted to drought conditions. After a few years, the water retention capacity of the soil and the soil structure improve, thanks to the dams and to the action of the root systems, which enable water to infiltrate the soil. Many local sorghum varieties have adapted to the heterogeneity of the soil in cultivated environments. An inventory of these varieties, characterized according to the farmers, was carried out in 24 villages around Maroua and Kaélé in northern Cameroon. The existing transplanted sorghums were found to belong to the *durra*, *caudatum* and *durra-caudatum* varieties, based on the classification by Harlan and De Wet [5.11].

The ecotypes are *safraari*, *majeeri*, *burguuri* and *ajagamaari*. Each variety has a local name and has specific characteristics, such as the length and the compactness of the panicle, adaptability to different soil types, pest resistance, organoleptic and transformation characteristics, and suitability for different food preparations. Some 45 local varieties have been identified, and the farmers' main selection criteria have been productivity and food quality. *Safraari* varieties are grown in over 42 percent of the total cultivated areas, because they are highly productive on typical vertisols, the flour is of good quality, and the stovers are sweet and favoured as feed for livestock. Very rustic varieties, such as *yaawu*, are being increasingly grown on newly cultivated soils and in degraded areas. This is because they are early maturing varieties (a factor that lowers risks), are not very demanding and thrive in spite of the low water retention capacity of these soils. The *burguuri* varieties are preferred for their resistance to pests, particularly the red-billed quelea (*Quelea quelea*). *Burguuri* sorghum is cultivated either along tree and bush zones or on field borders in order to protect the better-quality varieties that are cultivated in these areas. Grains vary in colour from red to pink and have a brown layer under the pericarp with a high tannin concentration that is bitter and unpalatable to birds. Some varieties have hairs, which further discourage attacks by birds. The bitter taste remains after the grains have been processed, so the *burguuri* variety is only used as a means of protecting other crops. In the *yaéré* (floodplain) areas, short-cycle varieties are generally used because these lands are covered by water for long periods of the year. If long-cycle varieties were to be used, their late harvesting would make them a target for birds. Another advantage is that early-maturing varieties reach the market earlier and therefore command higher prices. In the 24 villages investigated, not one variety of sorghum has been abandoned in recent times. Farmers are reluctant to cast aside traditional varieties because, first, they have inherited them from their forefathers and, second, they are well aware of the benefits of each one. For this reason, varieties with limited food or agronomic qualities are still cultivated and transplanted on a small scale in order to maintain seed. Among these are *majeeri wojanyaande* and *nyaawri*. The main reasons why farmers grow transplanted sorghum are as follows.

- They use it for domestic consumption.
- It suits their tastes and their traditional recipes. Each variety is considered to have specific nutritional, taste, appeal and handling values. For example, *cuscus* cooked with the *safraari* variety provides energy, while the *majeeri* is more often used for *bouillie*. The *burguuri* varieties are hard to shell and mill, while the tegument of the *ajagamaari* variety is easy to remove.
- Local populations are ready to pay a higher price – up to 25 percent more – for local varieties of transplanted sorghum.
- Even urbanized populations tend to maintain their traditional tastes and habits, thus creating new market opportunities for these local varieties.

* Centre de coopération internationale en recherche agronomique pour le développement (Cirad – TERA), Montpellier, France

>> RIGHT: FARMERS MAINTAIN AND CULTIVATE MANY DIFFERENT LOCAL VARIETIES OF SORGHUM ACCORDING TO THEIR DIFFERENT NEEDS. A TREASURE OF GENETIC RESOURCES FOR PRESENT AND FUTURE GENERATIONS

DORO LELEWA VILLAGE (N'GUIGMI), THE NIGER

Wild rice: a disappearing foodstuff

by **Van Nguu Nguyen** *

Oryza glaberrima is one of 21 species of wild rice found worldwide. Once common throughout West Africa, this valuable foodstuff is disappearing fast because of the introduction of cultivated rice plants from Asia. Left to its own devices, *O. glaberrima* grows spontaneously in many parts of the Lake Chad Basin, especially thriving on the marshy lands close to the lake and the rivers. It is an excellent source of food for both humans and animals and is traditionally harvested by local communities, who store it in leather sacks, baskets or calabashes.

However, increasingly, this precious wild rice is being ousted by the arrival of *Oryza sativa*, a cultivated species imported from Asia. Before planting the Asian rice in the paddy-fields, local farmers pull out the wild rice by its roots. The threat to biodiversity, and to the future of a species that has been used for generations, is one that urgently needs addressing. Some hope is offered by the launch of NERICA (New Rice for Africa), a hybrid strain developed by researchers from WARDA (West Africa Rice Development Association), from a cross between the newcomer *O. sativa* and the native *O. glaberrima*.

ORYZA GLABERRIMA [PLATE 21]

* Agricultural Officer, Crop and Grassland Service (AGPC), FAO

NEAR DAMASSAK VILLAGE, NIGERIA

LOCAL WILD RICE IS BEING OUSTED BY A CULTIVATED SPECIES OF RICE IMPORTED FROM ASIA

Agricultural by-products

Traditional agricultural systems of the Lake Chad Basin, apart from providing food for human consumption, responded to two additional (and often conflicting) requirements: the need to provide feed for livestock during dry and cold periods of the year, when forage availability is scarce; and the need to maintain soil fertility and protect the soil against erosion. In order to meet these three requirements, traditional cereal varieties were selected that maximized not only cereal production but also the production of leaves and residues. Today, the need to intensify productivity per unit of land has resulted in increased competition between the needs for food, feed and soil fertility.

Traditional production schemes do not satisfy increasing production demands and therefore need to be integrated with additional technologies. Among these sustainable technologies: hay and silage production can increase the amount of feed reserves for livestock; harvesting of alternative food sources, such as *kreb*, can increase cereal availability by maintaining soil cover and providing good feed; and intercropping, the introduction of fodder trees and the use of green manure can contribute to the cover and protection of soils.

NEAR DIFFA, THE NIGER

NEAR LIWA, CHAD

TRADITIONAL VARIETIES WERE SELECTED IN ORDER TO PROVIDE FOOD AND FEED. INTENSIVE PRODUCTION SYSTEMS CONCENTRATE ONLY ON CROP PRODUCTION RATHER THAN ON MIXED CROP-LIVESTOCK SYSTEMS

THE FAINT BORDERS OF AGRICULTURE

Like wild grasses, many other plant species are harvested without being cultivated. For centuries people have developed techniques to protect, enhance and manage species in the wild in order to eat them. The livelihood of a population depends to a large extent on the many plants that provide medicine, food and feed, and materials for building dams, boats and houses, fuel, etc. A few of them will be described here, in order to give an overview of their importance, the range of their traditional uses, and their significance in the lake's ecosystem and in peoples' daily lives.

WILD OR DOMESTICATED?

The Gimbe and Duupa people, living in the mountain region of Poli in northern Cameroon, have an agricultural economy based on the cultivation of sorghum and millet. To fortify their diet, they use a sauce based on vegetables that are partly cultivated and partly collected from the wild. Some 70 plants that are used by the two populations have been identified. They have been divided into three main groups.

1. Plants that are sown at the beginning of the growing season (e.g. *Amaranthus* spp. and *Vigna unguiculata*) at the same time or after the cereals, but receive no additional inputs until they are harvested.
2. Plants that are simply protected or not weeded from fields (e.g. *Crotalaria ochroleuca*, *Solanum nigrum* and *Justicia insularis*).
3. Plants that are directly harvested from the wild without the intervention of any human management (*Merremia pterygocaulos*, *Psophocarpus palustris*, etc.).

DANOUWANE VILLAGE (N'GUIGMI), THE NIGER

FOR CENTURIES PEOPLE HAVE DEVELOPED TECHNIQUES TO PROTECT AND MANAGE WILD PLANT SPECIES IN ORDER TO EAT THEM

Most species from the second group, subject to a very limited human management, are collected from cultivated land and from domestic gardens (e.g. *Aspilia africana*, *Portulaca oleracea*, *Corchorus* spp. and *Crotalaria ochroleuca*), but only from land that is far away from the villages (because land that is closer is considered to be polluted with human waste). On the other hand, leaves from trees such as *Ficus* spp., *Tamarindus indica* and species of Bombacaceae are harvested both from trees close to the villages and from trees scattered in the savannah.

There is therefore a continuity between cropped and wild species because different plants are subject to different levels of human management. It is thus difficult to draw a line between domesticated (cultivated) species and wild species. This is yet another example of traditional knowledge enabling farmers to make a living in a difficult environment without jeopardizing its biodiversity [5.12].

FICUS BURKEI [PLATE 23]

PORTULACA OLERACEA [PLATE 26]

BOSCIA SENEGALENSIS [PLATE 24]

VIGNA UNGUICULATA [PLATE 27]

TAMARINDUS INDICA [PLATE 22]

CROTALARIA NATALITIA [PLATE 25]

SOLANUM NIGRUM [PLATE 28]

NEAR KOUSSERI, CAMEROON

EVEN *CALOTROPIS*, LIKE EVERY OTHER PLANT, HAS A FUNCTION IN ITS ECOSYSTEM. LOCAL PEOPLE KNOW HOW TO EXPLOIT IT

CALOTROPIS PROCERA

Another good example of a crop that is superbly adapted to the local arid conditions is *Calotropis procera*. This hardy, indigenous shrub has a wealth of uses, including fodder for goats and camels, medicine, building, and the manufacture of tools and other items that can be sold to generate income [5.13] [5.14].

Description

C. procera is an evergreen, softwood perennial shrub. It has one or few stems, few branches and relatively few leaves, most of which are concentrated near the growing tip. Its very deep taproot has few near-surface lateral roots. The opposite leaves are oblong-obovate to nearly orbicular and short-pointed to blunt at the apex, with a nearly clasping, heart-shaped base and very short petioles. The flowers take the form of umbelliform cymes that grow at, or near, the ends of shoots. The shrub flowers throughout the year and its seeds, which are dispersed by the wind, can travel for several hundred metres. It reaches an average 2 m in height.

Distribution and habitat

C. procera is native to West Africa as far south as Angola, and to East Africa, Madagascar, the Arabian Peninsula and southern Asia. More recently, it has become naturalized in Australia, the United Mexican States and the Pacific islands.

It grows best in an open habitat where there is little competition. Overgrazed pastures provide perfect conditions, but it also grows well in beach-front dunes, on roadsides and on disturbed urban lots. It thrives in dry areas with between 150 and 1 000 mm of rainfall per year, at elevations of up to 1 000 m, and on all types of soil.

FITINÉ ISLAND (BOL), CHAD

THE MANY USES OF *CALOTROPIS* INCLUDE FIREWOOD, TIMBER, TRADITIONAL MEDICINE, SILK PRODUCTION AND RENNET

An indicator of degraded soils

Calotropis has been regarded as an indicator plant of highly degraded soil and poor grassland conditions because it can be a serious weed in pastures, overgrazed grasslands and poorly managed fields. It is difficult to eliminate the stands by management, and some form of chemical control would seem to be the only practical solution. On the other hand, a wealth of traditional uses for this plant are known, reinforcing FAO's approach that, if resources are well used and well managed, their functions in the ecosystems will become evident and useful.

NEAR N'GUIGMI, THE NIGER

IF *CALOTROPIS* IS WELL USED AND MANAGED, ITS FUNCTION IN THE ECOSYSTEM WILL BECOME EVIDENT

Traditional uses

Pastoralists and farmers have long valued this plant precisely for its ability to proliferate on poor soils, its pioneer function and its wide variety of uses.

- *Calotropis* is a useful "nurse crop" for other, more valuable species.
- Sheep, goats and camels all readily eat the leaves in conditions of extreme drought. If the leaves are chopped and mixed with other leaves, the fodder can also be used at other times.
- Because of its resistance to termites and its flexibility, the wood of *Calotropis* is widely used throughout the region for building houses and for making fishing gear.
- The wood is a renewable source of hydrocarbons and is therefore a potential "petrocrop" [5.15], [5.16]. The wood is quite light and its smoke has a strong smell, but its use must be developed within the framework of cheaper and sustainable energy sources in view of the heavy population pressure on deteriorating and degraded vegetation.
- In the past, the silky hairs of *Calotropis* were used to stuff pillows and new research shows that the plant could be used to make textiles.
- *Calotropis* is also recommended as a host plant for butterflies [5.17], which play an important role in maintaining biodiversity because of their role as pollinators. *C. procera* is a favourite place for butterflies to settle and lay their eggs. In particular, it is a recognized food plant of the caterpillars of the plain tiger butterfly (*Danaus chrysippus*).
- In human health care, the tissues, and especially the bark, are used to treat a variety of illnesses, including leprosy, fever, menorrhagia, malaria and snake bite [5.18]. Extracts, chopped leaves and latex from the plant have shown great promise as a nematicide [5.19]. The latex, however, is toxic and can cause blisters.

Artificial silk

Seed fibre from *Calotropis procera* is being investigated as an alternative source of cellulose, for use in the production of textiles. Early results have produced a yarn that can be used to make a promising form of artificial silk. In order to make it appear more like cotton, the fibre has been modified, making it flat and ribboned rather than hollow.

Behind the research is Libyan scientist Dr Aisha Omran El Breki, head of the Textile and Leather Research Department at the Industrial Research Centre in Tripoli. She believes that yarns from *Calotropis* could prove a useful source of income for communities living where this hardy shrub grows, as well as being an environmentally sustainable method of making textiles [5.20].

THERE IS AN INCREASED WORLDWIDE INTEREST IN THE PRODUCTION OF TEXTILES FROM NATURAL FIBRES SUCH AS THOSE OBTAINED FROM *CALOTROPIS* SEEDS [5.36]

Making cheese with *Calotropis*

One good example of the use of *Calotropis* in food preparation comes from the Peul women in Benin. For more than a century they have been making cheese using a technique that is little known in the rest of West Africa but that could be introduced to the Peul women living in the Lake Chad Basin. It involves the use of a vegetable coagulant made from *Calotropis procera*. The cheese is first washed and boiled, before being eaten fried, a process that ensures the product's bacteriological quality. The cheese is highly prized, although it is not made outside Benin.

The production process is very simple. Fresh filtered milk is heated slowly in a pot. The vegetable coagulant, made from *Calotropis*, is then added through a strainer, and the milk and the coagulant are heated again gently for 15–30 minutes. It takes about 5 litres of milk to produce 1 kg of cheese. Generally, the women produce 0.5–5 kg of cheese at a time, depending on the availability of milk and their chances of selling the product. After they are made, the cheeses are either kept in their whey or dried and kept on the roof of the hut. No particular preservative measures are taken.

Before being sold, the cheeses are reddened. This is done to make them more attractive for market. The process involves cooking the cheese in water that has been coloured with sorghum cobs or stalks. For better preservation, the cheeses may also be cooked in water containing salt and potassium.

O'Connor and Bekele [5.21] carried out experiments (at the International Livestock Centre for Africa [ILCA], at Debre Birhan experimental station in Ethiopia) on the production of coagulant from different parts of the *Calotropis* plant. They confirmed that the leaves, which are the parts used by the Peul women, give the best results. More research on different varieties of cheeses is warranted, coupled with chemical, organoleptic and shelf-life tests.

The very low cost of producing coagulant from *Calotropis procera* confirms that traditional knowledge is a source of safe, cheap, socially and environmentally acceptable technologies that could be developed and promoted in the many other countries where *Calotropis* is widespread.

THE NIGER

PHOTO: COURTESY OF N.SCHAREIKA

THE PRODUCTION OF CHEESE USING *CALOTROPIS* RENNET, ALREADY PRACTISED IN BENIN BY PEUL WOMEN, COULD BE INTRODUCED IN THE LAKE CHAD BASIN

Prosopis: friend or foe?

The presence in Africa of *Prosopis* spp., a leguminous tree from Latin America, was already documented in the nineteenth century. However, its dispersal started in the 1960s and 1970s, when it was introduced into several areas in order to fix mobile dunes and colonize very dry and sandy environments that were at risk of desertification. The trees, having a deep root system and good resistance to drought and to salinity, grew rapidly but they also spread towards the more fertile areas. Therefore many farmers started to see the tree as a dangerous weed.

In the Lake Chad Basin, in the Niger, a *Prosopis* forest 80 km in diameter has invaded the best recessional land. This has caused serious problems for the farmers, who have to burn and uproot the trees in order to plant their crops, and also for the fishermen, who can no longer move into the shallow waters of the lake because *Prosopis* and its roots are impeding the movement of boats. Chad reports some invasion of *Prosopis* around the lake, the extent of which is not known. Nigeria has not reported any *Prosopis* invasion of the lakeshore as yet. However, experts predict that, if the tree is not controlled, it might become invasive around the whole lake because it is advancing from the northern border southwards, mainly spread by animals that are eating the pods and dropping scarified seed.

The main problem with *Prosopis* is that, being a recently introduced species, local populations know very little about how to control it or how to utilize its products.

In 2001–2002 an FAO project based in N'Guigmi, on the Niger shore of the lake, promoted the sustainable use of the *Prosopis* tree by working with the local populations to demonstrate how to use the pods as food and feed, and the wood as construction material and for energy production. A total of 500 village women learned how to prepare *bouillie* (porridge), biscuits, syrup and coffee using *Prosopis* flour mixed in different proportions with local cereals, such as millet and wheat. As a result, they have been exposed to different cooking techniques, and local recipes have been developed with very satisfactory results. Kangar, a local non-governmental (NGO), is currently testing the effect of *Prosopis* feed with small ruminants. At the same time, the Institut national de la recherche agronomique du Niger (INRAN) prepared a map of the entire forest [5.22].

NEAR KOMADUGU RIVER, THE NIGER

PROSOPIS, INTRODUCED IN THE 1960s TO FIX DUNES, HAS FORMED THICK FORESTS THAT HAVE INVADED PRECIOUS RECESSIONAL LAND

PORT OF LELEWA (N'GUIGMI), THE NIGER

FISHING AND FARMING ACTIVITIES HAVE BEEN GREATLY DISTURBED BY THE RAPID SPREAD OF *PROSOPIS*. THE GOAL OF A RECENT FAO PROJECT WAS TO MAKE PEOPLE AWARE OF THE MANY USES OF THIS TREE

To summarize, *Prosopis* represents a clear example of the environmental risk brought about by introducing a new species into an ecosystem. Efforts must now be concentrated on the management and control of the tree, understanding its taxonomy and fully exploiting its potential in the fight against desertification; on its role as a source of firewood and good-quality food and feed; and, above all, on making the population aware of all this. Full responsibility lies with international institutions and national and local policy-makers to ensure that sufficient training and research support are given, within the framework of national and international strategies related to the sustainable use of introduced species.

NEAR DOUTHY VILLAGE (DAMASSAK), NIGERIA

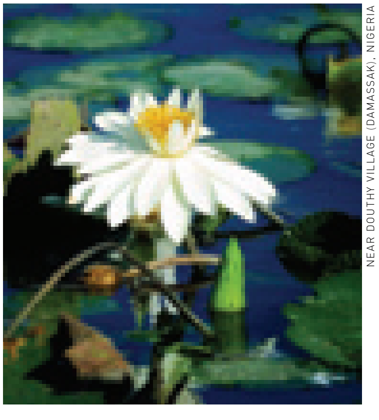
WATER LILIES PROVIDE GRAINS AND NUTS THAT ARE APPRECIATED AS FOOD AND SOLD AT MARKETS

WATER LILIES (*NYMPHAEA* SPP.)

Water lilies are found in many of the pools and inlets of the Lake Chad Basin. Their flowers are white or yellow and the plant can cover the whole expanse of a pool. Where there are fish, the lilies provide a suitable habitat beneath their leaves and on their stalks for the plankton and zooplankton on which fish can feed.

When the lilies ripen, their fruits burst and the grains they contain are eaten by the fish.

During times of severe famine, the fruits of the water lily are eaten by the people of the region. Entire families go in search of the fruits, which they dry before extracting the grains. These grains are milled and made into pasta. The nut, or tuber, which is formed at the root of the water lily, is greatly appreciated as a food. After being harvested and cooked, the nuts are sold in the market.



NEAR DOUTHY VILLAGE (DAMASSAK), NIGERIA

NEAR LIWA, CHAD

MANY DIFFERENT TREE SPECIES GROW IN THE ECOSYSTEMS OF THE LAKE CHAD BASIN

ACACIA SEYAL

Acacia seyal is one of over 60 African acacias. A thorny deciduous tree, it can reach a height of 6 or 7 m. It has a straight cylindrical trunk of about 60 cm in diameter and a smooth bark. It has spreading branches and flowers in the middle of the dry season, before, or at the same time as it produces leaves.

Its usual habitat is the clay soils of the lakeshores, as well as riverbanks and sandy promontories in rivers.

Pastoralists feed the leaves and pods to their livestock. The net energy contents of dry matter are high: 6–8 MJ per kg for foliage and 4–7 MJ per kg for fruits.

The digestible protein levels are also high: 100–150 g per kg for foliage and higher in fruits. Analyses of both foliage and fruits indicate a well-balanced mineral content and a very favourable quality in terms of proximate fractions (e.g. crude fibre 10–20 percent, ether extract <7 percent). Pods are sold for fattening sheep.

The dense wood is highly prized for fuel in areas where few other plants survive, and it is considered one of the best firewoods in Chad. It is also an excellent source of charcoal. Stands managed on a 10–15-year rotation yield 10–35 m^3 per ha of firewood.

The leaves are used in traditional medicine for the treatment of syphilis, conjunctivitis, diarrhoea and colds [5.23]. The tree is an important source of gum arabic [5.24], [5.25].

NEAR TAL DESERT (N'GUIGMI), THE NIGER

BALANITES AEGYPTIACA

Balanites is widespread in the Lake Chad Basin. It is a deep-rooted tree that can live for more than 100 years. Found on varied soils, it prefers valley soils but will grow in sand, sandy loams, clays, cracking clay and alluvial soils. Ecologically, it is very flexible, with excellent persistence. It withstands occasional flooding, can adapt to a wide range of situations and climatic conditions, has good drought tolerance and is not damaged by grass fires (except young trees) because of its deep taproot and thick bark. It invades areas that have periodic fires and areas with heavy livestock activity. Young plants are fairly termite-resistant.

B. aegyptiaca grows slowly and requires protection as a seedling. It attracts numerous insects but is very resilient. It is no longer much used in the rehabilitation of degraded areas and in desertification control projects because of its slow growth, but its planting should be encouraged because the tree is highly adapted to the ecosystem and has multiple uses.

Fruits appear in August and September and up to 125 kg of ripe fruit can be harvested. Fruits are called wild dates. The fruit pulp, although bitter, is edible. The tree produces fruit even in dry years, which makes it a highly appreciated food source. Pounded fruits make a refreshing drink, which becomes alcoholic if left to ferment. The fruit has been used in the treatment of liver and spleen diseases. It is also known to kill the snails that carry schistosomiasis and bilharzia flukes. The kernels are a source of cooking oil, soap and medicines (see Table 11).

The wood is used in the manufacture of tools, furniture, small dams and boats. Since it is durable and resistant to insects, it is ideal for tool handles and domestic items, such as spoons. It is also valued as firewood, because it produces almost no smoke and has a calorific value of 19.2 MJ per kg. Rooted cuttings readily form a living fence. Protein-rich leaves and shoots are an excellent source of fodder for livestock. The leaves make very good mulch and the tree is nitrogen-fixing [5.26], [5.27], [5.28]. Young branches are sometimes used to prepare a sauce.

Fishing with poison made from the bark of *B. aegyptiaca* is a widespread practice in the Lake Chad Basin, although clearly it can only be used in certain locations, i.e. not in the lake itself, nor in the rivers. This technique is mainly used in the wadis or pools, where water levels fall as the dry season approaches. Women pulverize the bark and add water to make a paste, which is then placed in the pools. After four to six hours, the fish float to the surface where they can be gathered easily. The poison does not affect species of *Silurides* or *Dipneustes*, but all other species trapped in these pools are susceptible and can be fished using this method. The poison apparently causes no ill effects to the people who eat the fish.

NEAR BOL, CHAD

THE FRUIT OF *BALANITES* IS EDIBLE

TABLE 11 **KERNELS OF *BALANITES AEGYPTIACA***

COMPOSITION	
Cellulose	4.56%
Lipids	41.20%
Carbohydrates	20.76%
Proteins	26.86%
Ash	3.02%
Water	3.60%

Source: P. Créac'h, 1993 [4.5]

<< LEFT: *BALANITES* IS SELDOM PLANTED FOR REHABILITATION OF DEGRADED AREAS BECAUSE OF ITS SLOW GROWTH, BUT ITS PLANTING SHOULD BE ENCOURAGED BECAUSE IT IS HIGHLY ADAPTED TO THE ECOSYSTEM

FAIDHERBIA ALBIDA

Faidherbia albida is a monotypic genus and is normally a deciduous tree, reaching 15–25 m in height, with a trunk of 1 m in diameter. It flowers at the beginning of the dry season, just after coming into leaf. It remains in leaf throughout the dry season and loses its leaves in the rainy season, providing shade when it is hot and allowing crops to be grown in its vicinity during the rains.

It grows in the Sudanian–Sahelian savannahs, from Senegal to East Africa, where its leaves and fruit are used by pastoralists as fodder for cattle and small ruminants in the dry season. In Nigeria the pods are appreciated by camels. It does best in sandy soils, flourishing in the same areas as millet.

FAIDHERBIA ALBIDA [PLATE 29]

F. albida is widely used and is well documented for increasing the yields of crops grown beneath it. The gum that spontaneously exudes from the trunk is sometimes collected like gum arabic, but it does not have the same properties. The timber, although straight-grained, dense and weighty, is soft and fibrous. It is used for building animal enclosures, huts and dug-out canoes, as well as for making many household objects and tools. In Nigeria, the bark is pounded and used as a packing material for goods carried on pack animals. The wood ash is used in soap-making and as a tanning agent for hides.

The tree is also highly valued in terms of conservation. It is the only species to lose its leaves during the rainy season, so farming under these trees is not only possible but also profitable. According to FAO [5.29], a full-grown tree can produce more than 100 kg of pods each year. Some scientists believe that, with proper management, yields could be increased to a much higher level than those of the grasses and annual crops grown beneath the tree. (Trees reach 2–4 m after only three or four years growth.)

This species of acacia also has a use in traditional medicinal. The root is used to treat nausea, pneumonia, coughing and diarrhoea, while the bark is effective as a disinfectant and for reducing fevers. The gum is used for treating inflammations and eye infections [5.30].

NEAR KALAMALOUÉ, CAMEROON

FLOATING ISLAND NEAR BOL, CHAD

AESCHYNOMENE ELAPHROXYLON

This soft-stemmed shrub with large orange-yellow flowers is found on the banks of rivers and lakes in Africa. From 2.5 to 8 m tall, it grows extremely quickly and can form very dense mats, where wildlife proliferates but fishing becomes very difficult. Seeds are transported by wind and water. The wood is lighter than cork and very resistant. It is used locally to make boats and rafts [1.6].

AESCHYNOMENE ELAPHROXYLON [PLATE 30]

BLANGOUA MARKET (KOUSSERI), CAMEROON

FRUITS OF *ZIZIPHUS* ARE RICH IN CAROTENE, VITAMINS A AND C, AND FATTY OILS

ZIZIPHUS MAURITIANA

This is a spiny, evergreen shrub or small tree of the Rhamnaceae family, up to 15 m high, with a trunk 40 cm or more in diameter; leaves are variable and alternate, in two rows. The fruit is a drupe, globose to ovoid in shape, and up to 64 cm when cultivated, usually much smaller in the wild. It is known for its ability to withstand difficult conditions, such as soil salinity, drought and waterlogging. *Z. mauritiana* is a fast-growing species. Fruiting starts after three to five years.

The fruit is eaten fresh or dried and can be made into a floury meal, butter, or a cheese-like paste that is used as a condiment. It is also used for sweet-making and pickling and is a good source of carotene, vitamins A and C, and fatty oils. A refreshing drink is prepared by macerating the fruit in water.

Z. mauritiana produces excellent firewood (the sapwood yields 20.5 MJ per kg) and good charcoal. Its drooping branches are easily accessible for harvesting. It yields a medium- to heavy-weight hardwood with a density of 535–1 080 kg per m^3. The wood is used for general construction, cabinet work, and the manufacture of furniture, tool handles and agricultural implements. This species is ideally suited to stabilizing coastal sand dunes and controlling soil erosion [5.31], [5.32].

ZIZIPHUS MAURITIANA [PLATE 31]

DEWA VILLAGE (DIFFA), THE NIGER

THE DUM PALM GROWS NATURALLY, BUT IT IS ALSO PLANTED AND CULTIVATED TO PROVIDE FOOD AND SERVICES

>> RIGHT: THE TRUNK AND LEAVES OF THE DUM PALM PROVIDE MATERIALS FOR MAKING ROPE, TWINE, WEAVING AND CONSTRUCTION

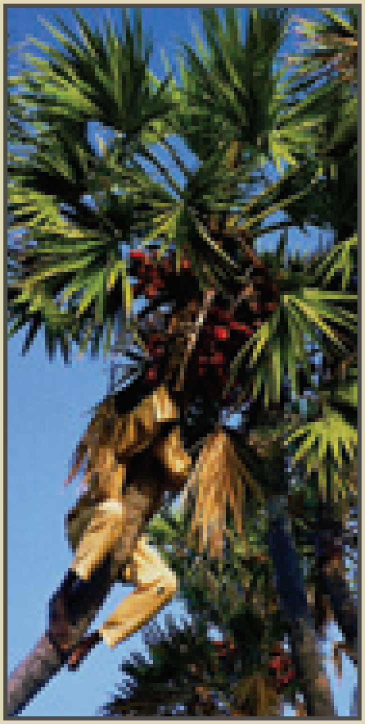
DUM PALM (*HYPHAENE THEBAICA*)

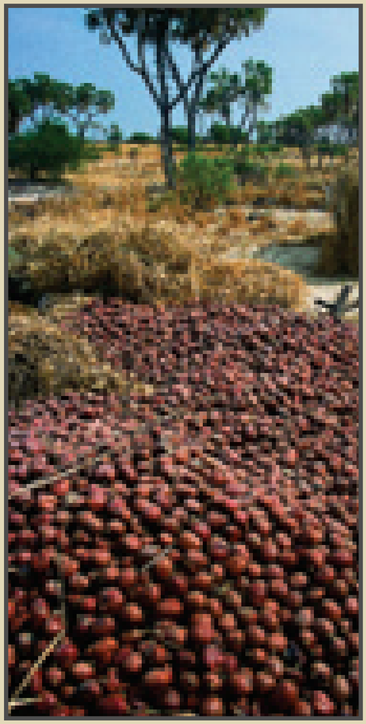
The dum palm, or gingerbread palm, is a deciduous, usually branched palm with two, four, eight or 16 heads of fan-shaped leaves. It occurs as dense, fire-resistant forests on coastal arid regions from East Africa to the continent of India. It is found in all the floodplains around Lake Chad and on the banks of the rivers that flow into the lake. It is propagated from seeds, and takes a long time to become established, but it can also be propagated from the suckers that originate from its base.

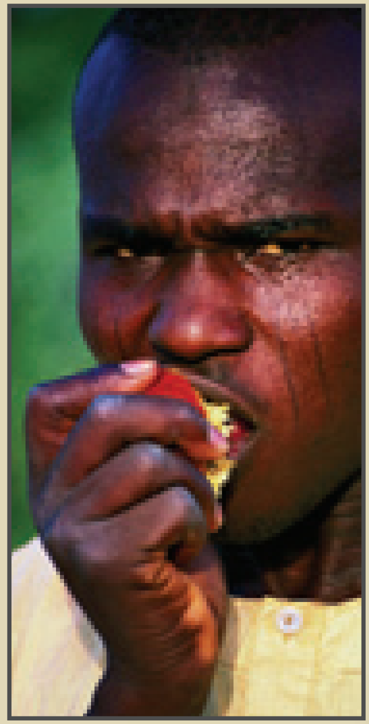
To the peoples of the deserts, where dum palms are found, this tree is a life sustainer. The trunk and leaves are used in much the same way as those of other palms: for making rope, twine, weaving and construction. The young leaves, before they unfold, are also used for weaving versatile mats. The sap obtained from tapping the apex of the palm is used for the usual wide range of purposes. The fruit pulp has a smell of gingerbread, hence the name "gingerbread palm". It is used in cooking in various ways, and varieties differ in their edibility.

The dum palm is currently being tested for its antifungal properties. Results have shown that a solution made from the fruits may be valuable in the treatment of fungal diseases [5.33], [5.34], [5.35].

BLANGOUA MARKET (KOUSSERI), CAMEROON







DEWA VILLAGE (DIFFA), THE NIGER

THE FRUIT PULP OF THE DUM PALM SMELLS OF GINGERBREAD , HENCE THE NAME "GINGERBREAD PALM"

The myriad uses of the dum palm

17 October 2001
Malam Fatori, Nigeria

Near Malam Fatori, on the road that leads to Damassak, in Bornu state, we make a slight detour to visit a Kanembu village. It is a small settlement of no more than 50 families, similar to many others hidden among the dunes. But this village is particularly interesting to us because of the special attention its inhabitants pay to the dum palm. This is evidenced by a large stockpile of dum palm fruit, measuring at least 7 m square and 2 m high, which stands at the entrance to the village. All around, there are palm trees growing, mostly over 15 m high and all with the characteristic division between the two main branches.

22 October 2001
Dewa, the Niger

Along the way, this time between Malam Kournadi and Diffa, we stop to photograph some superb specimens of dum palms. Our arrival is greeted with great cordiality, and the villagers vie with each other to respond to our curious questions about the use of this tree. One of them, Abdù, a young man who cannot have been more than 20 years old, climbs nimbly up a tree to fetch fresh fruit for us. There is very little flesh around the large kernel in the centre, but what there is has a pleasantly sweet flavour.

In these villages, and later in N'Djamena, we learn about the extraordinary versatility of this tree.

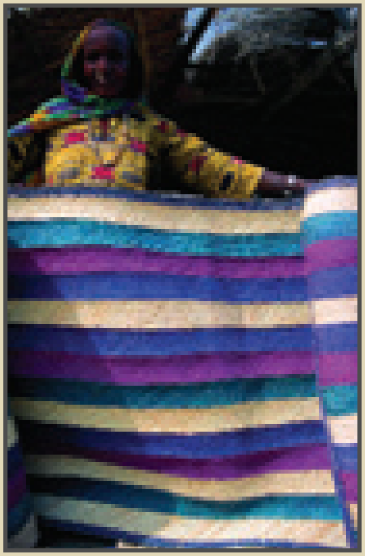
- Each dum palm yields around 40 fruits a year, usually picked by hand by young men like Abdù, who climb up the trunk with bare hands and feet.
- Its leaves are dried and plaited into mats, which are used for sleeping and shelter, as we have seen almost everywhere.
- Wood from its trunk is fashioned into kitchen utensils, while the fibres, soaked and mixed with those of the *Calotropis* (which give greater elasticity) produce strong ropes. In the Niger, they are used to tie up large boxes packed with smoked fish, ready for export to Nigeria.
- The roots of the dum palm are used to make fish traps – the double-chambered type. We have seen them at the mouth of the River Chari.
- The fruits themselves are generally used to make sweets, but in times of drought they represent an important source of food for survival.

PORT OF BLANGOUA, CAMEROON

DUM PALMS GROW IN THE FLOODPLAINS AND ON RIVER BANKS. THE LEAVES ARE PROCESSED AND TRADED OVER A WIDE AREA

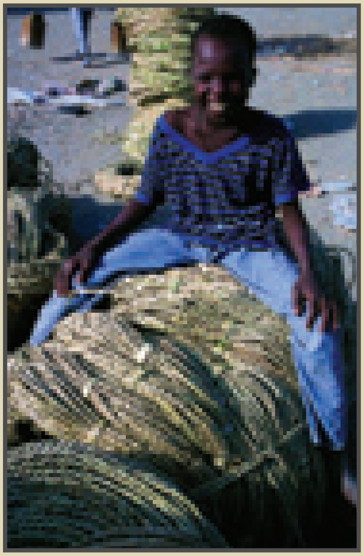
The dum palm has medicinal properties as well. The flesh of the fruit, dried and pulverized to produce an antiseptic powder, is used to treat epizootic aphtha in animals (foot-and-mouth disease). The usual treatment consists of three applications a day, for two or three days. An extract produced by boiling down the root is used to treat bilharzia.

The kernel, which is white and extremely hard, is known as "vegetable ivory". For generations, it has been used to make small precious objects, and even today it is used industrially to make buttons.



N'GUIGMI MARKET, THE NIGER

DUM PALM MAT



LELEWA VILLAGE (N'GUIGMI), THE NIGER

DUM PALM ROPES

CHAPTER 6

WATER AND LAND

*"My way
is every way
of my people,
and I drink,
every time I drink,
only the water
that I can hold
in the hollow
of my hand."*

[Peul proverb]

WATER AND LAND

by
the **authors** and
Olivier Berney [1]

6

BOL, CHAD

LAKE CHAD IS A PRECIOUS SOURCE OF FRESHWATER SURROUNDED BY AN EXTREMELY DRY ENVIRONMENT

INTRODUCTION

Worldwide, attention has been focused on the vital importance of water by the declaration of 2003 as the International Year of Freshwater. However, in spite of the growing recognition of the key role that water plays in development, more needs to be understood about the links between how it is used and the effects on the environment. Water is a precious and finite resource, crucial to the development of agriculture, but also fundamental to a whole range of other ecosystem services, including wildlife, fishing and livestock [6.1], [6.2].

In an area of virtual desert, the Lake Chad Basin offers a source of freshwater for the people who live on the shores of the lake and rivers and well into the hinterland. Farmers and pastoralists are keenly aware of the fluctuations in water availability and its effects on their lives, a fact which is reflected in the language that they use. They do not simply call the seasons "dry" or "wet". Instead, they refer specifically to the effect of rain on vegetation, using descriptions such as "necessary rainfall", "effective rainfall" and "useful rainfall".

[1] Technical Officer, Land and Water Development Divison (AGLW), FAO

WATER IS A FINITE RESOURCE — ITS WISE MANAGEMENT PROMOTES FOOD PRODUCTION AND ECOSYSTEM CONSERVATION

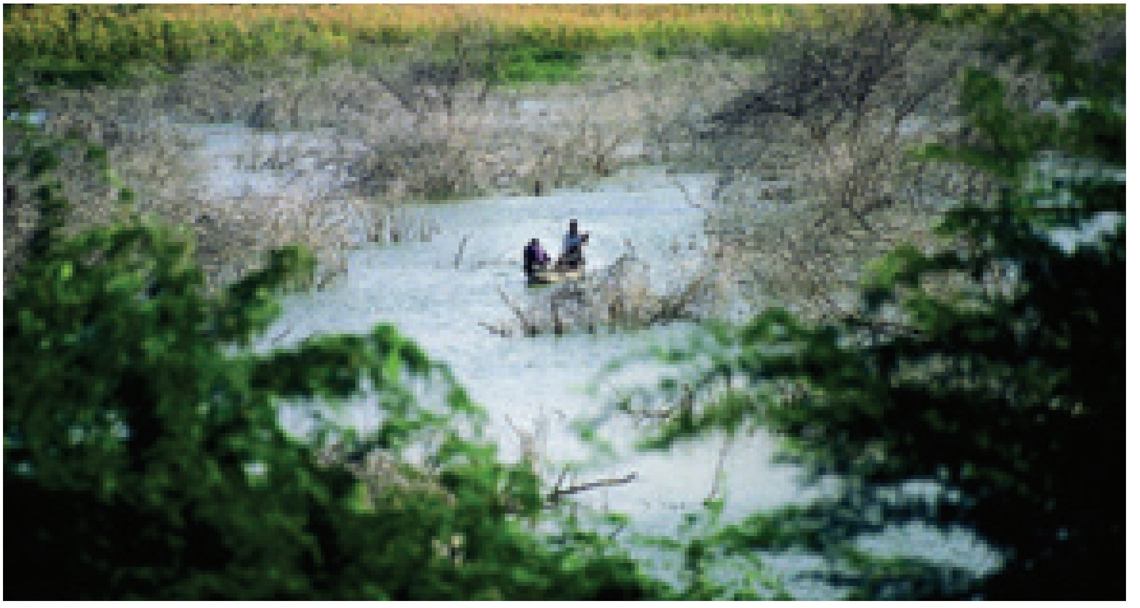
Local farmers have learned to adapt their agricultural systems to monthly, seasonal and yearly variations in rainfall. They can even predict the movements of the lake, since high and low water levels are a direct consequence of rainfall.

As a result, farmers and pastoralists have developed specific techniques in order to take advantage of the unique characteristics of this ecosystem without damaging it. These include the use of recessional land and natural wadis and ponds, the creation of polders and the construction of wells.

All efforts to increase food production should focus on enhancing these techniques, rather than replacing them with new intensive irrigation schemes, for example through the use of new water-saving or harvesting methods combined with improved agronomic practices, such as the following.

- The selection of drought-resistant seed.
- Integrated pest management.
- Introduction of legumes (*Vigna unguiculata* and others) intercropped with cereals.
- Rehabilitation of degraded soils using pioneer local cereal varieties combined with networks of water retention structures.
- Adequate maintenance of ground cover.
- Treatment of acid soils.
- Enhancing fish production from ponds and polders.

PORT OF DORO LELEWA (N'GUIGMI), THE NIGER



LARGE AREAS OF LAND ARE PERIODICALLY FLOODED. WHEN THE WATER RECEDES, THE SOIL STORES MOISTURE THAT CAN BE EXPLOITED FOR AGRICULTURAL PRODUCTION

RECESSIONAL LAND

The seasonal fluctuations in lake and river levels create large areas of land that are periodically covered and uncovered by water. As the water recedes, this land stores moisture that can be exploited for agricultural production.

Farming systems around the lake use both traditional and improved technologies to adapt to the changing lake levels. A first crop, generally a cereal, is obtained by cultivating during the rainy season. A second crop, for example, transplanted sorghum, *gombo* or vegetables, is produced from residual moisture that becomes available at the end of the rainy season, as lakewaters recede and large areas of fertile alluvial soils become available for direct planting [6.3]. A third crop can be obtained if small dams and pumps are available to provide irrigation water during the dry season. Lamentably, dykes and gates around the existing irrigated areas are often in poor condition, and the producers do not have the capital to improve them because of the low returns from farming. In old irrigated areas, bad irrigation management often leads to accumulation of salt on the soils and their consequent abandonment. High costs of fertilizers and difficult access to agricultural credit are behind the poor adoption of improved technologies that could increase the production in recessional land.

Recessional lands are also of particular importance for other reasons.

- **Preservation of biological diversity.** For many species of fish and waterfowl floodplains are of vital importance as breeding grounds as well as staging areas on their migration routes. All types of wetlands may harbour unique plants and animals.
- **Production of goods.** These lands are among the most productive ecosystems in Africa. Floodplains are important grazing areas for cattle and wildlife and a source of wild fruits, vegetables and medicines. Forests may yield valuable timber.
- **Production of services.** The lands can be an efficient, low-cost water purification system (herbaceous swamps), a recreation area (hunting, fishing and boating), and a buffer against uncontrolled floods.

Without these lands, the drylands of the West African Sahel would be both less productive and more hazardous as a place for people to live [6.4].

The Hadejia–Nguru wetlands

Extract from FAO Land and Water Bulletin No. 4 [6.4]**.**

The Hadejia–Nguru wetlands [6.5] concern a part of the floodplain of the Komadugu–Yobé river basin in the Lake Chad Basin in the northeast of Nigeria and are home to probably about a million people. The wetlands have formed where the waters of the Hadejia and Jama'are rivers meet the lines of ancient sand dunes aligned northeast–southwest. An area of confused drainage has formed here, with multiple river channels and a complex pattern of permanently and seasonally flooded land and dryland. The wetlands are nationally and internationally important for migratory waterfowl. They support extensive wet-season rice farming, flood-recession agriculture and dry-season irrigation. The floodplain also supports large numbers of fishing people, most of whom also farm, and is grazed by very substantial numbers of Fulani livestock, particularly cattle, which are brought in from both north and south in the dry season. There is also an important dispatch from the wetlands of fuelwood and fodder for horses. In the past, much of the rice, as well as fish and birds, was traded out of the area. This has changed, but there is now a strong export of other agricultural products, for example, peppers, wheat and fuelwood. The economic value of production from the wetlands is very large, many times greater than that of all the irrigation schemes for which the inflowing rivers are dammed, diverted and their waters used.

N'GUIGMI MARKET, THE NIGER

WETLANDS PRODUCE RICE AND VEGETABLES FOR BOTH HOUSEHOLD CONSUMPTION AND TRADING

There are natural changes, for example, the impacts of drought that have serious implications for the future of the wetlands and the sustainability of their production systems. There are also major economic changes within the wetlands themselves.

The extent of irrigation greatly increased over the 1980s, largely as a result of the advent of small petrol-powered pumps and the ban on the importation of wheat in 1988. As the use of small pumps spreads, conflicts are beginning to emerge between farmers and pastoralists, and between small and large farmers for access to land.

The wetlands have also been affected by developments elsewhere in the river basin. The construction of the Tiga Dam on a tributary of the Hadejia River in the early years of the 1970s has exacerbated the effects of the low rainfall of the two following decades. The result has been a reduction in the extent of flooding in the wetland. Most of the dams, irrigation schemes and water resources plans for the Yobé basin were prepared in the 1970s and early 1980s, using data for the relatively wet period up to 1973. The post-1972 drought has reduced the proportion of rainfall that runs off to the rivers. The 1988 flood at Hadejia was probably one of the largest for some years and it was augmented by the failure of the dam at Bagauda.

The Hadejia–Nguru wetlands have long been known as a centre of fish production. Upstream hydrological developments induced by irrigation projects threaten to degrade this important resource. Studies of floodplain fisheries have shown that fish production is closely related to flood extent. The existing and planned dams upstream of the Hadejia–Nguru wetlands are likely to have a serious impact on fisheries. Despite the lack of information specific to the Hadejia–Nguru wetlands, there are enough studies from other floodplains affected by hydraulic works to show that the effects of dams on fish communities are likely to be serious. The dams are likely to bring changes in river flow, loss of habitat, blocking of channels, changes in silt loading, plankton abundance and temperature, which are likely to affect fish communities.

The economic value of fish production from the floodplains adds weight to the argument in favour of maintaining the annual flooding of the wetlands. Moreover, the significance of fishing goes beyond its value in monetary terms. Fishing plays an important role in the flexibility and adaptability of the rural economy in the floodplains. A reduction in this flexibility through degradation of the fishery resource may have serious repercussions on the ability of communities to adapt to fluctuations in their environment. Many people are involved in fisheries and so the social consequences of any appreciable reduction in productivity will be felt throughout the area. Degradation of fisheries may also affect other sectors of the rural economy. Most people who fish also pursue other activities – such as farming, livestock rearing, manufacturing of crafts or trading – and the loss of, or reduction in one component of, the household economy is likely to affect activities in other sectors. There will also be "downline" effects on fish processors, fish dealers, customers and consumers.

PORT OF BLANGOUA, (KOUSSERI) CAMEROON

FORESTS AND BUSHLAND IN FLOODPLAINS PRODUCE FUELWOOD AND OTHER IMPORTANT NON-TIMBER PRODUCTS

In addition to producing fuelwood, the forest reserves and bushland of the floodplains yield important non-timber forest products that are significant to the livelihoods and subsistence of local communities. Some, including leaves, are important marketed commodities that generate substantial income. *Baobab* leaves are used widely as an ingredient for soups and stews and are especially important as a "drought food". Honey, produced by local beekeepers, is a highly valued commodity.

Since 1985, the area has been the focus of the Hadejia–Nguru Wetlands Conservation Project. This project has been run jointly by the Nigerian Conservation Foundation, IUCN (World Conservation Union), the Royal Society for the Protection of Birds and the International Council for Bird Preservation (now renamed BirdLife International). In 1990 a major development project was started by the European Community that included the eastern part of the area. The Northeast Arid Zone Development Programme (NEAZDP) has a very substantial budget to generate village-based development initiatives. Attention has tended to be directed in particular to the potential resources of the wetlands.

The economic importance of the floodplains suggests that benefits they provide cannot be excluded as an opportunity cost of any scheme that diverts water away from the floodplain system. Policy-makers should be aware of this problem when designing water development projects in the river system. Further analysis is also required of the type of "regulated flood projects" regime, which could maintain much of the floodplain system intact while still allowing some upstream water developments. Further investigation of all the economic benefits provided by the wetlands is also needed, and the sustainability of production within a floodplain area should be more thoroughly examined.

POLDERS

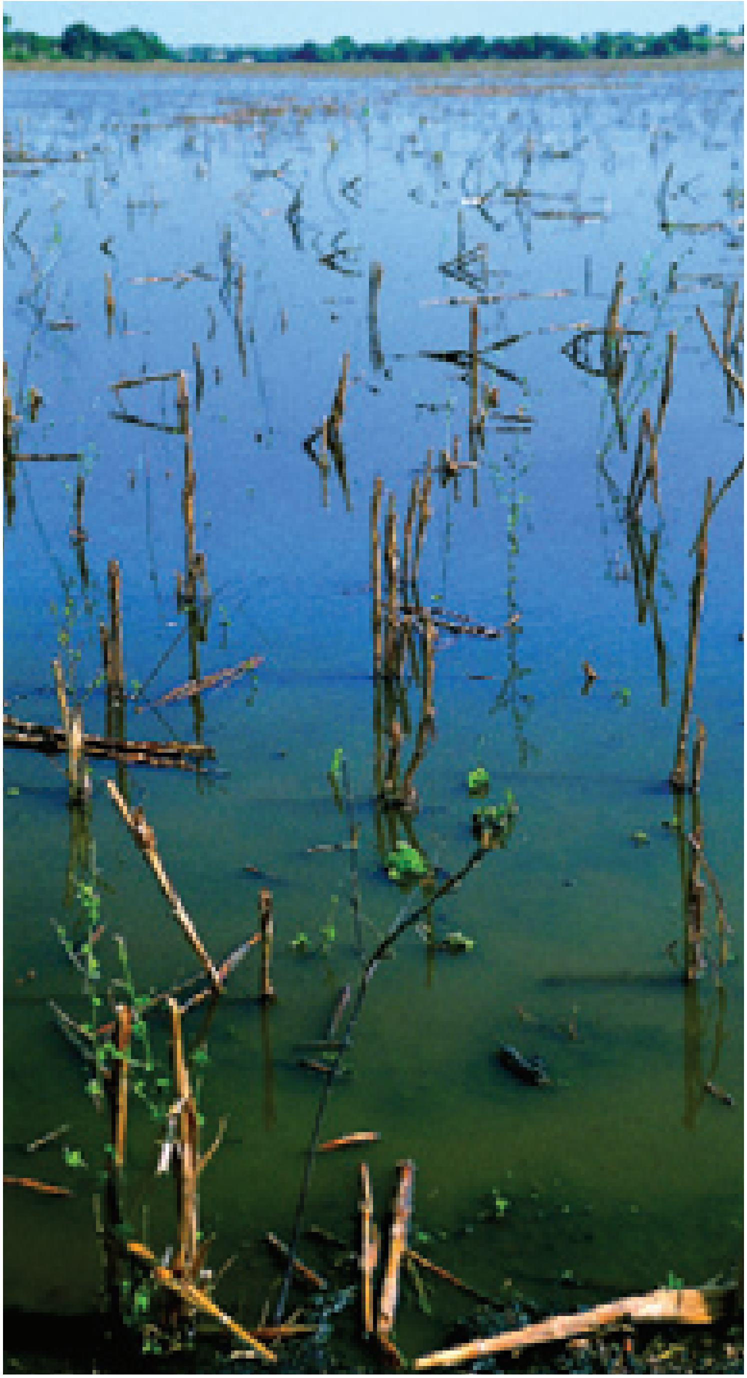
During annual spates, the long, narrow depressions located along the northern and eastern coast of the lake are flooded by lakewater, which normally recedes during the dry season. By closing these off at the inlets with a rudimentary dam, lake dwellers found they could produce a remarkably fertile plot of irrigated land, suitable for growing crops. Such a dammed wadi is currently called a "polder" [6.6].

Strictly speaking, the Dutch term "polder" represents an area where the water table can be regulated and controlled independently of the water level in the surrounding area. In this respect, a polder in Lake Chad can hardly be considered a true polder. However, a polder is also often considered as a low-lying area reclaimed from the sea or a lake and artificially protected against the risk of flooding. In Lake Chad, the term "polder" is used in this sense.

It is quite difficult to determine when polders started to be established. A dam appears on a map of the Kouri region dated 1913, but dams were most probably introduced long before then. More evidence of their use is available for later years, and they were already widespread along the northern shore of the lake in the 1950s.

Polder dams are traditionally built by embedding two rows of acacia tree trunks vertically at the narrowest point of the inlet. Palisades are fashioned using ropes made of *Calotropis* fibre and dum palm leaves, and the intervening space is filled in with sand. Dams can reach 100 m in length and are generally between 2 and 3 m thick [1.5].

As the waters are gradually absorbed into the soil, crops are planted. To begin with, the outer edges of the polder are cultivated, since this is where the water first recedes.



KLA AOUDOU POLDER (BOL), CHAD

POLDERS ARE NARROW INLETS FLOODED BY LAKEWATER. A SMALL DAM AT THE INLET MOUTH PREVENTS WATER FROM RECEDING, THUS ENABLING AGRICULTURAL PRODUCTION DURING THE DRY SEASON

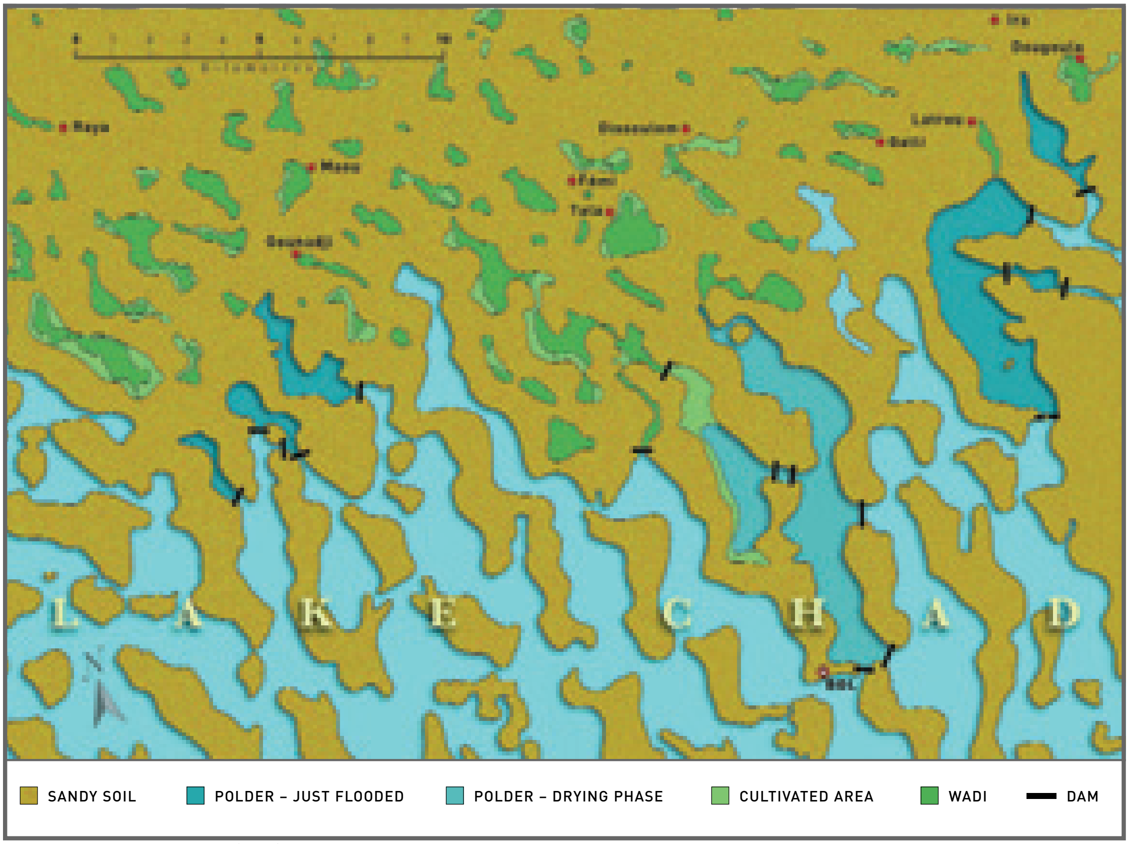
The central areas are reserved for later cropping. If the higher reaches dry out too quickly, shallow wells are dug to irrigate them. In this way polders can boost crop output from one harvest to three harvests per year.

The dams normally last for six to ten years, provided that the passage of cattle over the top of the dyke is not too heavy. In any case, polders are designed as a temporary structure. Every six to ten years, the dams are deliberately breached to allow in fresh lakewater to wash out the accumulated salt from the soil and deposit new layers of silt. Generally, the polder is then left to allow the original vegetation to re-establish, in order to restore the balance of the soil. Animals are let in to graze, and their dung contributes to the recycling of the organic material of the land. Since this is a nomadic society, the farmers move on to build new polders elsewhere, or to reactivate ones that have been allowed to lie fallow.

Lands irrigated using this system need no input of fertilizer. They are naturally rich in nutrients left by the lakewaters as they recede, and they are maintained by the system of cropping and fallow. The soils are generally hydromorphous and medium in terms of organic matter content, consisting of damp gley with calcareous alluvial deposits, which are developed to a greater or lesser degree after being submerged or saturated with water. These soils are rich in minerals and, initially, rarely saline. Today, sorghum, millet, rice, wheat, maize and vegetables are grown on polders.

It should be stressed that the farming practised in these polders is essentially subsistence cropping and not commercial. Only part of the available land is actually cultivated, because of the immense task of clearing spontaneous vegetation which, after just a few months of neglect, can reach a height of 2 m.

THE DAMS USED TO BE BREACHED EVERY FEW YEARS TO LET FRESHWATER INTO THE POLDER. RECENTLY, PVC PIPES HAVE BEEN INSTALLED IN SOME POLDERS TO AVOID THE NEED FOR BREACHING THE DAM



MAP OF POLDER AREA AROUND BOL (CHAD) IN 1956
DATA ELABORATED FROM ORSTOM/FAO [6.7]

In recent years, modifications have been made to the traditional method of building polders, with varying degrees of success. In some cases, polyvinyl chloride (PVC) pipes have been placed across the dam at the lowest point. When the polder is flooded, the pipes are closed off by jamming them with small sandbags. When the land becomes too dry, generally after two to three years, the sandbags are removed so that the polder can become flooded again. The process is repeated as the need arises. Sandbags can be replaced by installing valves on the pipes (for example, in the Kindjiria polder, a SODELAC (Societé de développement du lac) project with international funding, which covers a surface of 800 ha [6.8]). This system allows water to be let in without breaching the dam – a saving in cost and labour – and can work well provided that the principle of letting the polder rest and recuperate is respected.

KLA AOUDOU POLDER (BOL), CHAD

SANDBAGS ARE USED TO CLOSE OFF THE PVC PIPES

PERMANENT POLDERS: IS THIS THE WAY FORWARD?

Another adaptation of the polder introduces a more permanent structure, which is alien to the notion of versatility on which this system of irrigation is based. In this case, the dam is built from reinforced concrete, and motorized pumps are used to inject more lakewater as required. The water is directed along a network of channels, also built of concrete, so that land further afield can be irrigated. By its very nature, a concrete dam is likely to be more permanent: it is clearly much harder and more expensive to remove or abandon a dyke built of cement than one made of tree trunks and dum fibre. The intention is evidently to build a structure designed to remain in place on a permanent rather than a temporary basis.

Projects and plans aimed at intensifying polder irrigation, and at making it a continuous process, are moving forwards, although progress has been slowed by lack of tools and human resources. Intensification of irrigation would undoubtedly increase food production. However, gains in output must be offset against higher production costs and, perhaps more important, the invisible costs to the environment, which will only become evident much further down the line.

Flexible and cheap irrigation methods favour mobility: if a dam is inexpensive and easy to remove, farmers can move on when the time is right. These methods also promote cultivation rights based on consensus and tacit customary agreements, which in turn sustain mixed agropastoral production systems. Continuous polder use does not foresee access by animals, since its sole aim is to intensify agricultural output. Yet livestock have a valuable role to play in a production system. Animals provide meat, milk and

TER BOLET POLDER (BOL), CHAD

AS THE POLDER DRIES OUT, SHALLOW WELLS ARE EXCAVATED TO EXTRACT WATER

TRADITIONAL SMALL-SCALE POLDERS ARE QUITE EASY TO MANAGE. RECENTLY, LARGER POLDERS COVERING HUNDREDS OF HECTARES HAVE BEEN CREATED TO INTENSIFY PRODUCTION BUT THEIR ENVIRONMENTAL AND SOCIAL IMPACT SHOULD BE CAREFULLY EVALUATED

manure and also offer a degree of income generation and food security. If an area under polder irrigation is hit by drought, crops will fail no matter how sophisticated the structure, but animals can always be moved to better grazing pastures.

By their very nature, permanent polders encourage communities to become sedentary, a tendency that goes against traditional practice in the region and that deprives people of the flexibility that has enabled them to survive in the past. The new polders are much bigger than their forerunners. A traditional polder covers an average of 20 ha. By contrast, the polder that has been recently developed near Bol covers a massive 800 ha, attracting a huge increase in population in the process and putting an unsustainable strain on the land. Increasing yields mean that other issues have to be addressed, such as access to markets. Indeed, once new crops have been introduced, and production has been intensified beyond subsistence needs, the entire system and infrastructure will have to be overhauled. Additional roads will need to be built. Services will have to be provided for the new populations.

Less obviously, at least in the short term, continuous polder use will take its toll on the environment. Permanent polder use can cause salt buildup in soil and groundwater, making the land less fertile. The overuse of water in one area can lead to inadequate supplies in another, a factor that can lead to the disruption of the delicate wetland system on which the Lake Chad Basin relies. The result will be losses in wildlife, fish stocks and vegetation. Already, the effects of intensification plans have begun to make themselves felt. In some parts of the lake, wetland areas are drying out, a process that is leading to changes in the migration patterns of birds, feeding and breeding grounds for fish and wildlife, and grazing for livestock. As part of the ripple effect, pastoralists are also having to alter their seasonal pattern of movement between arid and wetland environments.

The sustainability of traditional systems related to irrigation and use of freshwater must be studied and evaluated both from the environmental and from the production point of view.

There is still a lot to do to ensure a more rational and sustainable use of the limited surface water, starting with a complete inventory and the establishment of reliable regulations concerning existing installations and their exploitation [6.8].

BOUDOU ANDJA WADI (DUM DUM), CHAD

WADIS ARE DEPRESSIONS THAT COLLECT RAINWATER. SOME OF THE MOST ANCIENT WADIS ARE SOURCES OF SALT AND EDIBLE ALGAE USED BY HUMANS AND LIVESTOCK (SEE ALSO CHAPTER 9)

WADIS

A useful natural source of water in the Lake Chad Basin comes from the wadis. In arid countries the Arabic term wadi (French *oued*) means "a temporary watercourse", which is most often dry but which carries huge quantities of water and mud during flood events. Around Lake Chad wadi has a different meaning and refers to the ancient depressions on the edges of the lake bed and low-lying floodplains near the rivers that collect rainwater. As a result, they may be full at certain times of the year and dry at others. The depressions vary greatly in size and shape. Some are round, but often they are long and narrow, resembling small rivers when water is plentiful. Wadis with steeper banks tend to collect more water and more organic matter.

Wadis are made up of stratified lacustrine alluvial soils, which are rich in organic matter, with swelling calcium and montmorillonite clay formations. For centuries, local communities have used wadis for a variety of purposes, depending on their needs and on the particular type of wadi. Some of the most ancient wadis are sources of natron or salt to supplement the diet of livestock. Others are set aside to provide drinking–water for animals. Wadis with a good supply of water may serve as a breeding ground for a valuable alga (*dihé*: see chapter 9). Many are used cultivated and cropped, and farmers have developed traditional skills to get the most out of these naturally fertile areas, which often allow them to produce a second harvest [1.5].

The crops planted will depend on the season – a wadi may be farmed with cotton or vegetables in the dry season and wheat, sorghum or maize in the rainy season.

NEAR GUITTE (N'DJAMENA), CHAD

SOME WADIS PROVIDE FRESHWATER FOR AGRICULTURE AND LIVESTOCK

Periodically, the wadi will be left fallow to allow the spontaneous regeneration of *Acacia*, *Boscia senegalensis*, *Salvadora persica* or *Capparis decidua*, which provide good fodder for cattle. Often, the edges of wadis are planted with date palms (*Phoenix dactylifera*) or are used for grazing. Wadis are frequently rich in the wild grasses known as *kreb*, which are highly prized by pastoralists for whom they provide food security in the dry season.

NEAR LIWA, CHAD

PALM TREES ARE OFTEN PLANTED AROUND THE EDGES OF WADIS

PONDS

Ponds are permanent, semi–permanent or temporary sources of freshwater used by villagers in their daily lives. They vary very much in size, depth and water quality. They are used for drinking–water, irrigating vegetables, watering animals and for fishing. Use of water from ponds is regulated at village level and agreements are established with pastoralists from outside the village who need water for their livestock.

KINASSEROM ISLAND (BOL), CHAD

NEAR GUITTE (N'DJAMENA), CHAD

PONDS ARE SMALL FRESHWATER BASINS USED BY VILLAGERS FOR THEIR DAILY NEEDS

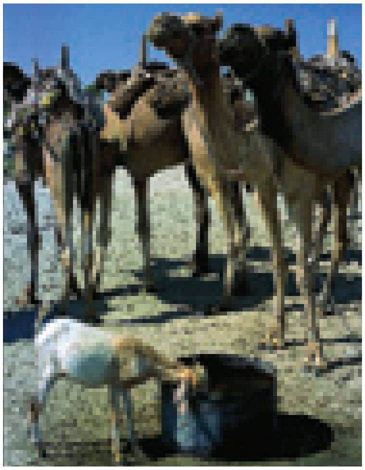
THE WELL NEAR LOWA, (TAL DESERT), THE NIGER

GENERATIONS OF HERDERS HAVE LEARNED HOW TO FIND WATER, DIG WELLS AND MAINTAIN THEM

PASTORAL WELLS

The ability to find water, to move, to follow the rains – seeking the presence of water in wells and pools – is absolutely vital for the region's pastoralists. Generations of herders have learned how to find water, how to sink wells and how to maintain them. Likewise, the region's pastoralists have long experience in deciding who uses the water from traditional wells and what contribution should be exacted for the service. These rules have never been written down but are part of a long oral tradition and are essential for the smooth running of the system.

The use of grasslands is inextricably linked to water supply and management. Animals cannot survive unless there is a source of water within at least 20 km, or 30 km in the case of camels. The average daily requirement of cattle is 20–30 litres of water and 5–10 litres for small ruminants. However, it is also crucial to balance the quantity of livestock with the grasslands and water available in a given area. Local herders know that water that is too freely available attracts more livestock, which in turn destroys the pastureland, making it difficult to feed them in the future. The



NEAR LIWA, CHAD

THERE MUST BE A BALANCE BETWEEN THE NUMBERS OF ANIMALS AND THE AVAILABILITY OF WATER AND GRASSLAND answer lies in balancing the number of animals with the potential grassland and water available.

Traditional wells are usually located in a depression and have a mouth with an average diameter of 1 m, depending on the composition of the surrounding soil. The well shaft is generally square in shape and is reinforced with criss-crossed tree trunks. *Acacia raddiana*, *Commiphora africana* and *Balanites aegyptiaca* are most commonly used for this purpose. In the spaces between the trunks, grass (*Cyperus conglomeratus*) is used to prevent sand from seeping into the water. The lip of the well is slightly raised to prevent it from filling with mud and polluted water.

The lifespan of a traditional well depends on a range of factors, including the stability of the soil, the speed at which the chemical composition and humidity of the soil cause the wooden supports to rot, and the well's capacity to survive during the rains. Some wells collapse during the rainy season as a result of being located in the lowest parts of depressions, which makes them prone to flooding.

Communities decide who digs the wells and who can use them. Water is never refused to other pastoralists because, according to a local saying, "refusing water is to refuse life". However, a strict code dictates the order in which people may use the well and the compensation that should be made for the service. Outsiders are generally allowed access to a well on condition that their animals are free from disease. If a herder reaches a well when it is sanding up, he may be expected to help rebuild it or clear the sand. Often, he will leave a ram or ewe in thanks when he and his animals move on.

NEAR LIWA, CHAD

THE COMMUNITIES DECIDE WHO DIGS THE WELLS AND WHO CAN USE THEM

NEAR DIFFA, THE NIGER

WOMEN OR CHILDREN LOOK AFTER THE ANIMALS USED TO LIFT THE WATER

LIFTING THE WATER

Since most traditional wells are between 10 and 50 m deep, animals are used to extract the water. The animal – generally a camel or two donkeys – is harnessed to a rope made of palm fibre or nylon, at the end of which is a scoop either made of leather or fashioned from the inner tube of an old truck tyre.

Water extraction is a regimented routine, around which most of the other daily activities revolve. Lifting begins at 09.00 hours and finishes at around 18.00 hours, although it may continue late into the night when the need arises.

The herders take turns at watering their animals, with the first to arrive moving on so that they leave enough space for the newcomers.

Women generally take charge of the camel or donkeys used to lift the water, although young boys may also help. As well as drawing water for the cattle, women also have the task of storing the water in plastic or rubber gourds made of inner tubes, which are subsequently transported by donkeys. Water for human consumption is carried in bags made of goatskin or sheepskin. These leather waterskins keep the water fresh because of rapid evaporation from the surface by the wind. Today many waterskins have been replaced by containers made of old truck tyres.

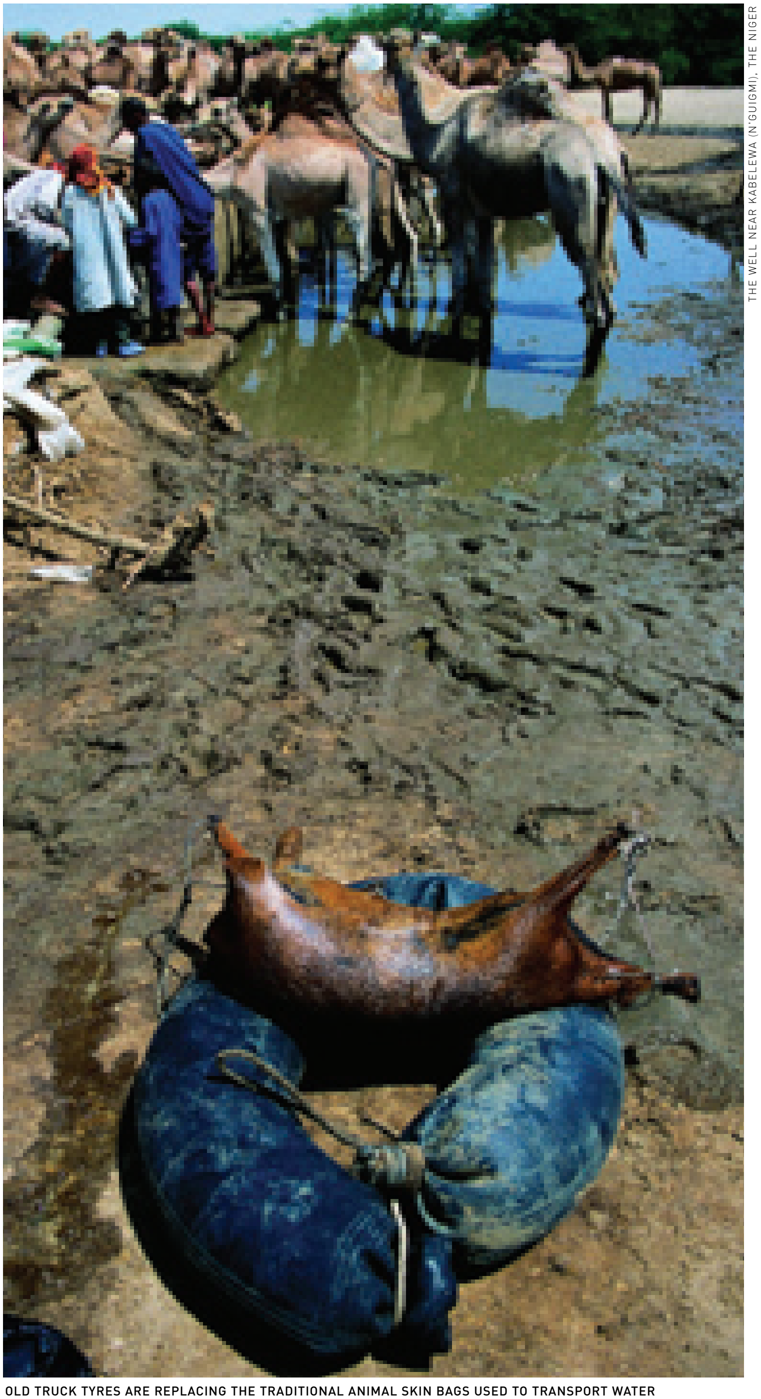
ARTESIAN WELLS

The artesian aquifer from the Pleistocene extends beneath the whole of the Lake Chad Basin and is located within sands and silts at a depth of about 250–400 m. The geographic limits of this system – its depth and its lateral extent – are not yet known exactly. A number of deep boreholes to tap the artesian resources have been drilled since the early 1960s, when the average artesian discharge was about 8 m^3 per hour. The discharge has progressively diminished to zero in a number of these wells. There is no exhaustive inventory of the wells and the original logs have been lost. All the original water control superstructures have been disrupted so that the wells now discharge without control.

Traditional saying

The Fulbe say:

"If you want to know how many animals a Peul has, and the height of his straw at the end of the dry season, just look at the depth of his well. If his water is not far from the lip and there is plenty of it, he will draw more scoops out than you in one day, and will be able to water more animals. But the grasses around the well will be eaten more quickly and the cattle will grow thin. The well in the depression and the grassland around it are like the heart and the stomach: they must live in harmony, otherwise a man is sick."



THE WELL NEAR KABELEWA (N'GUIGMI), THE NIGER

OLD TRUCK TYRES ARE REPLACING THE TRADITIONAL ANIMAL SKIN BAGS USED TO TRANSPORT WATER

THE WELL NEAR KABELEWA (N'GUIGMI), THE NIGER

ABOVE AND BELOW: ACTIVITIES ARE HECTIC AROUND WELLS

THE WELL NEAR KABELEWA (N'GUIGMI), THE NIGER

IRRIGATION

Until the 1970s the irrigation strategy favoured the development of large projects with a view to higher productivity of the irrigated land. However, because of maintenance problems and periods of low rainfall, this strategy did not produce adequate results.

At present, out of an estimated potential of over 1.1 million ha of irrigated land in the area of the conventional basin, around 100 000 ha are actually irrigated [6.4], and the maximum sustainable development should not exceed 400 000 ha according to a study financed by the United Nations Development Programme (UNDP) [6.9]. These data for the four riparian countries are shown in Table 12.

NEAR MALAM FATORI, NIGERIA

SMALL PUMPS ENABLE THE PRODUCTION OF 1-2 ADDITIONAL CROPS PER YEAR

NEAR MAMOURI (BOSSO), THE NIGER

IRRIGATION SHOULD BE A SERVICE TO AGRICULTURE, NOT AN END IN ITSELF

NEAR MALAM FATORI, NIGERIA

CURRENTLY, IRRIGATED AREAS REPRESENT ONLY A SMALL PERCENTAGE OF THE ESTIMATED IRRIGATION POTENTIAL

TABLE 12 **COMPARISON OF POTENTIAL AND ACTUAL IRRIGATED AREAS IN THE FOUR RIPARIAN COUNTRIES OF THE LAKE CHAD BASIN**

	Irrigation potential			Reduced irrigation potential (UNDP study)			Actual irrigated area
COUNTRY	**Within conventional basin (ha)**	**Outside conventional basin (ha)**	**Within the whole basin (ha)**	**Within conventional basin (ha)**	**Outside conventional basin (ha)**	**Within the whole basin (ha)**	**Within the whole basin (ha)**
Cameroon	80 000	20 000	100 000	46 700	20 000	66 700	13 820
Chad	700 000	135 000	835 000	142 500	135 000	277 500	14 020
Nigeria	300 000	202 000	502 000	204 000	100 000	304 000	82 821
The Niger	40 000	8 000	48 000	3 000	8 000	11 000	2 000
TOTAL	**1 120 000**	**365 000**	**1 485 000**	**396 200**	**263 000**	**659 200**	**112 661**

Source: FAO, 1997 [6.4]

PORT OF BLANGOUA (KOUSSERI), CAMEROON

NEAR N'DJAMENA, CHAD

CONSIDERABLE INCREASE IN HARVESTS CAN BE ACHIEVED BY COMBINING MODERN WATER MANAGEMENT TECHNIQUES WITH TRADITIONAL FARMING PRACTICES

ENVIRONMENTAL CONSIDERATIONS IN IRRIGATION DEVELOPMENT

Irrigation has contributed significantly to the alleviation of poverty and food insecurity, and to improving the quality of life for rural populations. However, the sustainability of irrigated agriculture is being questioned, both economically and environmentally. Inadequate attention to factors other than the technical engineering and projected economic implications of large-scale irrigation or drainage schemes in Africa has all too frequently led to great difficulties.

The sustainability of irrigation projects is dependent on the consideration of environmental effects, as well as on the availability of funds for the maintenance of the implemented schemes.

It is essential for irrigation projects to be planned and managed in the context of overall river basin and regional development plans, including both the upstream and downstream catchment areas.

The expansion and intensification of agriculture made possible by irrigation have the potential for causing the following.

- Increased erosion.
- Pollution of surface water and groundwater from agricultural biocides.
- Deterioration of water quality.
- Increased levels of nutrients in the irrigation and drainage water, resulting in algal blooms, proliferation of aquatic weeds and eutrophication in irrigation canals and downstream waterways.

Large irrigation projects that impound or divert river water have the potential to cause major environmental disturbances as a result of changes in the hydrology and limnology of river basins. Reducing the river flow changes the land use and ecology of the floodplain and can cause saltwater intrusion into the rivers and groundwater of adjacent lands. Diversion of water through irrigation further reduces the water supply for downstream users, including municipalities, industries and agriculture. A reduction in river base flow also decreases the dilution of the municipal and industrial wastes that are added downstream, posing pollution and health hazards.

The potential negative environmental impacts of most large irrigation projects include the following.

- Waterlogging and salinization of soils.
- Increased incidence of water-borne and water-related diseases (for example malaria and bilharzia).
- Negative impacts of dams on natural flooding, fisheries and wildlife.
- Reduced farming flexibility – irrigation may only be viable with high-value crops, thus reducing extensive activities such as grazing animals, operating woodlots, cultivation of crops for self-consumption.
- Changing labour patterns that make labour-intensive irrigation unattractive.
- Problems of resettlement or changes in the lifestyle of local populations.

User participation at the planning and design stages of new schemes and of the rehabilitation of existing schemes, as well as the provision of extension, marketing and credit services, can minimize negative impacts and maximize positive ones [6.4].

WAYS TO MITIGATE THE NEGATIVE IMPACTS OF IRRIGATION PROJECTS

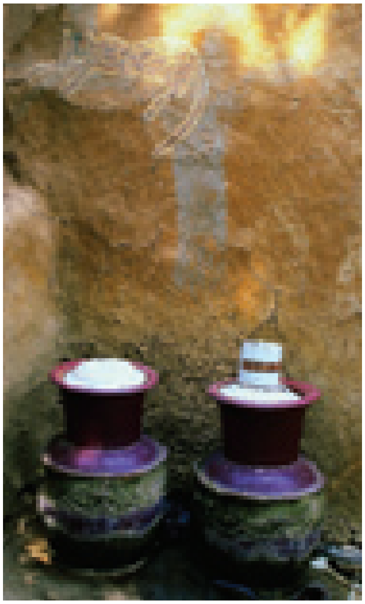
There are ways to mitigate adverse effects of irrigation development.

- Using locally available materials, tools and human capacities.
- Careful planning and monitoring of the effect of any new technology on the other components and functions of the ecosystem.
- Giving priority to demand and perceived needs, and adaptation to social and cultural models and consumption habits.
- Enabling low investment and access to microcredits in order to favour direct investments by farmers.
- Using sprinkler irrigation and micro-irrigation systems to decrease the risk of waterlogging, erosion and inefficient water use.
- Using treated wastewater, where appropriate, to make more water available to other users.
- Maintaining flood flows downstream of the dams to ensure that an adequate area is flooded each year, for example for fishery activities.

WATER HARVESTING AND CROP MANAGEMENT

Increasing water productivity, improving water management methods, harvesting water in structures such as furrows, building microdams and improving drainage systems to control soil salinization all allow farmers to conserve rainwater and direct it towards their crops. Considerable increase in harvests can be achieved by combining modern water management techniques with traditional farming practices, including the following.

- Managing water to maximize crop/livestock systems.
- Selection of appropriate seeds and cultivars resistant to drought.
- Cultural and agronomic practices that reduce water evaporation, for example variable row-spacing and application of mulches.
- Adopting biological pest control practices.
- Boosting soil fertility and improving nutrient management to raise the yield.


GAOUI VILLAGE (N'DJAMENA), CHAD

IRRIGATION SCHEMES SHOULD BE ADAPTED TO SOCIAL AND CULTURAL MODELS AND CONSUMPTION HABITS


TER BOLET POLDER (BOL), CHAD

>> RIGHT: WISE WATER MANAGEMENT IS A COMMITMENT TO FUTURE GENERATIONS

KINASSEROM ISLAND (BOL), CHAD

Notes from a journey

Traditional water management

12 October 2001
Kabelewa, the Niger

We make a stop near the village of Kabelewa, a few kilometres from N'Guigmi. Here, as a result of a project of international cooperation, an artesian well was dug a few years ago. We want to see the well in order to document its impact on the life of the people around it.

We are greeted by chaos: the sudden abundance of water in an area of previous scarcity has created a dangerous attraction. Not only does the land around the well not offer pasture for all the thousands of animals brought there for watering, but also the forced coexistence of unrelated ethnic groups has created some tension. Arabs with camels, Peul with zebu and goats, Mobber and Kanouri with zebu and sheep, Wodaabe with M'Bororo cattle: they all crowd in and push at the borders of the large space around the well and, after a reasonable wait, demand access to the water. But the number of animals is great, the waiting lasts into the next day, and the nervousness increases. It is not clear who organizes the turns, nor what criteria are used. We will ask the people responsible for the project how they intend to proceed.


AT THE WELL NEAR LOWA, (TAL DESERT), THE NIGER

MADAME RAGATÀ, TOWN COUNCILWOMAN OF N'GUIGMI


THE WELL NEAR KABELEWA (N'GUIGMI), THE NIGER

ABOVE AND BELOW: PEOPLE AND ANIMALS CROWD AROUND A RECENTLY DUG ARTESIAN WELL


THE WELL NEAR KABELEWA (N'GUIGMI), THE NIGER

13 October 2001
Tal Desert, the Niger

From N'Guigmi we proceed southwest for 15 km, towards the Tal Desert. Issufa Gumayé, a well-known guide of the area, is at the wheel of the ancient four-wheel-drive vehicle. With no track to follow, nor any sign that we can detect, he tackles the trip with enthusiasm and skill. We are accompanied by Madame Ragatà, a woman of Arab origin, who arrived as a child at the shores of Lake Chad with her nomad family of cattle breeders. Over the years, Madame Ragatà has earned the trust and respect of the local community to the point of becoming a town councilwoman of N'Guigmi. In addition, she has become a specialist in the management of this area's rarest and most precious resource: water. With great intelligence, she uses it to create lush oases in the middle of the desert.

Madame Ragatà takes us to the Lowa well, a traditional well still animal-powered: a camel pulls a rope to bring to the surface a leather bag overflowing with water. At a phreatic stratum 50 m deep runs perennial water. Since it is so close to the desert, it is mostly Arab nomads who go there daily to water their camels.

Madame Ragatà is a woman with an iron hand and acknowledged authority. With booming voice, she settles any controversy among the Arab nomads, the Peul and the cattle breeders of the area; in fact, she knows the needs, rights and obligations of each and is respected by everyone. Issufa Gumayé says that, so far, there has not been a problem she has not solved; smiling slyly, he translates for us a Peul song about how women "seem subordinate, but in reality ...". Looking at Madame Ragatà, there can be no doubt: she is in charge, both within the family and outside of it. But apart from the personal qualities of Madame Ragatà, the situation at the Lowa well seems to confirm the importance of the involvement of the local community and local experts in the management of problems related to the ecosystem.

AT THE WELL NEAR LOWA, TAL DESERT (N'GUIGMI), THE NIGER

MADAME RAGATÀ IS AN ACKNOWLEDGED AUTHORITY IN SETTLING THE DISPUTES AROUND THE WELL

CHAPTER 7

FISHERIES

"Where there is water,
Buduma people and fish
cannot be separated."

[Buduma proverb]

FISHERIES

by
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C. Béné[2]
T. Jolley[2]
B.M.B. Ladu[3]
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7

KINASSEROM ISLAND (BOL), CHAD

FISHERIES ARE AN IMPORTANT ECONOMIC ACTIVITY IN THE LAKE CHAD BASIN

INTRODUCTION

The arid zone of sub-Saharan African (latitudes 9–13°N), including the Sahel, and the Sudanian and Guinean savannah belts, contains some of the most productive and economically important inland fisheries in the whole of the continent, mainly in the form of large areas of seasonally inundated tropical wetlands [7.1]. Although reliable statistics and information are not widely available, fisheries such as the Sudd (River Nile floodplain) in the Sudan, the central delta of the River Niger in Mali, and the Lake Chad Basin are thought to produce several hundred thousand tonnes of fish each year [7.2].

In the case of the Lake Chad Basin, the fisheries are operated almost exclusively by thousands of artisanal fishermen using fishing gear and boats based on traditional designs. The fishermen exploit a wide range of fish species within a complex of lake, river, floodplain and swampland environments, of which they have a good knowledge and understanding. Fishing operations form an integral part of many household economies, along with farming. A significant proportion of the fish catch is smoked and dried. It then enters a well-organized commercial fish-marketing chain which extends to the large urban markets of southern Nigeria, including Lagos, Ibadan, Onitsha and Enugu, where the dried fish is much prized by local consumers.

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NEAR KANIRAM VILLAGE (MALAM FATORI), NIGERIA

FISHERIES ARE OPERATED ALMOST EXCLUSIVELY BY THOUSANDS OF FISHERMEN USING TRADITIONAL GEAR, TRAPS AND BOATS BASED ON LOCAL DESIGN

FISH PRODUCTION

The regional and international importance of the inland fisheries of the Lake Chad Basin has long been recognized by travellers, various observers and, more recently, by fisheries scientists and policy-makers. In the nineteenth century, Denham, a British explorer, noted in his journal that:

"The sweet and pleasant waters of the lake (Lake Chad) abounded in fish which the women caught by wading in and then, having formed a line facing the shore, charging through the shallows, grabbing them as they tried to swim away or leapt upon the shore" [7.3].

More recently, in the 1970s, a team of French scientists from ORSTOM (Office de la recherche scientifique et technique d'outre-mer, now Institut de recherche pour le développement, or IRD) undertook an extensive investigation of the Lake Chad Basin environment from their base at N'Djamena. It was estimated that the fisheries could be harvested sustainably at a level of 180 000 tonnes each year during "normal" hydrological periods with good influent floods into the lake. For the period 1960–2000 the average annual catch has fluctuated at around 50 000–80 000 tonnes.

In 1992, the Lake Chad Basin Commission (LCBC) produced its *Master plan for the development and environmentally sound management of the natural resources of the Lake Chad Conventional Basin* [7.4]. The economic importance of fisheries for millions of people in the riparian countries was emphasized and the need for appropriate management in the future was highlighted.

STATISTICS

It has also been long recognized that our knowledge and understanding of the fisheries of the Lake Chad Basin are very limited. FAO [7.1] confirmed that the information deficit for inland fisheries in the arid zone of West Africa is particularly acute. In the case of the riparian countries of the Lake Chad Basin (Nigeria, Chad, Cameroon and the Niger), national fisheries statistics were considered to be unreliable and incomplete.[1] More seriously, the information that is available tends to lack the necessary multidisciplinary coverage required for effective planning and management.

In response to the widely perceived information deficit for the fisheries of the Lake Chad Basin, and the need to upgrade our knowledge and understanding in order to provide a basis for future planning and management, a series of international research projects have been undertaken since 1993. Based on collaborative work between African and European scientists, the research projects have significantly helped to address the information deficit for the Lake Chad Basin fisheries.

The primary objective of this chapter is to profile the fisheries of the Lake Chad Basin using the up-to-date information available from the recent collaborative research projects.

1 Two other countries (Central African Republic and the Sudan) have also joined the Lake Chad Basin Commission, but there is very little information available about their fisheries.

Information on the fisheries of the Lake Chad Basin is provided by three recent international projects

- ***Traditional management of artisanal fisheries in northeast Nigeria*** 1993-1997, funded by the Department for International Development (DFID) Project No. R5471. Implemented by the University of Portsmouth, United Kingdom; University of Maiduguri, Nigeria; and the Federal University of Technology, Yola, Nigeria (Neiland [7.5]).
- ***Sustainable development of African continental fisheries: a regional study of policy options and policy-formation mechanisms in the Lake Chad Basin***, 1999-2002, funded by the European Commission (INCO) Project No. ERBICI18CT980331. Implemented by the University of Portsmouth, United Kingdom; Institut de recherche pour le développement (IRD), Senegal; National Institute for Freshwater Fisheries Research (NIFFR), Nigeria; Ministry of Livestock, Fisheries and Animal Industries (MINEPIA), Yaoundé/Maroua, Cameroon; Ministry of Environment and Water Direction of Fisheries and Aquaculture (DPA), N'Djamena, Chad; Lake Chad Basin Commission (LCBC), Chad (Neiland and Béné, [7.6]).
- ***Study of the impact of the fish trade on sustainable livelihoods in the Lake Chad Basin***, 2002-ongoing, funded by the DFID/FAO Sustainable Fisheries Livelihoods Programme (SFLP). Implemented by IDDRA and the University of Portsmouth, United Kingdom; NIFFR, Nigeria; MINEPIA, Cameroon; DPA, Chad; Department of Fisheries, the Niger; and Department of Fisheries, Central African Republic (Neiland, Jolley and Béné, [7.7]).


NEAR DUMBA VILLAGE (BAGA), NIGERIA

SINCE 1998, THERE HAVE BEEN SOME SIGNS THAT WATER LEVELS IN THE LAKE ARE RISING SLIGHTLY

<< LEFT: SWAMPLAND AND FLOATING ISLANDS COVER LARGE AREAS OF THE LAKE
NEAR BOL, CHAD

ENVIRONMENT

The characteristics and performance of the Lake Chad Basin fisheries are closely linked with regional hydrological regimes and the distribution of water. This is largely determined by climatic patterns, but human activities, such as irrigation and dam construction, are also important. While the arid zone of Africa is characterized by fluctuating climate and hydrology, there has been a marked change over the past 50 years that has caused Lake Chad in particular to change from a stable, shallow lake (covering a northern and a southern basin) to a more unstable, marshy or swampland environment (with some open water only in the southern basin).

During the 1970s and 1980s, dam construction on major influent rivers, such as the Yobé in Nigeria and the Logone in Cameroon, further altered the hydrological pattern in the Lake Chad Basin. This led to the loss of an estimated 200 000 ha of floodplains along the lakeshore and rivers, which were critical fish breeding and nursery areas. The important *yaéré* floodplain south of Lake Chad was affected very severely at this time. Sahelian droughts in 1982–1984 reduced the water flows even further and, by 1990, Lake Chad covered less than 2 000 km^2. Around this open-water area, the swampland covered a further 4 000 km^2. By 1998, there were some signs that water flows in the influent rivers to Lake Chad were rising, and that Lake Chad and the floodplains were increasing in size. For example, in the year 2000, the northern basin of Lake Chad was reported to have experienced some flooding.

KANIRAM VILLAGE (MALAM FATORI), NIGERIA

IN THE LAKE CHAD BASIN THERE ARE 176 SPECIES OF FISH. THIS RICH BIODIVERSITY IS AN IMPORTANT CONTRIBUTION TO THE FOOD SECURITY OF THE POPULATION

RESOURCES

There are 176 species of fish in the Lake Chad Basin. Together they form a large, multispecies fish resource. For fisheries monitoring purposes, the species can be grouped into 21 major genera or family groups (Table 13). The drastic environmental changes that have affected the region have also had an impact on the composition of the fish resource and, in turn, on the catch composition recorded by fishermen. Detailed research has been undertaken that highlights the relationship between environmental changes and fish population ecology [7,8] and also on the fisheries [7,9]. During the "drying period" (1972–1978), natural selection operating on the fish communities favoured "marshy" species (e.g. *Clarias* catfish, tilapiine cichlids and *Heterotis* spp.) endowed with adaptations of diet, reproduction and respiration that allowed them to survive and dominate this unstable and hostile environment (low water, high temperature and low dissolved oxygen). "Lacustrine" species (e.g. *Lates, Hydrocynus*, *Labeo* and *Distichodus*) could not survive in these conditions and soon disappeared from the new swampland.

This process of change was also hastened by opportunistic fishing in the northern basin of Lake Chad, as concentrated fish populations were easily targeted and fished out by fishermen. Today, "marshy" fish species still dominate the fisheries of the Lake Chad Basin (Table 13) and "lacustrine" fish are found only in the small area of "open water"of Lake Chad and in some of the larger river channels and floodplain lakes of the Logone and Chari, along with other riverine and migratory species (e.g. *Alestes*).

KANIRAM VILLAGE (MALAM FATORI), NIGERIA

FRESH FISH BEING SOLD IN THE MARKET IN KANIRAM VILLAGE

NEAR DUMBA VILLAGE (BAGA), NIGERIA

BLANGOUA MARKET (KOUSSERI), CAMEROON

ENVIRONMENTAL VARIATIONS HAVE A DRASTIC IMPACT ON THE COMPOSITION OF THE FISH RESOURCE

TABLE 13 **COMPOSITION OF FISH IN THE LAKE CHAD FISHERIES IN 2001 (PERCENTAGE COMPOSITION ON THE BASIS OF MARKET MONITORING)**

Genera or groups	Baga-Doro, Nigeria	Kinasserom, Chad	Mean values
Alestes	0.43	3.27	1.85
Auchenoglanis	–	1.78	0.89
Bagrus	–	2.54	1.27
Clarias	50.03	23.02	36.52
Distichodus	–	0.01	0.01
Gymnarchus	0.01	17.00	8.50
Gnathonemus	–	–	-
Heterotis	18.89	25.17	22.03
Hydrocynus	–	3.25	1.63
Hyperopisus	–	0.42	0.21
Labeo	0.01	0.21	0.11
Lates	–	4.36	2.18
Mormyrops	2.07	0.35	1.21
Mormyrus	0.29	0.07	0.18
Petersius	–	–	-
Peterochephalus	–	0.53	0.27
Polypterus	–	0.38	0.19
Protopterus	2.90	–	1.45
Schilbe	–	–	-
Synodontis	0.01	0.69	0.35
Tilapiine cichlids	25.36	16.95	21.15
Total	**100.00**	**100**	**100.00**

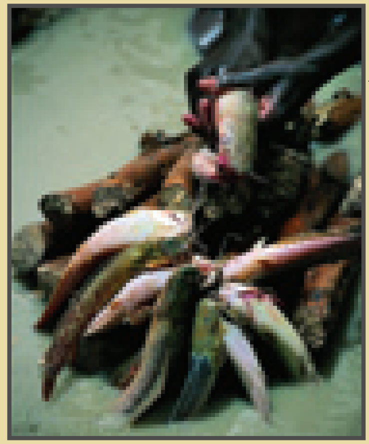
Source: T. Jolley *et al.*, 2002 [7.10]

Changes in the Lake Chad fishery

A tale of two fish: the freshwater sardine (*Alestes*) and the catfish (*Clarias*)

Before 1970, the small sardine-like fish called *Alestes baremoze* was an important component of the fisheries of the Lake Chad Basin. Feeding on zooplankton, *Alestes* was abundant in the zones of reed-bed islands and the archipelago of Lake Chad, and was also found in the open waters. During periods of rising river levels and flooding (from October to December), huge numbers of *Alestes* would migrate into the Logone and Chari rivers and invade the surrounding floodplain to breed in the shallow waters. With the subsequent decrease in water levels a few months later, adult and juvenile fish would retreat into the main channels and eventually into Lake Chad. The annual cycle of migration of both adults and juveniles, which is adapted to the hydrological patterns, is crucial to the maintenance of the stock of *Alestes* in the Lake Chad Basin system. In particular, the setting of fishing nets along river channels and in the floodplain areas of northern Cameroon was also timed to coincide with this pattern of migration. As a result this species made up a large part of the catch in these seasonal riverine fisheries.

Since 1970, and up to the present day, the fisheries of the Lake Chad Basin have witnessed a significant decline in catches of *Alestes*. Instead, the fisheries are now dominated overall by *Clarias* catfish. One of the main reasons for this has been the change in environmental conditions in the Lake Chad Basin. The recent Sahelian drought periods, decline of river flows, the reduction in the size of Lake Chad and the emergence of large areas of swampland in the southern and northern basins have not favoured fish such as *Alestes*. The life cycle and migration of *Alestes* has been severely disrupted. Instead, highly resilient and fast-breeding omnivorous fish, such as *Clarias*, have taken their place. *Clarias* is perfectly adapted to the new swampland conditions and can even breathe air, through auxiliary gills, in low-water conditions. *Alestes* remains a minor component of the river fisheries in the region at present.



NEAR KALAMALOUÉ, CAMEROON

THE CATFISH IS PERFECTLY ADAPTED TO SWAMP CONDITIONS. IT CAN SURVIVE IN VERY LOW WATER CONDITIONS BECAUSE IT CAN BREATHE AIR THROUGH AUXILIARY GILLS

NEAR KALAMALOUÉ, CAMEROON

THE SHRUB *AESCHYNOMENE ELAPHROXYLON* IS NATIVE TO THE LAKE. ITS WOOD, BEING VERY LIGHT, IS EXPLOITED AS A CHEAP AND NATURAL MEANS OF FLOTATION

>> RIGHT: THE MIGRATION CYCLES OF THE *ALESTES* HAVE BEEN DISRUPTED BY THE DECLINE IN RIVER FLOWS. THEIR NUMBERS ARE DECREASING IN FAVOUR OF HIGHLY RESILIENT AND FAST-BREEDING OMNIVOROUS FISH, SUCH AS THE CATFISH (*CLARIAS*)

NEAR KALAMALOUÉ, CAMEROON

CHARI RIVER, CHAD

THE SEASONAL FLUCTUATIONS IN WATER LEVELS AND IN THE MIGRATORY CYCLES OF FISH ARE WELL KNOWN AND ARE EXPLOITED BY FISHERMEN

SEASONALITY AND FISHING GROUNDS

As well as the major environmental changes described above, the nature and extent of the swampland and floodplain environments, and of the open waters of Lake Chad itself, also vary on an intra-annual seasonal basis. This is largely dictated by the seasonal patterns of discharge of the two major influent rivers, the Logone and the Chari. Because the basin is very flat and Lake Chad is shallow, the surface area of the lake varies widely in response to even small changes in seasonal inflow. Each year during the flood period (from September to December), Lake Chad's open waters expand, causing water levels to increase in the fringing swampland and inundating previously dry areas. In effect, floodplains fringe both the lake and the main river channels, and both increase in size during the flood period.

Conversely, as the riverine discharge decreases (from February to April), the receding floods leave numerous temporary ponds and areas of swampland scattered along the floodplains. The seasonal changes in the aquatic environment have a major impact on the fish populations. Fish move into the floodplain areas to feed and to breed, and then retreat with the floods to the main channels and open lake along well-defined channels and outlets. Many fish are trapped and concentrated in isolated pools and swamps, which shrink and dry out within a few months.

There are at least eight different "types" of fishing grounds exploited across the Lake Chad Basin (Table 14). Seasonal ponds and receding channels are the most commonly used, followed by major rivers (Chari and Logone), the open waters of Lake Chad and

TABLE 14 **TYPES OF WATERBODY EXPLOITED IN THE LAKE CHAD BASIN**

Type of waterbody	Numbers of waterbody types exploited by villages in different regions				
	Aggregate	(%)	*Yaéré*	Chari delta	Western shores
Seasonal ponds and receding channels	39	(31 %)	9	15	15
Main river*	30	(23 %)	8	22	-
Lake Chad's open waters	22	(17 %)	-	8	14
Permanent ponds and oxbows	15	(12 %)	1	13	1
Tributaries**	9	(7 %)	9	-	-
Artificial reservoir***	6	(5 %)	6	-	-
Irrigation channels	4	(3 %)	4	-	-
Floodplain	3	(2 %)	3	-	-
Total waterbodies	**128**	**(100 %)**	**40**	**58**	**30**
Number of different waterbodies	8		7	4	3
Total number of villages surveyed	**64**		**20**	**29**	**15**

* Main river = Chari and/or Logone

** Tributaries of the Logone = Logomatia, Loromé Mazéra, Mayo Vrick and Petit Gorom

*** Maga reservoir

Source: C. Béné *et al.*, 2002 [7.11]

permanent ponds. A comparison among different regions shows that the *yaéré* floodplain offers the greatest diversity of fisheries, followed by the river deltas (e.g. Chari) and then shoreline areas, such as those on the western shore in Nigeria. The fact that the seasonal ponds and receding channels are the most common type of fisheries across the basin indicates that fishing has developed as a temporary activity that is adapted to the seasonal dynamics of the environment and that, in particular, makes the most of water and fish movements (flood/recession).

CHARI RIVER, CHAD

ALL COMPONENTS OF THE ECOSYSTEM FOLLOW THE FLUCTUATIONS: FISH, LIVESTOCK, WILDLIFE, AGRICULTURE AND PEOPLE, WHO CAN MOVE THEIR ENTIRE HOUSEHOLDS, ACCORDING TO THEIR RHYTHM

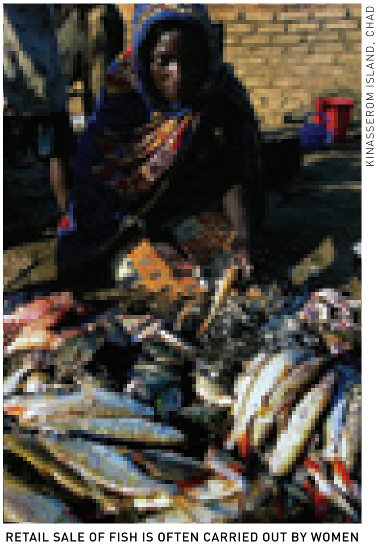
DANOUWANE VILLAGE (N'GUIGMI), THE NIGER

THE MAJORITY OF RURAL HOUSEHOLDS DERIVE THEIR INCOME FROM A COMBINATION OF FISHING, FARMING AND OTHER OCCUPATIONS

OCCUPATIONS AND FISHING INCOME

The majority of rural households participate in the fisheries of the Lake Chad Basin on a seasonal and part-time basis. Many so-called "fishing households" earn most of their income from a combination of fishing, farming and other occupations (Table 15). Within the fisheries specifically, catching fish is the major occupation. Catching is also usually linked to other occupations within the fisheries, including fish processing, fish trading, the transportation of fish and the supply of fishing gear and other inputs. For example, on the western shore of Lake Chad (Table 15), catching involves nearly all fishing households (94 percent); however, specialization in "catching only" involves less than 15 percent of households. The combination of catching, processing and trading is the most common one, involving about 30 percent of households in the fisheries. The transportation of fish is also an important occupation on the western shore, involving about 25 percent of fishing households.

KINASSEROM ISLAND, CHAD



RETAIL SALE OF FISH IS OFTEN CARRIED OUT BY WOMEN

PORT OF BOSSO, THE NIGER

THE TRANSPORTATION OF FISH IS AN IMPORTANT OCCUPATION, INVOLVING 25 PERCENT OF FISHING HOUSEHOLDS

NEAR CHARI RIVER, CHAD

SUN DRYING OF FISH

TABLE 15 **INCOME SOURCES AND OCCUPATIONS IN THE FISHERIES OF THE LAKE CHAD BASIN (WESTERN SHORE, NIGERIA)**

Income sources for fishing households	Contribution (%)
Fishing	54
Farming	39
Labouring	1
Others	6
Total	(100 %)
Occupation*	**Households (%)****
Catching	94
Catching only	15
Catching, processing, trading and transport	26
Input supply	<15

* Occupations undertaken by fishing households within the fisheries sector as part of their livelihoods

** Percentage of fishing households involved in each occupation based on socio-economic surveys

Source: A. E. Neiland *et al.*, 1994 [5.5]

FISHING METHODS

A total of 20 different types of fishing gear are used in the Lake Chad Basin. These can be classified into six major categories: active nets, static nets, traps, fish fences, hooks and others (see Table 16). In general, many types of fishing gear are based upon traditional designs but, increasingly, much of the gear, although manufactured locally, employs modern materials, such as nylon twine, or rope, in the case of nets, imported from elsewhere.

Most fishing households across the Lake Chad Basin tend to own and use the same set of simple and individual fishing gear, namely floating/sinking gillnets, small basket traps (Malian traps), hook lines, chamber traps, castnets and dipnets. However, larger and more expensive types of gear, such as dragnets or seine nets, tend to be owned by wealthy households and to be operated by larger groups of people. In general, wealthier households tend to have the largest number and diversity of fishing gear compared to less well-off households [7,11]. While many

NEAR LELEWA VILLAGE, THE NIGER

MALIAN TRAP CALLED *NDURUTU*

NEAR KANIRAM VILLAGE (MALAM FATORI), NIGERIA

SOME 20 DIFFERENT TYPES OF FISHING GEAR ARE USED IN THE LAKE CHAD BASIN. THIS CLAP-NET IS CALLED *HOMA* IN THE HAOUSSA LANGUAGE

NEAR DUMBA VILLAGE (BAGA), NIGERIA

TWO FISHERMEN SHOW THEIR BOULTER. A GOURD IS TRADITIONALLY USED AS A FLOAT ON SHALLOW WATER

TABLE 16 **CLASSIFICATION OF FISHING GEAR IN THE LAKE CHAD BASIN**

GEAR CATEGORY	Description
Active nets (e.g. seine net, or *taru*; dipnet, or *sakama*; clap-net, or *koma*; castnet, or *birgi*)	Nets of various sizes (mesh as small as 1 cm, usually multifilament) operated by a single fisherman or a team from the river/lakeside, boats or wading, usually in waters free of obstructions (e.g. weeds). Fish are often collected or entangled in a restricted section or bag (e.g. seine net, liftnet, clap–net, castnet).
Static nets (e.g. stake nets, or *kalli*)	Nets of various sizes, operated singly or by teams of fishermen, which can be set in most waters and left unattended for some time (hours, overnight, days). Some types of fishing gear are supported by sticks or poles (e.g. stake nets), others by floats, weights and ropes. Fish are usually entangled.
Traps (e.g. chamber traps, or *ndurutu*; pot traps, or *gura mali*)	Static gear often in the form of reed baskets (e.g. chamber trap) or net-covered, pot-like frames (e.g. Malian traps) of various sizes with single or multiple chambers, usually baited. Set and allowed to fish usually in shallow water and swampy areas.
Fish fences (e.g. fence of chamber traps, or *dumba*)	Fences of various designs and sizes, but often of reed mats and supporting poles, built across a river or stream to channel fish into a trap. No bait. Often built across seasonal rivers. Significant catch of juvenile fish.
Hooks (e.g. longline of hooks, or *kugoya*)	Large hooks (no. 2/3) used singly, or multiple smaller hooks (no. 12/14) on a longline (of various lengths), set baited or unbaited to snare fish. Set and left unattended in open water or swampy areas.
Others (e.g. fishing spears)	A large range of miscellaneous, often traditional gear specific to particular fishing conditions, areas and ethnic groups (e.g. various types of fishing spears).

Source: A. E. Neiland, *et al.*, 2000 [7.12]

NEAR DUMBA VILLAGE (BAGA), NIGERIA

FISH FENCES ARE USED TO CATCH FISH DURING THEIR MIGRATION FROM OPEN LAKE TO FLOODPLAINS. FISHERMEN KNOW FISH BREEDING CYCLES AND HAVE ADAPTED THEIR FISHING METHODS ACCORDINGLY

>> RIGHT: FISH TRAPS ARE MANUFACTURED LOCALLY ACCORDING TO TRADITIONAL DESIGN BUT THE USE OF MODERN IMPORTED MATERIALS SUCH AS NYLON TWINE AND ROPE IS INCREASING

households own small fishing canoes, these are not always needed for fishing, especially in floodplain areas. Indeed, many of the fishing sites are accessible from the shore or by wading through shallow water.

A particular feature of fishing in the Lake Chad Basin is the construction of complex fish fences across drainage channels and small river courses leading from floodplain areas. Here, large catches of juvenile fish are taken during the receding flood. The design and construction of these fences is based on long-established traditional knowledge and patterns of social organization and cooperation within particular riparian communities.

In the *yaéré* floodplains (in northern Cameroon and southern Chad), during the recession season, a large number of fish fences are set up across the channels connecting the floodplain areas to the main river (Logone) and its tributaries (Logomatia or Petit Goroma in Cameroon, Salamat in Chad). These fences aim to catch migratory fish leaving the flooded plains, especially *Alestes* spp. One example of this type is the Malian fence (or *barrage*) on the Ba-Illi tributary of the River Logone in Chad. The local fishermen (from the Kotoko ethnic group) set up a dam made of wooden fences across a channel or shallow part of the river. Just in front of these fences (upstream) are fixed 400–500 large Kotoko traps, attached to tall wooden sticks fixed in the river bed. The traps, with a mouth oriented downstream, will catch the fish that turn back when trying to escape the fences. One interesting point to notice is that the traps closer to the fences (which will catch the largest proportion of the fish) usually belong to the most important and richest families. The traps belonging to other villagers take a secondary position.

Downstream, behind the fences, a series of pirogues are positioned. These will catch the few *Alestes* and *Hydrocynus* that manage to escape the traps and try to jump over the fences. Usually the yield of these fishing barriers is remarkably high. Several

NEAR DUMBA VILLAGE (BAGA), NIGERIA

tonnes per day can be caught during the peak period, and a catch of 30 tonnes per week was reported to be common in the late 1950s [7.13]. Obviously these massive structures preclude the use of other fishing gear on the same fishing grounds.

Interestingly, along the western shore of Lake Chad in Nigeria, a new form of fish fence, called a *dumba*, has appeared in recent years [7.14]. A *dumba* is a row of Malian fishing traps. These small chamber traps (up to 1 m high and 500 cm in diameter) consist of a wooden frame and a net covering, with a small side entrance and a larger hole at the top for retrieving the catch and are similar to a lobster pot. They can be baited or unbaited. Typically, a *dumba* is strung across shallow channels, usually at the end of the dry season (to catch or sieve both adult and juvenile fish moving into and out of the floodplains, depending on the seasonal flow). The *dumba* fishing technique was introduced to the region by Malian fishermen and is currently the most profitable technique used in the area. The siting of the *dumba* is crucial and the selection of sites requires key local knowledge of water channels, water movements and fish movements. There are comparatively few good *dumba* sites on the western shore of Lake Chad, and the most important have already been claimed either by a single fisherman or groups of fishermen. All *dumba* are licensed by local authorities for a flat fee of $200. More recently, attempts have been made to outlaw *dumba* fishing, since it is considered to be a "destructive fishing method" by government administrators. *Dumba* catch a high proportion of juvenile fish and they may have an impact on fish-stock recruitment, although this has not yet been investigated by scientists.

DELTA OF CHARI RIVER, CHAD

FISH FENCES ARE TYPICALLY PLACED ACROSS WATER CHANNELS

BALATUNGUR VILLAGE (BOSSO), THE NIGER

BOATS ARE NECESSARY TO REACH THE FISHING GROUNDS, WHICH MAY BE LOCATED SEVERAL KILOMETRES AWAY FROM THE SHORE

TRANSPORT

The need to own a fishing canoe, and an outboard engine, is becoming more important in the river deltas and, most important, in the open-water areas of Lake Chad. In these areas, a boat is necessary to access the fishing grounds, which may be located on the fringes of small islands or shallow banks several kilometres from the shore. In these vast lake environments, fishing is both challenging and often hazardous (there are many reported incidents of drowning during stormy weather on the open lake).

The open waters of Lake Chad have long been the domain of professional and full-time fishermen from ethnic groups such as the Buduma. The fishermen, often accompanied by their families, travel great distances to fish and they use longlines and gillnets in the open waters. They make temporary camps on floating islands of vegetation, where they dry their catch before returning to key island markets, such as Kinasserom. In some places, fish traders either own or hire large motorized canoes to transport fish from the fishing grounds back to the markets and also to supply various goods to distant fishing camps.

BALATUNGUR VILLAGE (BOSSO), THE NIGER

MOST OF THE FISH IS PACKAGED AND TRANSPORTED BY ROAD TO THE URBAN MARKETS OF SOUTHERN NIGERIA

OPEN LAKE (BOL), CHAD

IN THE VAST LAKE ENVIRONMENT, FISHING IS CHALLENGING AND OFTEN HAZARDOUS

FISHING PATTERNS AND OTHER ECONOMIC ACTIVITIES

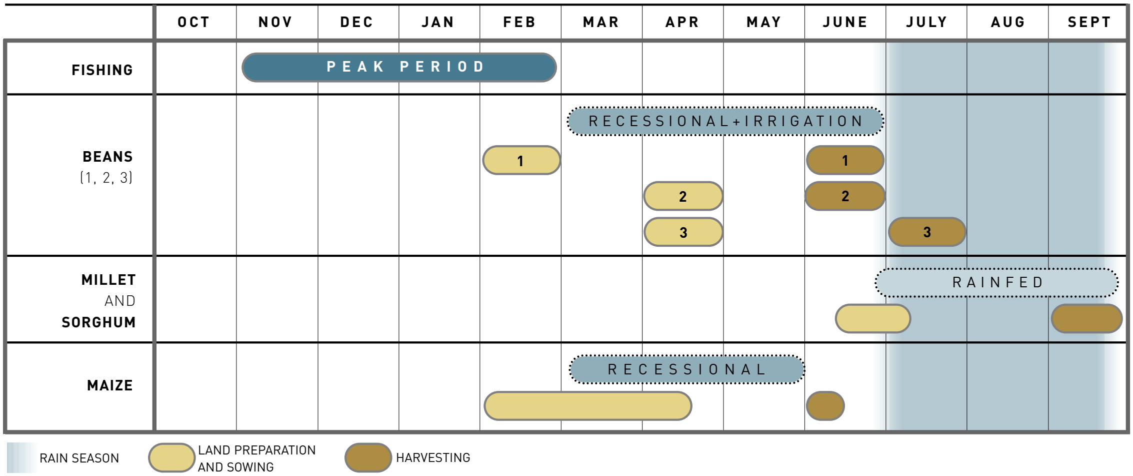
The seasonal and interannual hydrological patterns in the Lake Chad Basin have a major influence on the economic activities pursued by rural households. In general, the mixture and diversity of activities are adapted to the local flood regime which, of course, varies according to the location within the basin.

WESTERN SHORE

Along the western shore of Lake Chad, in villages such as Dabar Shatta Kwatta (see Table 17), the peak fishing period is between November and February, on both the open waters of the lake and the floodplains and associated channels. (This is a period of significant fish migration as the flood builds, peaks and then recedes.) Some permanent pools on the floodplain may be fished all year round.

Farming is also undertaken throughout the year, using both recessional and rainfed cropping systems. Usually the first planting of maize and beans starts in February, as Lake Chad starts to recede; harvesting then takes place in June with the onset of the rains. A second planting of rainfed crops occurs in June, with a harvest three months later in September, at the beginning of the dry season. Many households also tend to keep a small number of cattle, goats and sheep.

TABLE 17 **ACTIVITY CALENDAR FOR DABAR SHATTA KWATTA VILLAGE, LAKE CHAD (WESTERN SHORE, NIGERIA)**



Source: A. E. Neiland *et al.*, 1994 [5.5]

SOUTHERN SHORE

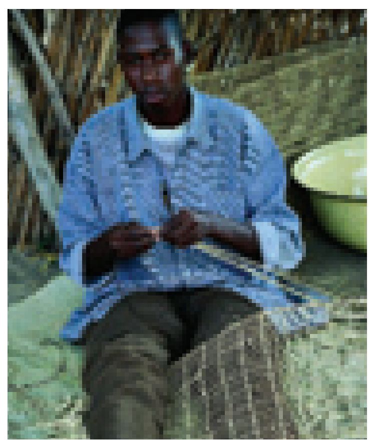
Along the southern shore of Lake Chad, in Chad and Cameroon, fishing is practised throughout the year on the lake itself and also in the Chari River and its tributaries and permanent ponds. Periods of activity and yields vary as follows: high levels of fishing activity and catch during water recession and low waters (from January to April); reduction of fishing activity and lower catches during the flood period (from July to September); and even lower catches during periods of high water, when fish are widely dispersed on to floodplains (from October to November). In seasonal floodplain ponds left behind by receding waters, fishing continues from September to December, depending upon the size of the fish and their location.

Fishing households also farm in this region. Cultivation of recessional floodplain areas is common and takes place close to the permanent waters of Lake Chad and the Chari River. Farming (cereals, legumes, vegetables, fruit and fodder) becomes the dominant household activity during certain hydrological phases, e.g. during the flood period (from August to October). Rainfed cropping systems (millet, sorghum, maize and legumes) are also widespread in the Chari Delta and last almost five months from the first sowing in July. Animal husbandry is limited to the stabling of cattle, sheep and goats throughout the year.

Yaéré

In the *yaéré* floodplains, although fishing is a year-round activity, the intensity varies according to the type of waterbody. The peak period along the Logone River occurs from July (as the water rises) until March, while along the Logomatia (a major tributary) it takes place from August to December. Fishing activity on the floodplain itself, which is less intense than on permanent waterbodies, follows the floods in September and ceases in February. In permanent ponds, fishing is carried out during the dry season (from October to April) until the Logone and Logomatia rivers offer more attractive fishing grounds.

As far as agriculture is concerned, millet is sown after the rains in June, while rice is planted in July. These crops are then harvested in October and December respectively, after the rains cease. As in the other parts of the Lake Chad Basin, many households also keep cattle, sheep and goats. Cattle exploit the free grazing around villages during the dry season, but are kept within the village at other times of the year.



KANIRAM VILLAGE (MALAM FATORI), NIGERIA

MAKING A TRADITIONAL TRAP (*N'DURUTU*) FROM DUM PALM FIBRE

PRODUCTION

Fisheries production (or fish caught/landed) in the Lake Chad Basin during the year 2000/2001 was estimated at 68 784 tonnes wet weight (Table 18). This estimate is based on a monitoring system covering all the main fish markets and trade routes within the riparian countries of the Lake Chad Basin. The largest of these markets is Baga-Doro in Nigeria, followed by much smaller markets at Kinasserom and N'Djamena in Chad. The calculation of fisheries production takes careful account of the quantity of fish marketed, the fish consumed locally and the loss of weight caused by drying in the case of dried/smoked fish.

Although there are relatively few accurate statistics on fisheries production in the Lake Chad Basin, the current estimates, when taken together with previous data, indicate that fisheries production is probably increasing at the moment. The lowest level of production (21 704 tonnes in 1982) coincided with a reduced discharge of the Chari River and a reduction of fishing because of the civil war in Chad. The highest production (220 000 tonnes in 1974) was attributable to intensive fishing during a period of drought and concentration of fish stocks in Lake Chad [7.15].

CONSUMPTION

Fish are an important part of the diet of most people in the Lake Chad Basin and constitute an essential source of protein. Earlier research found that rural fishing-farming households in the Lake Chad Basin (western shore in Nigeria) retained 19 percent of their total catch per year for domestic use [5.5]. This was equivalent to one tonne of fish per year which was not sold commercially at that time. Although

LELEWA VILLAGE (N'GUIGMI), THE NIGER

FISH PRODUCTION IN THE YEAR 2000/2001 WAS ESTIMATED AT OVER 68 000 TONNES

TABLE 18 **FISHERIES PRODUCTION IN THE LAKE CHAD BASIN, 1969–2001 (IN TONNES, BASED ON TRADE ROUTES MONITORING)**

Year	Baga-Doro	Other markets	TOTAL
1969	20 000	8 800	28 800
1970	46 800	18 700	65 500
1971	86 300	28 700	115 000
1972	123 400	42 300	165 700
1973	153 600	37 900	191 500
1974	172 600	47 400	220 000
1975	84 500	44 400	128 900
1976	68 500	39 700	108 200
1977	37 200	14 800	52 000
1978	70 698	30 299	100 997
1979	67 817	29 064	96 881
1980	64 886	27 808	92 694
1981	58 222	24 852	83 174
1982	15 193	6 511	21 704
1983	21 379	9 162	30 541
1984	28 446	12 191	40 637
1985	21 934	9 400	31 334
1995/96	32 627	32 627	65 254
2000/01	58 730	10 053	68 784

Source: T. Jolley *et al.*, 2002 [7.10] there is no current information on household food consumption patterns, local reports indicate that a high proportion of the retained fish is consumed within the household (Bukar, personal communication). Of course, some care must be taken with these global and average values. There is also no doubt that fish from the Lake Chad Basin contribute to the food supply in many urban centres, particularly in Nigeria. Information on the socio-economic impact of fisheries, including food security, is provided below.

TRADE

The commercial trade in fish originating from the Lake Chad Basin is very important in West Africa. In 2001, the total volume of fish products passing through the key regional markets was 57 320 tonnes (wet weight) and this was valued at $23 471 698 (first sale). Most of the fish is traded in various dried and smoked forms, and is eventually packed into sacks or boxes for road transport. The largest fish market in the Lake Chad Basin is Baga-Doro in Nigeria, near the lakeshore. This handled about 48 942 tonnes (wet weight) of fish, valued at about $20 million, in 12 months (2000/2001).

Most of the fish that is packaged and traded in the fish markets of the Lake Chad Basin is transported by road (a journey of three to four days) to the urban markets of southern Nigeria. For example, the principal destinations from Baga-Doro are Enugu (23 percent total traded fish weight), Onitsha (22 percent), Lagos (11 percent) and Ibadan (11 percent). A smaller proportion of the fish is traded locally within the Lake Chad Basin itself, although no data on local trade routes or quantities are currently available.

NEAR CHARI RIVER, CHAD

FISH REPRESENT AN ESSENTIAL SOURCE OF PROTEIN FOR MOST INHABITANTS OF THE LAKE CHAD BASIN

BALATUNGUR VILLAGE (BOSSO)

MOST OF THE FISH IS TRADED IN VARIOUS DRIED AND SMOKED FORMS AND PACKED IN SACKS OR BOXES FOR TRANSPORT

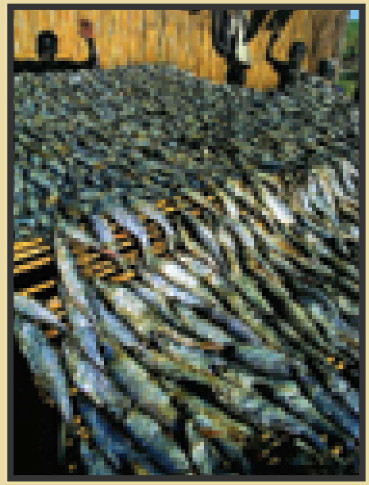
Artisanal fish-processing and fish-packaging methods

Over 80 percent of the fish catch in the Lake Chad Basin each year is traded. A small amount of fresh fish (sometimes on ice) is transported to N'Djamena and Maiduguri. The larger proportion is processed and packaged, using artisanal methods, ready for shipment by road to urban markets in southern Nigeria.

There are four main processing methods.

1. Sun-drying of small whole fish, such as *Alestes* species, laid out on the ground sometimes on grass mats; bigger fish can also be dried in this way, when eviscerated and laid flat. The product of this process is called *salanga*.
2. Smoking of fish pieces (larger fish cut into pieces, scaled and eviscerated) using local wood in a simple smoking kiln (1-3 m square x 0.5-1 m high) constructed of mud bricks overlaid with a metal grating to hold the fish, and topped with corrugated metal sheeting or matting to retain the smoke. Sometimes the kiln has two separate chambers: one for the fire and one for smoking. The resulting product is called *banda*.
3. Smoking in a kiln of large *Clarias* catfish (the most common local fish) coiled and tied head-to-tail, then skewered with a pointed stick, to produce *tonkoso*.
4. Charburning of fish pieces or small, whole fish by laying them on a loose mat of dried grass, then sun-drying for a week (this method is very common in the fishing camps located on the floating islands of Lake Chad where wood is scarce and costly).

Fresh fish for processing, or fish already processed, is brought to major markets, such as Baga-Doro in Nigeria, and packed into sacks or cardboard cartons for road shipment. Within the market, there are groups of artisans who specialize in particular activities, including sack or carton construction, fish packing, rope making and sack/carton tying, and the loading of fish lorries. Each market destination in southern Nigeria has its own "signature" fish sack or fish carton.



KINASSEROM ISLAND, CHAD

SUN-DRYING OF SMALL WHOLE FISH ON THE ISLANDS WHERE WOOD IS SCARCE AND COSTLY

KANIRAM VILLAGE (MALAM FATORI), NIGERIA

CLARIAS CATFISH BEING SMOKED IN A KILN ON THE MAINLAND, WHERE WOOD (MAINLY FROM *PROSOPIS*) IS ABUNDANT

>> RIGHT: THE FISH-SMOKING KILN IS MADE OF MUD BRICKS, OVERLAID WITH A METAL GRATING TO HOLD THE FISH AND TOPPED WITH CORRUGATED METAL SHEETING TO RETAIN THE SMOKE

NEAR CHARI RIVER, CHAD

CHAPTER 8

WILDLIFE

"When two elephants fight, the grasses carry the wounds."

[African proverb]

WILDLIFE

by
Paul Scholte[1],
Wim C. Mullié[2],
the **authors**
and **Douglas Williamson**[3]

8

NORTHERN, CHAD PHOTO: COURTESY OF P.SCHOLTE

LAKE CHAD IS STILL AN INTERNATIONAL STRONGHOLD FOR WILDLIFE, YET ANTELOPES SUCH AS THE DAMA GAZELLE ARE THREATENED WITH EXTINCTION BY HUNTING AND COMPETITION WITH LIVESTOCK

INTRODUCTION

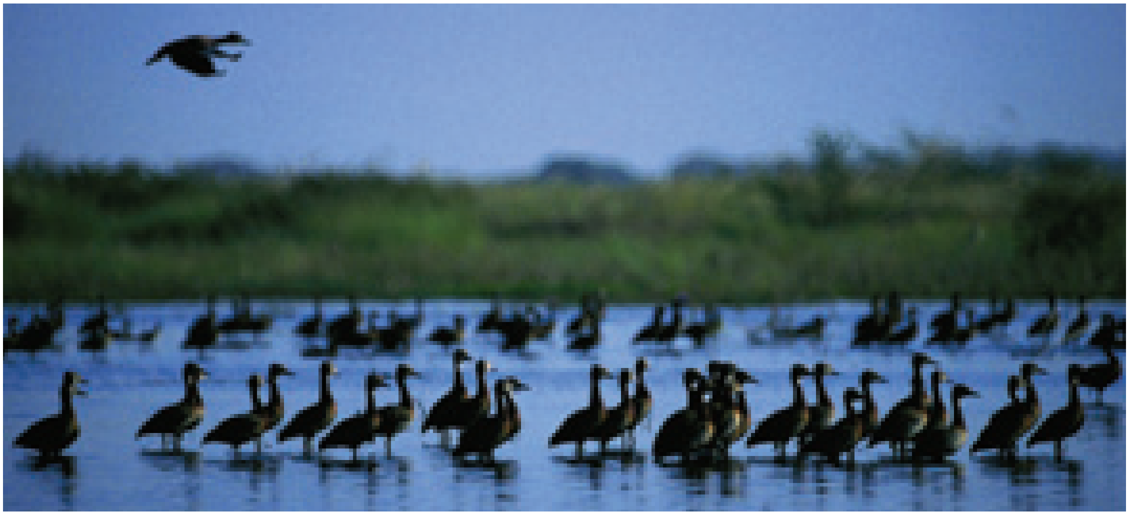
"When one recalled the large number of antelopes which the traveller encounters on all sides in the regions of Bornu, even in the neighbourhood of inhabited places, the difference was astonishing." The German explorer Nachtigal, who spent several years travelling in the Lake Chad Basin, made this remark while passing through the Sudan in 1874 [8.1]. Even at the beginning of the twenty-first century, the Lake Chad Basin remains an international stronghold for wildlife, particularly antelopes, such as the addax (*Addax nasomaculatus*) and dama gazelle (*Nanger dama*) in the Sahel and the korrigum (*Damaliscus lunatus korrigum*) and red-fronted gazelle (*Gazella rufifrons*) in the savannahs [8.2], as well as the black-crowned crane (*Balearica pavonina*) and a variety of other waterbirds in the basin's wetlands [8.3], [8.4]. The basin also harbours tourist attractions such as the elephant (*Loxodonta africana*), giraffe (*Giraffa camelopardalis*) and lion (*Panthera leo*) [8.5]. The basin's wetlands – Lake Chad, Lake Fitri, floodplains and dispersed ephemeral depressions – are the pillars underlying the ecology of the Lake Chad Basin and explain much of the variety and abundance of its wildlife and its spatial and temporal distribution.

Local communities in the Lake Chad Basin have always exploited wildlife, as evidenced by the abundance of hunting scenes in centuries-old rock paintings. With a generally low population pressure this exploitation has taken place on a more or less sustainable level. However, there has also been excessive hunting, which has led to the extinction of species such as the western black rhino (*Diceros bicornis longipes*), which roamed most of the basin until the early twentieth century. Elephants were almost driven to extinction at the end of the nineteenth century because of the rising demand for ivory in Europe and the United States. However, they recovered remarkably well in the second part of the

1 Ecologist and Wildlife expert, until 2000 Education and Conservation Professor in Cameroon at the "Ecole pour la formation des spécialistes de la faune" and presently Visiting Scientist and Consultant at the Center of Environmental Science of Leiden.

2 Chief Technical Advisor of CERES - Locustox Foundation - Senegal, FAO Locustox Project GCP/SEN/053/NET.

3 Forestry Officer (Wildlife and Protected Area Management), FORC,FAO.


NEAR GUITTE (N'DJAMENA), CHAD

BIRD POPULATIONS ARE UNDER PRESSURE FROM THE INTENSIFICATION OF FISHERIES, GRAZING AND AGRICULTURE IN WETLANDS

twentieth century, when protected areas were created and effectively managed, receiving an influx of elephants from other places. With the increasing population pressure during the twentieth century, exploitation of the wildlife outside protected areas has steadily intensified. The instability experienced during the last few decades, especially in Chad and the Niger, triggered a collapse of wildlife populations both in and outside protected areas, threatening the survival of a dryland fauna that could be found nowhere else. International recognition for the area's outstanding wildlife has long been wanting but recently a series of wildlife conservation activities has been initiated throughout the basin.

In this chapter we present the main wildlife assets of the Lake Chad Basin and discuss their importance for conservation as well as for other wise-use purposes. This review of experiences from the basin may guide future directions in wildlife management.


NORTH CAMEROON

PHOTO: COURTESY OF P.SCHOLTE

SKINNING OF AN "ILLEGALLY" HUNTED MONITOR LIZARD: MANAGEMENT STARTS BY GIVING PEOPLE OFFICIAL USER RIGHTS

WAZA NATIONAL PARK, CAMEROON

WILD HERBIVORES MIGRATE OVER LONG DISTANCES IN SEARCH OF GOOD-QUALITY GRASSLANDS. NOMADS OFTEN FOLLOW THE SAME MIGRATION PATTERNS WITH THEIR LIVESTOCK

LARGE MAMMALS

SAHELIAN FAUNA

Although grasslands in the sandy northern part of the Lake Chad Basin generally have a low biomass, they have a high nutritional value. This explains why nomads make such an enormous effort to migrate into these areas each rainy season with their herds of cattle, intensively exploiting the short and young grasslands for a few weeks only. Lack of water and a rapidly diminishing stock of grass oblige the herders to move back to the south at the start of the dry season, when they migrate either into the grasslands of the lakes and floodplains or further south into the Sahelo–Sudanian savannahs. This migration pattern is not unique to pastoralists but, until recently, was also followed by the scimitar oryx (*Oryx dammah*), addax, dama gazelle, dorcas gazelle, red-fronted gazelle and korrigum. These species have suffered from the increasing grazing pressure on the northern grasslands and the fragmentation of the southern fringe of the Sahel by millet cultivation, which have blocked their migration routes into the wetlands and savannahs. Armed militia and rebels have further reduced the herds, which once numbered thousands of animals. Present populations, of scattered individuals only, are confined to either the northern Sahel (the addax and the dama and dorcas gazelles) or to the savannahs and floodplains further south (korrigum and red-fronted gazelle). With the exception of the oryx, which has been driven into extinction, their populations in the Lake Chad Basin represent the world's last remaining individuals; all feature on the Red List of Threatened Animals compiled by the World Conservation Union (IUCN).

TABLE 21 **SIMPLIFIED HYDROSERE OF LAKE CHAD WETLANDS**

WATER LEVELS	Water depth (m)	Flood duration (months)	Plant life Common name	Plant life Scientific name	Characteristic animal life
OPEN WATER without vegetation	>3				Hippopotamus, otters, ducks, storks
DEEP	3–5	>6	Water lily	*Nymphaea* spp.	Jacana
	3	<6	Acacia forest	*Acacia nilotica* *Mitragyna inermis*	Breeding colonies of egrets, storks
FLOODING	1–3	4–5	*Bourgou*	*Vossia cuspidata* *Echinochloa stagnina*	**Wet season:** Sitatunga herons, egrets, ducks
	0.2-0.7	3–4	Wild rice *Kreb*	*Oryza longistaminata* *Echinochloa pyramidalis*	**Dry season:** Kob, reedbuck, waterbuck, pratincole, ruff, black-crowned crane, ducks
SHALLOW	0.2–0.5	2–3	Vetiver	*Vetiveria nigritana*	
	<0.4	1	Wild sorghum	*Sorghum arundinaceum*	Elephants Weaver birds
	<0.2	<1	*Kreb*	*Echinochloa colona* *Panicum laetum*	Variety of birds, including black-crowned crane and quelea
DRY LAND					

Source: P. Scholte, 2003

WETLAND FAUNA

Wetlands provide high-quality forage when surrounding grasslands have dried out. The productivity of these inundated grasslands is particularly high because of the availability of soil moisture throughout the year, combined with some of the richest soils on the African continent. Wetlands vary, from the vast Lake Chad to the relatively small lakes Fitri and Iro, also called "mini-Chads", in central and southeastern Chad respectively. Lakes Fitri and Iro fill up quickly during the rainy season but are reduced to small tracts of open water during the dry season. Because of their relatively small size, they provide little refuge for wildlife during droughts; this, for example, led to the extinction of the hippopotamus in Lake Fitri in 1913. Floodplains along the Chari and its tributaries, the Logone and the Komadugu, resemble these smaller lakes in many ways but are even more sensitive to human pressures. Neglected until recently by many researchers are the smaller floodplains and depressions, which are dispersed over virtually the entire basin and contain water only during the rainy season [8.6] [8.7].

Wetlands in the Lake Chad Basin have a characteristic sequence of plant species (hydrosere) that is related to maximum water depth and duration of flooding (Table 21).

Two species of otter (*Lutra maculicollis*, *Aonyx capensis*) as well as hippopotamuses (*Hippopotamus amphibius*) are found in the surface waters of the Lake Chad Basin. However, although

BLANGOUA VILLAGE (KOUSSERI), CAMEROON

DELTA OF CHARI RIVER, CHAD

HIPPOPOTAMUSES IN THE LAKE CHAD BASIN HAVE ADAPTED TO THE PRESENCE OF HUMANS

<< LEFT: THE HEAD OF THIS DEAD HIPPOPOTAMUS HAS BEEN CONFISCATED BY LOCAL AUTHORITIES TO PREVENT ILLEGAL TRADE OF IVORY

these species have adapted to the presence of humans, their numbers, especially of the hippotamus, have fallen sharply. The sitatunga (*Tragelaphus spekei*), an antelope with elongated hoofs well adapted to muddy soil, can nowadays only be found in reed beds and papyrus swamps, where human access is difficult. The kob (*Kobus kob*) is the most abundant antelope species in the wetlands of the Lake Chad Basin. Although less adapted to wetlands than the sitatunga, it is strongly dependent on the nutritious *bourgou* vegetation. During the dry season, an estimated 25 000 kob could be seen in the Waza–Logone floodplain. However, the construction of an upstream dam and the subsequent drying of the floodplain, exacerbated by the droughts of the 1970s and 1980s, have left a mere 5 000 individuals. Increased pressure on the lake habitat has reduced populations of other species, including the African elephant, which is now mostly confined to the national parks situated in the Sahelo–Sudanian savannah.


WAZA NATIONAL PARK, CAMEROON

PHOTO: COURTESY OF P.SCHOLTE

ELEPHANT FEEDING ON *ACACIA SEYAL*

SAHELO–SUDANIAN SAVANNAH FAUNA

In contrast to the Sahelian grasslands, there is a high grass biomass in the Sahelo–Sudanian savannah further south, but this is only of low quality. Leaves of trees and shrubs, such as the common *Acacia sieberiana*, *A. seyal* and *Balanites aegyptiaca* (see Chapter 5) have a considerably higher nutrient quality and are intensively browsed by giraffes and elephants. The clayey soils, where water forms ponds for a few weeks each year during the rainy season, support a vegetation characteristic of the drier parts of the wetlands (Table 21). Grass biomass is sufficiently high to allow for bushfires, which trigger the regrowth of nutritious grasses in humid places early in the dry season. Later in the dry season, regrowth occurs only in wetlands.

The characteristic large mammal community of the savannah includes the giraffe, elephant, lion, African buffalo (*Syncerus caffer*) and a variety of antelopes, such as roan (*Hippotragus equinus*), korrigum, red-fronted gazelle and kob. The density of this wildlife, which is mostly confined to national parks such as Waza and Zakouma, exceeds those of surrounding countries. This is probably because of the basin's rich soils and its variety of habitats, which include wetlands (dry season) and upland and sandy areas (rainy season), thus allowing a short-range migration.

Elephants in the Lake Chad Basin once occupied all habitats except the driest Sahelian grasslands, but are becoming increasingly confined to the Sahelo–Sudanian savannah. Although elephants consume large quantities of water and vegetation, competition with livestock is generally non-existent. Nevertheless, local communities around all the protected areas in the Lake Chad Basin complain that elephants cause severe damage to agricultural land, and there are serious conflicts between the laws protecting the elephants and the people who live in the region.

KALAMALOUÉ NATIONAL PARK, CAMEROON

NEAR DIFFA, THE NIGER

OVER 500 SPECIES OF BIRDS HAVE BEEN RECORDED IN THE LAKE CHAD BASIN

BIRDS: THE LINK BETWEEN WETLANDS

The number of bird species recorded from Chad, fairly representative for the basin, is 532, including 354 residents and 155 migrants, of which 117 are Palaearctic in origin. With 379 bird species, Waza–Logone (Cameroon) is probably the most varied area in the basin, if not the best studied ornithologically [8.8]. The Sahelian grassland birdlife is spectacular, with bustards (*Ardeotis arabs*, *Neotis denhami* and *N. nuba*, *Eupodotis senegalensis* and *Lophotes savilei*) still commonly present; only the ostrich (*Struthio camelus*) is now limited to protected areas such as Waza and Zakouma. Waterbirds, discussed below, are among the most spectacular creatures in the Lake Chad Basin. The sight of hundreds of pelicans, marabous, storks and egrets gathered in a depression when the floodplain dries up, feasting on stranded fish, is unforgettable.

From aerial surveys we know that, at least until the early 1980s, the Lake Chad Basin held internationally important populations of waterbirds [8.9]. However, it was not until the mid- to late 1990s that new aerial censuses were undertaken [8.4]. These revealed high numbers of waterbirds at Lake Fitri (almost 300 000) and on the lower Logone and Chari floodplains and Lake Chad (each more than 100 000) (see Table 22). To these figures can be added the almost 300 000 waterbirds counted on ephemeral wetlands in the Niger during the same period [8.4], although two or even three times this number can be expected [8.7]. It has become increasingly evident that the Lake Chad Basin harbours a substantial proportion of the world population of the black-crowned crane (*Balearica pavonina pavonina*), black heron (*Egretta ardesiaca*) and several species of

TABLE 22 **PRINCIPAL WATERFOWL AREAS IN THE LAKE CHAD BASIN***

Scientific name	Common name	Status**	Area	Country	Numbers
Phalacrocorax africanus	Long-tailed (reed) cormorant	R	Lower Chari Lake Fitri Logone floodplains Lake Chad	Cameroon Chad Chad Niger	1 294 3 013 9 687 1 725
Casmerodius albus	Great egret	R	Lake Fitri	Chad	3 626
Egretta ardesiaca	Black egret	R?	Waza–Logone Logone floodplains	Cameroon Chad	1 189 7 068
Egretta garzetta	Little egret	R, PM	Hadejia–Nguru	Nigeria	6 177
Bubulcus ibis	Cattle egret	R	Hadejia–Nguru	Nigeria	53 775
Ardeola ralloides	Squacco heron	PM	Waza–Logone Lake Fitri Logone floodplains	Cameroon Chad Chad	3 000 3 060 14 368
Mycteria ibis	Yellow-billed stork	R	Lake Chad	Niger	2 152
Leptoptilos crumeniferus	Marabou	R	Lake Chad	Niger	3 021
Platalea alba	African spoonbill	R	Lake Chad	Niger	2 475
Dendrocygna bicolor	Fulvous tree duck	R	Lake Fitri Logone floodplains	Chad Chad	5 469 1 518
Dendrocygna viduata	White-faced whistling duck	R	Waza–Logone Lower Chari Kalamaloué Lake Chad Lake Fitri Lower Chari Logone floodplains Hadejia–Nguru	Cameroon Cameroon Cameroon Chad Chad Chad Chad Nigeria	4 987 14 148 6 113 74 044 95 238 4 003 24 645 21 328
Plectropterus gambensis	Spur-winged goose	R	Waza–Logone Lake Fitri Hadejia–Nguru	Cameroon Chad Nigeria	4 442 2 195 1 917
Sarkidiornis melanotos	Knob-billed duck	R	Lake Chad Lake Fitri Logone floodplains	Chad Chad Chad	5 025 8 295 1 295
Nettapus auritus	Pygmy goose	R?	Waza-Logone	Cameroon	102
Anas acuta	Pintail	PM	Lower Chari Lake Fitri	Cameroon Chad	24 730 36 865
Anas querquedula	Garganey	PM	Lower Chari Lake Fitri Hadejia–Nguru	Cameroon Chad Nigeria	173 080 97 332 34 106
Anas clypeata	Shoveler	PM	Lake Chad	Niger	11 300
Aythya nyroca	Ferruginous duck	PM	Lake Fitri	Chad	3 800
Grus virgo	Demoiselle crane	PM	Logone floodplains	Chad	24
Balearica pavonina	Black-crowned crane	R	Waza–Logone Lake Chad Lake Fitri Lower Chari	Cameroon Chad Chad Chad	1 704 261 441 228
Vanellus spinosus	Spur-winged plover	R	Lake Chad	Niger	4 095
Limosa limosa	Black-tailed godwit	PM	Lake Chad Lower Chari Logone floodplains Hadejia-Nguru	Cameroon Cameroon Chad Nigeria	8 770 13 226 1 500 7 473
Philomachus pugnax	Ruff	PM	Logone floodplains Lake Chad	Chad Nigeria	33 754 200 052
Rhynchops flavirostris	Skimmer	R	Upper Chari	Chad	225
Larus cirrocephalus	Grey-headed gull	R	Logone floodplains Lake Chad	Chad Niger	848 4 870
Chlidonias hybridus	Whiskered tern	PM	Logone floodplains	Chad	622
Gelochelidon nilotica	Gull-billed tern	PM	Lake Chad	Niger	426
Glareola pratincola	Red-winged (collared) pratincole	R?, PM	Waza–Logone Logone floodplains	Cameroon Chad	1 888 9 692

* areas supporting more than 1 percent of known populations in 1999–2001

** R = Resident; PM = Palaearctic migrant

Source: after the approach of T. Dodman & C.H. Diagana, 2003 [8.4]

LOGONE FLOODPLAIN, CAMEROON

PHOTO: COURTESY OF P.SCHOLTE

THE FISH-EATING YELLOW-BILLED STORK IS A COMMON RESIDENT IN CHAD, AND IS SOMETIMES CONSIDERED A PEST BY FISHERMEN

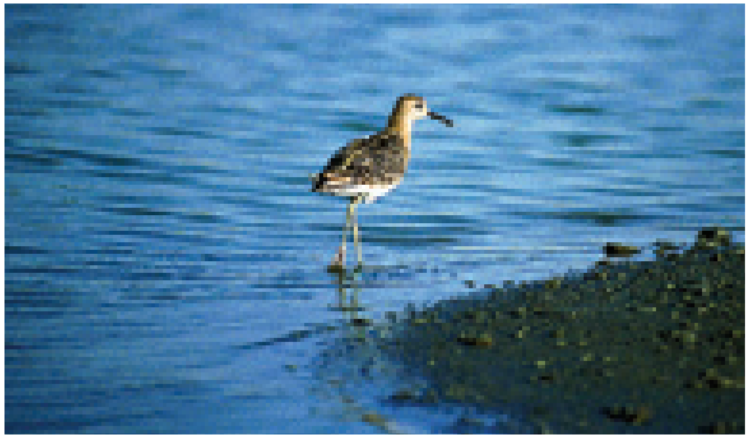
duck (e.g. *Dendrocygna viduata*, *Plectropterus gambensis* and *Sarkidiornis melanotos*) (Table 22). The Lake Chad Basin is also an important wintering ground for several western European bird species, such as the white stork (*Ciconia ciconia*) [8.10] and little egret (*Egretta garzetta*).

The numbers given in Table 22 are based on single counts from the early dry season and do not reflect the dynamics of birds moving between the various wetlands in the Lake Chad Basin. (The fluctuating Lake Chad reaches its maximum water level late in the dry season, when all surrounding areas, including the floodplains, are drying up.) Neither do these dry-season counts show the importance of the ephemeral wetlands that contain water earlier in the dry season [8.7].

By speculating on this link, we can deduce the following sequence, based on waterbird observations throughout the basin during most periods of the year. During the rainy season from June to September, hundreds of small, mostly ephemeral wetlands, dispersed over the Lake Chad Basin, harbour large numbers of Afro-tropical waterbirds (ducks, waders), many of which breed at this time of the year. A few weeks later, after the end of the rainy season, a proportion of these birds moves into the floodplains along the Chari, Logone and Komadugu–Yobé rivers, which dry up only in the early to mid–dry season (December–February). European migratory birds, such as the white stork, egrets, ducks, waders such as the ruff (*Philomachus pugnax*), and others join the Afro-tropical birds. Later in the dry season, birds are expected to move into the Lake

Chad area, which has by then reached its maximum level, before migrating back to Eurasia, whereas Afro-tropical waterbirds will rest there until the onset of the rains. Species such as the garganey (*Anas querquedula*) and black-winged stilt (*Himantopus himantopus*) seem to prefer ephemeral wetlands, whereas the white-faced whistling duck (*Dendrocygna viduata*) has a preference for the larger lakes, including Lake Chad, and riverine habitats.

Bird populations are under pressure from the intensifying use of the wetlands in the Lake Chad Basin. As mentioned above, the construction of an upstream dam in the Logone floodplain has resulted in a loss of more than half the population of the threatened West African subspecies of black-crowned crane, as well as a reduction in the wintering grounds for intercontinental migrants. On a wider scale, the intensification of fisheries, grazing and agriculture is putting further pressure on the basin's wetlands. A relatively new phenomenon is the capture of birds for commercial purposes or consumption, which especially threatens vulnerable breeding colonies.

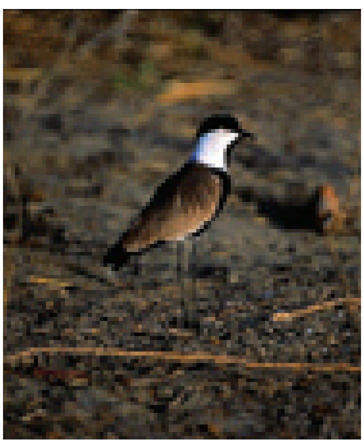


NEAR LELEWA VILLAGE (N'GUIGMI), THE NIGER

RUFF, THE MOST ABUNDANT WADER IN THE LAKE CHAD BASIN

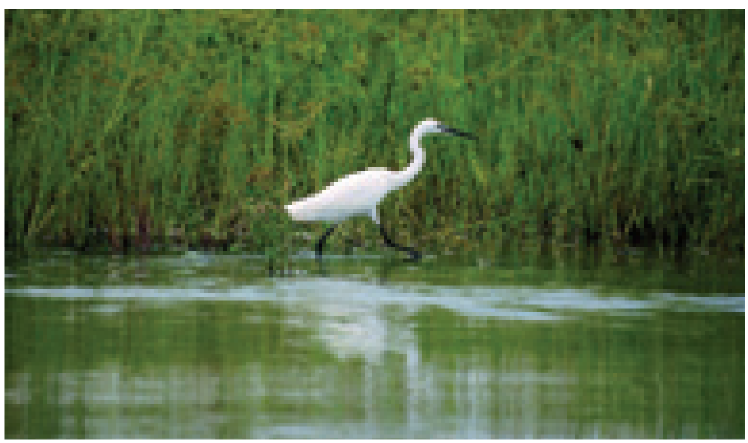
NEAR MALAM FATORI, NIGERIA

SQUACCO HERON



NEAR BOL, CHAD

SPUR-WINGED PLOVER



NEAR MALAM FATORI, NIGERIA

LITTLE EGRET

Lake Chad Basin: an international meeting point for wildlife

The Lake Chad Basin occupies a special biogeographic position in the otherwise monotonous Sahelian region from Senegal to the Sudan. At times in history, the expanding and shrinking lake has resulted in the isolation of Sahelian animal populations, which explains why the distribution of some subspecies is limited to the basin, for example, the korrigum (*Damaliscus lunatus korrigum* cf. *D. l. tiang*) and black-crowned crane (*Balearica pavonina pavonina* cf. *B. p. ceciliae*). In some species, the isolation has led to the evolution of distinct subspecies, such as the Kanuri red-fronted gazelle (*Gazella rufifrons kanuri*) [8.11].

On the other hand, many migratory birds travel long distances to reach the Basin. Satellite-tracked white storks (*Ciconia ciconia*) from Germany, Poland and Israel, followed on their migration through the Nile Valley, subsequently turned west deep into Chad, possibly following grasshoppers [8.10], [8.12]. In the Lake Chad Basin, these eastern European white storks meet their western European counterparts, showing that the previous distinction between populations arose because earlier researchers had neglected to consider the Lake Chad Basin. It is probable that other migratory birds common in the basin, such as the great white pelican (*Pelecanus onocrotalus*) [8.13] and purple heron (*Ardea purpurea*), may also have a more mixed origin, further highlighting the importance of the basin for European birds.

LOGONE FLOODPLAIN, CAMEROON

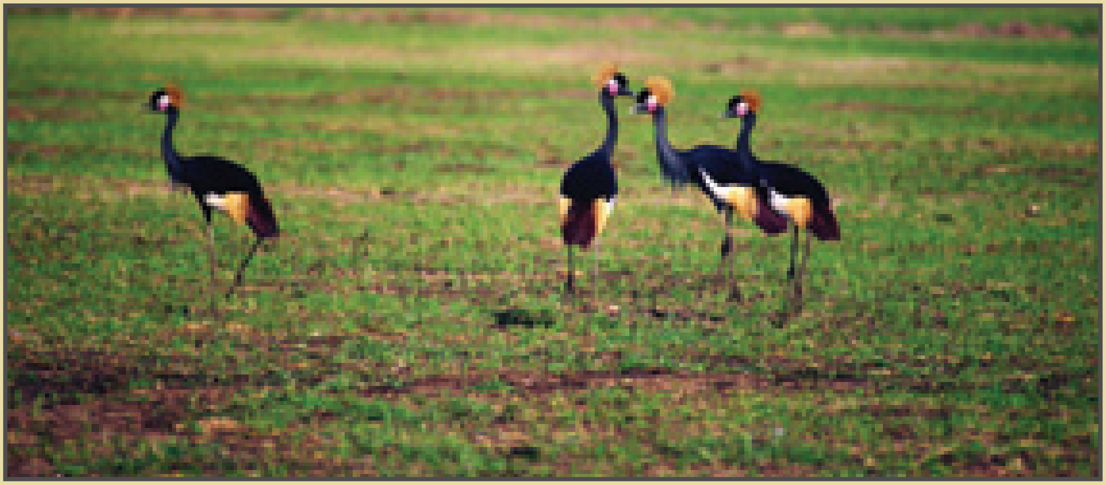


PHOTO: COURTESY OF P.SCHOLTE

BLACK-CROWNED CRANE

OPEN LAKE, CHAD

WHITE PELICAN

WAZA NATIONAL PARK, CAMEROON

SINCE 2000, VIRTUALLY THE WHOLE OF LAKE CHAD HAS BEEN PROCLAIMED A TRANSBOUNDARY RAMSAR SITE OF INTERNATIONAL IMPORTANCE

PROTECTED AREAS

Formal protection in the Lake Chad Basin started in 1936 with the creation of the Zina–Waza Hunting Reserve (Cameroon), which was designated a national park in 1968. From the 1960s onwards, there has been a steady movement to create protected areas in the Central African Republic, Chad and Nigeria, based mostly on the presence of spectacular wildlife, such as elephants, giraffes and large antelopes (Table 23). Since 2000, virtually the whole of Lake Chad has been proclaimed a transboundary Ramsar[1] site of international importance, following a declaration by the Lake Chad Basin Commission (LCBC). The area thus formally protected has reached a size of over 6 million ha, equivalent to about 6 percent of the area of the conventional basin (Table 23). Apart from the Ramsar site on its Lake Chad shores, no formally protected areas are found in the Niger region of the Lake Chad Basin.

Protected areas listed in Table 23 exclude forest and faunal reserves that have never had any management structure and that are true "paper reserves". Nevertheless, only 13 percent of the institutionalized protected areas, mostly national parks, have a moderate or high degree of management effectiveness, implying that less than 1 percent of the Lake Chad Basin is under true protection. With the exception of the Lake Chad Basin National Park (Nigeria), these protected areas have benefited from external assistance via bilateral, multilateral or international cooperation (Table 23). It should be understood that the column entitled "Management effectiveness" in Table 23 may hide management constraints such as the present low number of park guards in

1 The Convention on Wetlands, signed in Ramsar, Islamic Republic of Iran, in 1971, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Ramsar Convention has identified a list of wetlands of international importance.

the Waza National Park (only eight of the 40 needed) which, until recently, was compensated for by ample equipment availability and especially by the improved relations with local communities.

With the designation of Ramsar sites on the Lake Chad shore, there has been a start to much-needed transboundary cooperation. For wildlife, boundaries do not exist and elephants, giraffes and korrigums frequently migrate between the Waza National Park in Cameroon and the Chingurmi–Duguma section of the Lake Chad Basin National Park in Nigeria. Zakouma's elephant population is also known to cross the Chadian boundary into the Central African Republic during the rainy season. For too long, poachers have exploited the limited control of national states along their frontiers, making cross-boundary poaching the main threat for Waza National Park, as the mortalities among its park personnel sadly testify. Recently, a collaboration programme has begun between the Waza and Lake Chad Basin National Parks concerning anti-poaching patrols and the creation of awareness among villagers living on the international boundary. In the long term this should lead to mixed patrolling and regular exchanges in their management programmes.


NEAR BOL, CHAD


WAZA NATIONAL PARK, CAMEROON

THE SPECTACULAR PRESENCE OF GIRAFFES IS MAINLY CONFINED TO PROTECTED AREAS

TABLE 23 **MAIN PROTECTED AREAS IN THE LAKE CHAD BASIN***

COUNTRY	Protected area	Protection category	Climatic zone	Size (1 000 ha)	Management effectiveness	External assistance	Participation by local communities***
CAMEROON	Waza	National park, biosphere reserve, Ramsar site	Sahelo-Sudanian	170	Moderate	Netherlands	Consultation, sometimes functional
	Kalamaloué	National park	Sahelian	5	Low	No	Passive
	Mozogo-Gokoro	National park	Sudanian	2	Moderate	No	Passive
CENTRAL AFRICAN REPUBLIC	Manova-Gounda-St Floris	National park, World Heritage Site	Sudanian	1 740	Moderate-low	European Union (EU)	Information–giving, locally functional
	Bamingui-Bangoran	National park, biosphere reserve,	Sudanian	1 070	Low	Some EU countries	Passive
	André Felix	National park	Sudanian	170	None	No	None
CHAD	Zakouma	National park	Sahaelo-Sudanian	300	High	EU	Information–giving
	Manda	National park	Sudanian	114	Moderate	France	Information–giving
	Fitri	Biosphere reserve, Ramsar site	Sahelian	195	No formal, yet traditionally high	Global Environmental Fund (GEF) planned	-
	Wadi Achim – Wadi Rime****	Faunal reserve	Sahara-Sahelian	7 795	None	No	None
	Lake Chad	Ramsar site	Sahelian	1 650	None	GEF planned	-
THE NIGER	Lake Chad	Ramsar site	Sahelian	340	None	GEF planned	-
NIGERIA	Lake Chad Basin	National park (four distinct sectors)	Sahelo-Sudanian	228	Moderate?	No	Passive?
	Hadejia-Nguru	Reserve - partly national park, Ramsar site	Sahelo-Sudanian	300	Moderate-low	IUCN, BirdLife, GEF	Information–giving

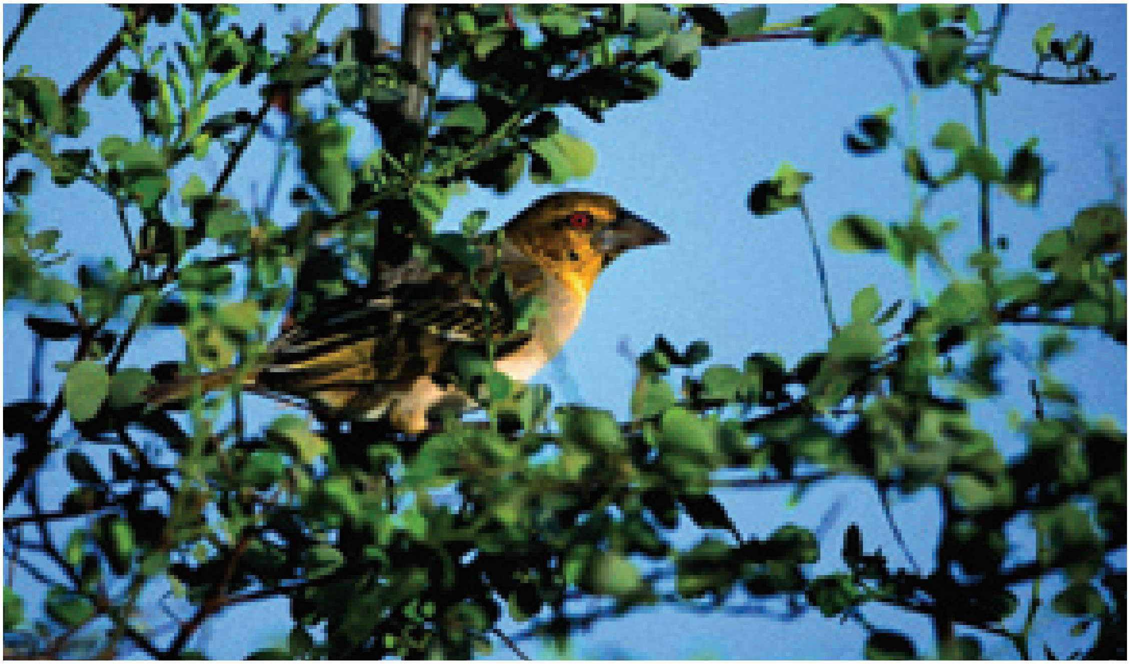
* Excluding gazetted forests and most faunal reserves

** Central African Republic: based on Blom, *et al.*, 2001 [8.14]; Chad: based on Scholte & Robertson, 2001 [8.15], pers. obs.; Cameroon: based on Fotso *et al.*, 2001 [8.16] and Scholte, pers. obs.; the Niger: based on WWF - Living Rivers Web site and Brouwer, *et al.*, 2001 [8.17]; Nigeria: based on Ezealor, 2001 [8.18] and Saleh, 2003 [8.19]

*** Following Pretty *et al.*, 1995 [8.20]

**** Wadi Achim – Wadi Rime situated just north of the conventional basin, indicated for their importance for Sahelian fauna

NEAR GUITTE (N'DJAMENA), CHAD



QUELEA IS CONSIDERED TO BE A PEST OF CULTIVATED CEREALS

WILDLIFE CONSERVATION AND WISE USE

Worldwide there is increasing recognition that the only way to ensure the survival of wildlife is by giving it a monetary value, thus providing incentives for its conservation and wise use. The variety of experiences in the Lake Chad Basin should inspire future initiatives for optimizing the use of its wildlife both in and outside protected areas. Some examples of this are shown in the following pages.

THE RED-BILLED QUELEA: A PEST OR A RESOURCE?

The red-billed quelea (*Quelea quelea*) is traditionally considered a pest of cereals, particularly of millet and irrigated rice [8.21]. In the past, various attempts have been undertaken around the Lake Chad Basin to eradicate the species [8.22] or to study its migratory behaviour in order to develop successful strategies for control or damage prevention [8.23], [8.24]. Such strategies include a simple adaptation of the crop calendar of irrigated rice so that the vulnerable crop stages occur during the absence of the quelea [8.25]. This is possible because queleas have a well-defined migration pattern and, in some periods of the year, they are almost absent [8.23], [8.24]. Various methods have been employed to control queleas. The most rigorous, which are still in use, involve the application of avicides, such as fenthion or cyanophos [8.21]. These avicides belong to the organophosphate family of chemicals and are characterized by a high acute toxicity. They are not only toxic to the quelea, but may also pose risks to any humans, livestock and non-target species entering treated areas [8.21]. Perhaps less obviously, another group is exposed to the residues: consumers of queleas.

Populations of the countries of the Lake Chad Basin consume queleas in large quantities. In the recent past, when chemical treatments were used more commonly than they are nowadays, it was not unusual to see villagers entering a roost after it had been treated in order to collect dead or dying birds. These were

DELTA OF CHARI RIVER (N'DJAMENA), CHAD

QUELEA IS ALSO A RESOURCE BECAUSE IT IS TRADITIONALLY EATEN BY LOCAL PEOPLE

degutted and dried on the roofs of their houses for later consumption. It was mainly children who collected the birds. During aerial treatments of large roosts in the Niger, crop protection agents had to spend the night near the roost in order to prevent children from entering.

Queleas are also captured in large numbers by indigenous methods for marketing in western Chad and northern Cameroon. These birds are free from chemical residues and are a highly prized, protein-rich addition to the daily menu. The history of quelea-trapping in the Lake Chad Basin probably goes back many decades, but it certainly received a major boost when Hadjerai from the Guera in central Chad settled in western Chad during the major drought period that hit the Sahel in the late 1960s to early 1970s. Hadjerai *piégeurs*, as they are called locally, use triangular nets on moonless nights to trap birds in their roosts. Such a net was once shown to elderly Mousgoum and Kotoko fishermen along the Logone in Maga, northern Cameroon, and they immediately recognized it as a net that they had used in the past for fishing; some of them produced their nets, which they had kept for 20 years in their houses. These nets became obsolete after the dams along the Logone were constructed in the 1970s, cutting off 600 000 ha of the Waza–Logone floodplain from annual flooding. Their nets no longer had any use until the Hadjerai gave them a second life: to "fish" for the quelea.

Fishermen in northern Cameroon have adapted another fishing method to trap queleas: that of the *épervier*, or castnet. They discovered that queleas roosting in *Typha* marshes could be trapped at night by throwing a castnet over the roosting birds. Although using this net did not trap as many birds as the triangular net, the method was good enough to produce some benefits. Meanwhile, these methods have spread to other areas of northern Cameroon [8.26].

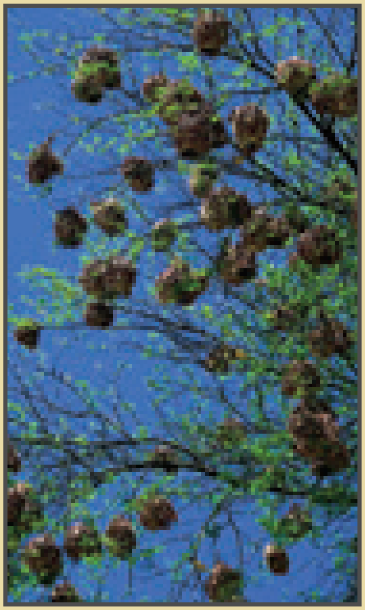
"Fishing" for queleas deserves attention from crop protection departments, which traditionally regard the bird as a pest rather than as a resource. Bringing together the farmers, trappers and crop protection agents may be the start of a fruitful cooperation leading to sustainable use of a bird hitherto considered as Africa's feathered locust [8.27].

"Fishing" for the quelea: Hadjerai *piégeurs* show that pest species are valuable resources

Going out with the Hadjerai at night is certainly a special experience. Clad entirely in black, they wait until the moon has disappeared and, when the owner of the net climbs on the shoulders of two of his companions, to fold the net backwards around a tree where queleas have gathered, he looks more like a huge bat than a human being. The queleas, startled, fall into the net and are rapidly collected in empty millet bags, where they simply suffocate. Usually, the throats of the first 20 or 30 birds are cut, to comply with religious obligations. They are representatives for the other 20 000 birds that a team easily traps in a couple of hours.

At first light, the birds are being plucked, roasted and dried. Then they are packed in bags and, on donkeys and trucks, are taken to the markets of N'Djamena or Maroua, where they are sold by Hadjerai women. In 1993 and 1994 sales of queleas in N'Djamena were estimated to be worth up to 38 million CFAF * [8.28]. This was of an estimated 10 million birds sold annually – a very conservative estimate, since *piégeurs* in the Zakouma area showed that 700 000 queleas could be trapped in a single night! Such revenues are important when compared to capitalized crop losses: based on these conservative estimates, they could compensate for 23–40 percent of millet crop losses [8.28]. An economic analysis further demonstrated that the market was not yet saturated and that realistic potentials for the use of "quelea flour" for fish and poultry feed existed [8.26].

* 1 000 CFAF are equivalent to 1,52 euros.



NEAR BAGA, NIGERIA

QUELEA NESTS

WAZA NATIONAL PARK, CAMEROON

PHOTO: COURTESY OF P.SCHOLTE

YEAR-ROUND AVAILABILITY OF WATER HAS INCREASED QUELEA POPULATIONS

>> RIGHT: QUELEA HUNTERS CAN CATCH AS MANY AS 700 000 BIRDS IN A SINGLE NIGHT
DELTA OF CHARI RIVER (N'DJAMENA), CHAD

DELTA OF CHARI RIVER (N'DJAMENA), CHAD

SUPPORT AND TRAINING SHOULD BE PROVIDED FOR HUNTERS SO THAT THEY CAN DEVELOP NILE MONITOR RANCHING AS A SOURCE OF INCOME

RANCHING OF THE NILE MONITOR

The Nile monitor (*Varanus niloticus*) deserves particular attention because it already generates benefits for local people and these could be increased by appropriate interventions. This lizard grows up to 1.5 m in length, lives in burrows and, like all monitors, is a daytime predator, feeding on insects, molluscs, fish, birds, eggs, snakes and small mammals. The semi-aquatic monitor can undergo aestivation for several months during the cooler drier season. High densities of the Nile monitor have been recorded around Lake Chad [8.29], where it finds an ideal habitat in the prolific aquatic vegetation, mostly between the islands, where fishing is limited and the few inhabitants tend to be mainly subsistence farmers and pastoralists.

The Nile monitor is hunted for its meat and skin, a practice based on an age-old and thorough understanding of the lizard's movements and habitat. In a single day, a team of hunters, often using baited hooks, may catch up to 30 or 40 Nile monitors. The captured animals are kept alive until the following day, when they are killed, often as part of a ceremonial sacrifice, skinned and the meat is smoked. Once the Nile monitor season is over, the hunters return to their farming, fishing or pastoral activities.

Nile monitors are eaten or sold in local markets; their meat is considered a delicacy by the local people, who also use their organs and tissues for medicinal purposes. Traditional methods of salt-drying and smoking the meat are known but no information is available on the consumption and potential market of dried meat. The skin, which is very durable and extremely beautiful, is highly prized on the international market. If managed

N'DJAMENA, CHAD

THE SKIN OF THE NILE MONITOR IS DURABLE AND HIGHLY PRIZED ON THE INTERNATIONAL MARKET

BALATUNGUR VILLAGE (BOSSO), THE NIGER

NILE MONITOR MEAT IS CONSIDERED A DELICACY ON LOCAL MARKETS AND ITS ORGANS ARE USED FOR MEDICINAL PURPOSES

sustainably, this reptile could be a useful source of extra food and income for communities living in the Lake Chad Basin.

Despite research on the monitor's reproductive biology [8.30], little is known about how to increase monitor production. One option might be the ranching of Nile monitors, which would provide new working opportunities for local hunters without affecting wild populations. However, more needs to be understood about trading practices in Nile monitor meat and skins. The villages that sell the skins are registered, but the traders deal directly with the hunters, fixing the prices and establishing the rules of the market. The hunters sell Nile monitor skins for 400 CFAF*, while the intermediaries sell them on for an average of 600 CFAF. Records show that, between 1980 and 1985, trade in skins averaged over 400 000 per year. Between 1985 and 1991, Cameroon exported 806 522 skins, and Chad 200 082 skins. Since 1993, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has limited the annual export quotas to 80 000 for Cameroon and 75 000 for Chad. Ostensibly, these quotas have been respected, but information is lacking on the illicit international trade, local craft uses of the skins, and especially meat consumption and other uses of organs and body parts, which have been estimated to be three to four times as high [8.30].

Proper regulations should be put in place before any action can be undertaken.

Support will be needed to help hunters in the development of Nile monitor ranching in order to maximize profits while maintaining an ecological balance. Awareness campaigns should be devised and launched to ensure that local people use hunting techniques that guarantee the long-term preservation of the species.

* 1 000 CFAF are equivalent to 1,52 euros.

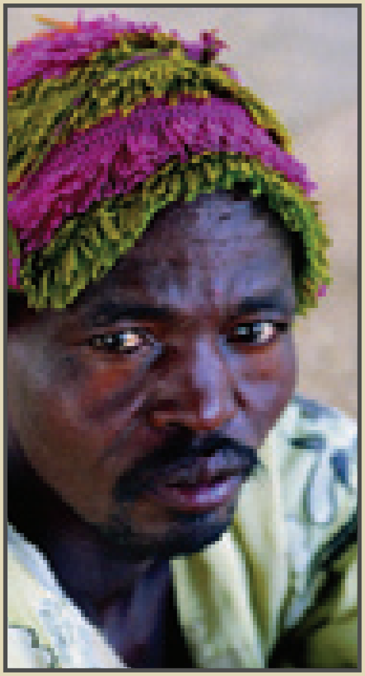
On the trail of Lake Chad's last hunters

17 October 2001
Port of Kaniram, Nigeria

Here we encounter for the first time a "professional" hunter. His name is Awalé Mohawan. We try to strike up a conversation, but we read mistrust in his eyes. He has an understandable reluctance, as a great many restrictions have been imposed on hunting, in an effort to curb the anarchy and the excesses that have followed the recent fighting. And it is traditional hunters like this man who pay the heaviest price. Awalé Mohawan and his like are a dying breed; once venerated and considered heroes, who protected the villages from wild beasts, today they have been reduced to the role of poachers and pursued by the law. We make an appointment for the following day. But we will wait in vain.

DELTA OF CHARI RIVER (N'DJAMENA), CHAD

THE NILE MONITOR IS HUNTED BY PROFESSIONAL HUNTERS AND ALSO OCCASIONALLY BY FISHERMEN AND FARMERS AS A SOURCE OF EXTRA FOOD AND INCOME



KANIRAM VILLAGE, NIGERIA

AWALÉ MOHAWAN, PROFESSIONAL HUNTER

17 March 2002
Hadidé, Chad

After several attempts, we manage to make contact with another "professional" hunter, Mohamed Issa, who seems happy to talk to us. He has a permit from the Direction de la protection de la faune et des parcs nationaux to hunt varans (monitor lizards). These large lizards are found throughout Chad and are hunted – or should we say fished – by virtually all lake dwellers. For some of them it is also an important source of income in the off-season. But for professionals like Mohamed Issa, the best season for this activity is between March and June. We follow him as he makes his daily rounds, checking his fishing lines placed along the lakeshore, hidden by the reeds. He uses size five hooks, with meat-based bait (although the precise recipe will remain a secret).

We start the rounds in the boat: nothing. Fish have nibbled at the bait but not a trace of varans. As we approach the third line, we see movement in the water: something big is snapping at the bait. We silently observe the hunter as he expertly hauls aboard a fine example of varan, about 1.2 m in length. Throughout the operation, Issa keeps a close eye on the lizard's tail. For, although provided with very sharp teeth, jaws with a deadly grip and exceptionally long claws, varans use their tails as swords, to deliver rapid and violent thrusts. The hunter is especially careful not to damage the skin, for it is this which will earn him the greatest profit when he sells it at the N'Djamena market. The meat will be sold, preferably fresh, but if there is a great quantity, it will also be preserved – dried or smoked – to be exported to Nigeria. The varan is used in traditional medicine as well, while the Peul tribe uses it as a gri-gri to ward off poisonous snakes.

The law has set a limit of 80 000 on the annual catch of monitor lizards, and such is the number of skins that are said to be exported from Chad to France each year. All of them pass through the warehouse owned by Mustapha Kuimé, the only trader in varan skins operating in N'Djamena.

>> RIGHT: HUNTING TECHNIQUES MUST GUARANTEE THE LONG-TERM PRESERVATION OF THE SPECIES

DELTA OF CHARI RIVER (N'DJAMENA), CHAD

From enemies to discussion partners in conservation

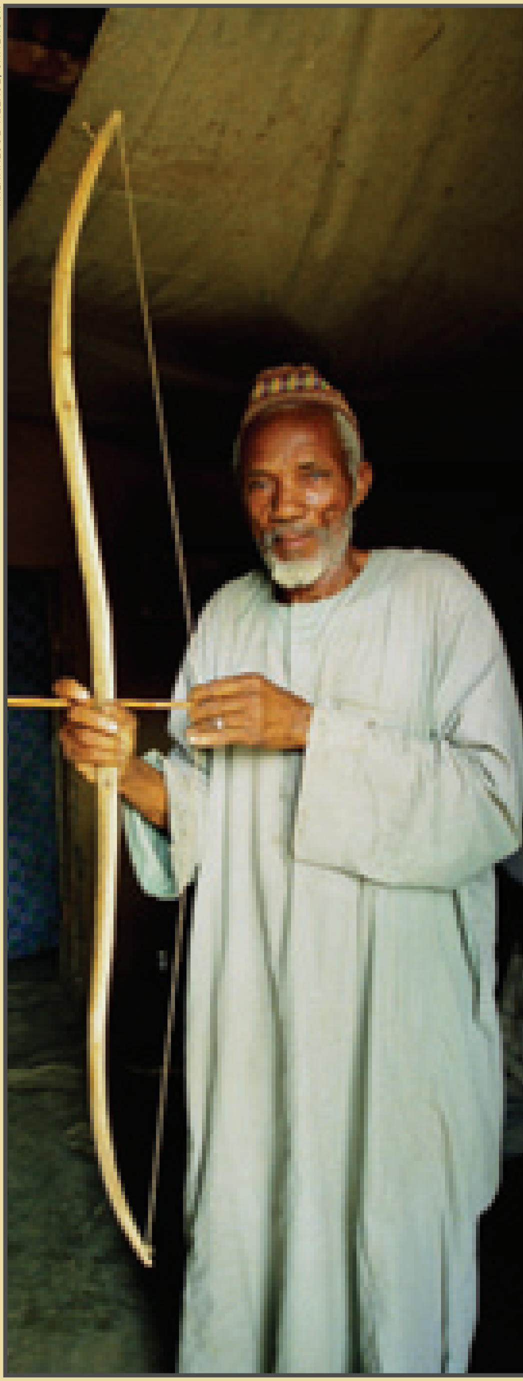
Waza National Park is one of the many protected areas where contacts between local communities and park authorities have for a long time been under considerable strain. Many local communities still bear the emotional scars of being evicted from their villages and of being banned from exploiting the traditional resources that now lie in a "protected area". Moreover, they are frustrated by their low revenues from tourism, as young men from the cities have taken up the jobs at the tourist camps. On the other hand, park authorities complain about the complicity between local communities and poachers, as well as the stubbornness of villagers and herders who continue to exploit grazing and fishing inside the national park.

During field controls, tensions regularly rise. For example, park guards who are trying to stop the herding of livestock inside the park may be confronted with the sudden disappearance of the herdsmen on their arrival. Frustrated, the guards try to chase the cattle, or to take one or two with them in order to make the owner reveal himself. Yet cattle are not easy to catch and so, after some bad experiences, instructions are issued to shoot one of the cows, provoking strong reactions. Another example is that of the fishermen, who generally enter the protected area during flooding, when the roads are inaccessible and when they can exploit the rich fishing without being bothered by the park authorities. However, when these fishermen have dried the fish and transported it to local markets, they are chased by the park guards, who confiscate all the fish, even if some of it came from outside the national park. Even more complicated is the situation regarding villages situated right on the park boundaries, where every activity in their surroundings is formally "illegal".

This was the situation in 1993, when the Waza–Logone project started working with local communities to enhance their involvement in the management of Waza National Park. Participatory discussion sessions in each village and pastoralist's camp were held in order to understand further what was going on and, above all, to gain the confidence of local communities. Intensive cooperation with the park authorities was also needed, because they were afraid of losing control of the situation. With the agreement of all parties, a management plan was drawn up in 1996/97, and clear rules were subsequently formulated regarding activities in the park; these included activities allowed under guidance (grasscutting, gum Arabic collection), activities allowed under conditions laid down in a contract (fishing), and activities that were strictly forbidden (hunting) [8,31]. Ecodevelopment activities were initiated to equip villages with basic sanitation. A committee of representatives of local communities was created, and the park authorities were obliged to consult the members on all matters related to the national park, as well as giving them a stake in some of the revenues from the tourist camps.

Six years after the approval of the management plan by the Minister of the Environment, poaching and illegal exploitation still exist in Waza National Park. However, the atmosphere between park authorities and local communities has improved dramatically, as all now realize that they mostly share a common interest. In 1999, for example, the low number of park guards motivated the local communities to approach the Minister of the Environment, because they were worried about the low level of surveillance. In the meantime, they selected village guards to assist the park authorities, a situation unimaginable ten years ago.

KALAMALOUÉ VILLAGE, CAMEROON

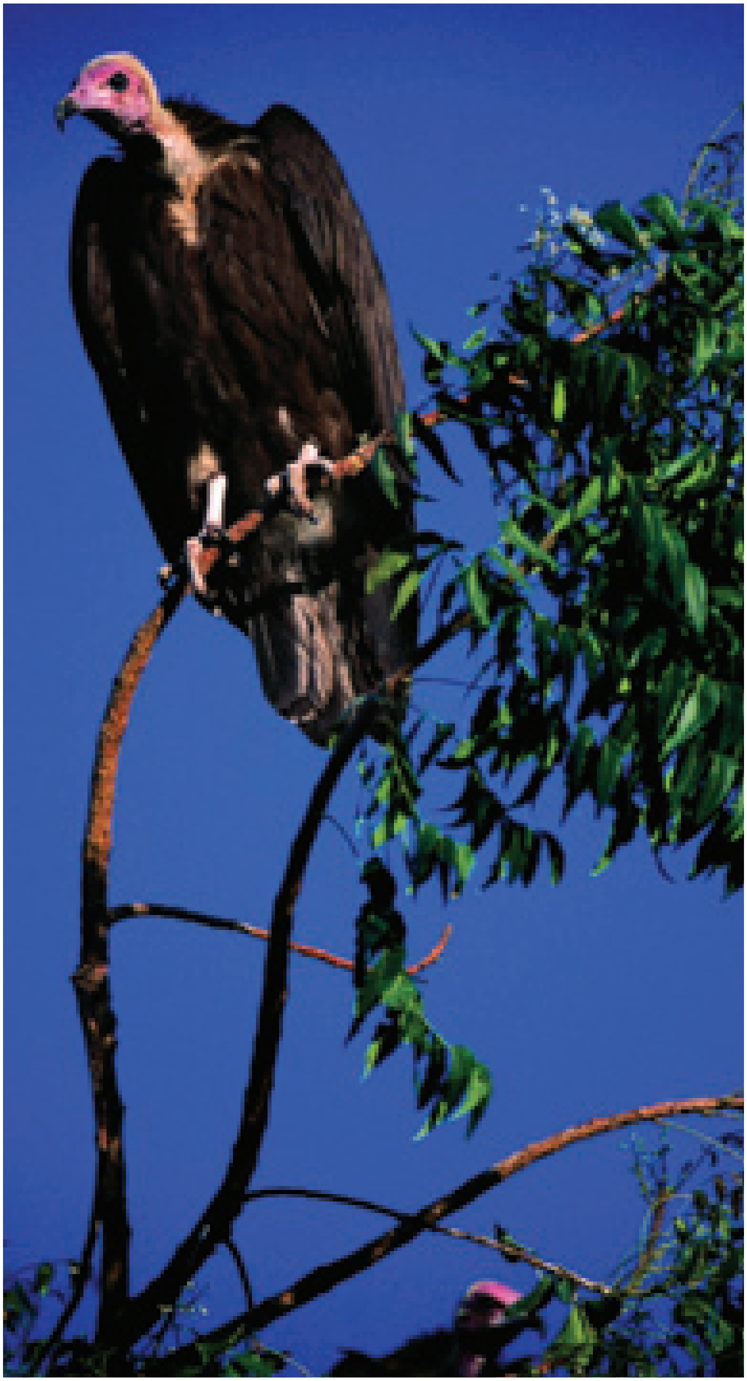


TRADITIONAL HUNTERS, SUCH AS UMARU OUSMANE, INCREASINGLY ASSIST PARK AUTHORITIES IN CONTROLLING WILDLIFE

TOURISM

Tourism is widely regarded as one of the most appropriate ways of optimizing the use of wildlife resources. A good example in the basin is Waza National Park (Cameroon), which is probably the best known and most visited national park in central Africa. Annually, 5 000 visitors are attracted by its large elephant population, as well as by its lions and giraffes and the spectacular concentrations of kob, korrigum and waterbirds during the dry season. Yet even here, in this most visited national park in the basin, the revenues generated by entry fees are not enough to cover the running costs of its management, let alone the costs of reserving this tract of land for conservation purposes. Indirect revenues, such as travel costs and souvenirs, are an important additional source of finance, but they are difficult to quantify or to exploit as an incentive for the area's protection.

Efforts have been undertaken to increase tourist numbers; for example, a hotel was constructed near the park entrance in the 1980s, although it has never been used. Recently, initiatives have been undertaken to direct more of the revenues from visiting tourists into local communities by the construction and successful exploitation of a local tourist camp. Among the other protected areas in the basin, the Lake Chad Basin National Park (Nigeria), Zakouma National Park (Chad) and Manovo–Gounda–St Floris (Central African Republic) each receive only a few hundred tourists a year at most, despite relatively important investments in their lodging facilities. The inaccessibility of the area, which is 1 000 km from N'Djamena (Zakouma National Park) and Bangui (Manovo–Gounda–St Floris), and the lack of spectacular wildlife (Chad Basin National Park), combined with a general lack of any tourism tradition, hamper any development of tourism in these countries.



NEAR BOL, CHAD

THE DEVELOPMENT OF TOURISM IN THE LAKE CHAD BASIN IS STILL SLOW, MAINLY BECAUSE OF SCARCITY OF SPECTACULAR FAUNA AND A GENERAL LACK OF TOURISM TRADITION

NORTHERN CHAD

PHOTO: COURTESY OF P.SCHOLTE

DORCAS GAZELLE, STILL THE MOST ABUNDANT ANTELOPE IN THE LAKE CHAD BASIN

GAME-HUNTING TOURISM

For decades there has been a tradition of game-hunting tourism in the humid infertile savannahs of the upper Lake Chad Basin, in the northeastern Central African Republic and just outside the basin in Cameroon. Since the 1990s, game hunting of elephants has been allowed in the basin part of northern Cameroon, but its poor organization does not meet international standards. Western hunters pay up to €25 000 for a two to three week safari, targeting trophy species such as the giant eland (*Tragelaphus derbianus*), African buffalo, elephant and others. Because of the extremely low carrying capacity of these savannahs for livestock grazing, let alone agriculture, game hunting has proved to be a sustainable land use, if controlled by specialized management. Unfortunately, the northeastern Central African Republic has witnessed increasing pressure from pastoralists in their quest for new pastures after the loss of grazing lands further north. Insecurity has become a major problem and large-scale poaching has become prominent. Game-hunting revenues in the northeastern Central African Republic dropped from over €6 million in 1988 to less than €3 million in 1995 [8.32]. In Cameroon, conditions for game hunting are positive, yet the pressure of increasing cotton cultivation threatens its long-term prospects. In both the Central African Republic and Cameroon, efforts are being undertaken to give local communities a more important stake in the exploitation of their territories, thus increasing their revenues and ensuring their commitment to the wise use of wildlife.

WILDLIFE AS PART OF A MULTIPLE LAND-USE SYSTEM

With the collapse of wildlife populations in the Sahelian grasslands in the 1970s and 1980s, areas with high wildlife densities and low human populations have become increasingly rare in the Lake Chad Basin. The northeastern part of the Central African Republic is the only area where there is still the potential for land use to be focused exclusively on wildlife. Elsewhere, direct as well as indirect revenues from tourism do not compensate for other potential uses of the protected areas. Lately, several protected areas in the basin have benefited from conservation development projects, thus supplementing the revenues from the protected area with infrastructures such as health clinics and wells. The results of these projects are limited, however, because of the generally short intervention periods, as well as the negative impacts of development activities right on the border of protected areas [8.33]. These constraints have motivated the development of international payment schemes to compensate local communities for the conservation of biodiversity, but their implementation will take several years – too long to be of much help for the pressing problems in the Lake Chad Basin.

The consideration of wildlife as part of a multiple land-use system seems to be the most pragmatic option for the basin's protected areas. Moreover, for decades, the presence of wildlife alongside land uses such as grazing, fishing, and collecting fruits and gum Arabic has been the existing situation in most protected areas, although it has not been recognized as such or developed [8.34]. Priority should be given to the involvement of local communities, which have so far had only a passive role (Table 23). Local communities can and should play a major role in assisting protected-area authorities, based on their recognition of the protection status of wildlife. In return, the communities should be given the exclusive rights to exploit resources such as gum Arabic and straw, and possibly fish and grazing in the protected areas, under strict conditions laid down in a contract. No miracles should be expected and the Waza National Park experience shows the need for a gradual approach in which a strong governmental presence is indispensable for dealing with armed poachers. At present, none of the protected areas in the Lake Chad Basin has the appropriate regulations, although the IUCN Protected Area Category VI [8.35] provides a suitable framework. Few protected-area managers in the Lake Chad Basin have any experience of community wildlife management, and an institute such as the Garoua Wildlife College in northern Cameroon could play an important role in enhancing their abilities [8.36].


TRADITIONAL PAINTING BY ROKY, FROM MOUNDOU VILLAGE (N'DJAMENA), CHAD

LOCAL COMMUNITIES MUST BE INVOLVED IN PROTECTING AND MANAGING WILDLIFE AS PART OF A SUSTAINABLE EXPLOITATION OF LOCAL RESOURCES.

Notes from a journey

N'GUIGMI, THE NIGER

UNTIL THE 1930S, ELEPHANTS WERE COMMON IN THE NIGER PART OF THE LAKE CHAD BASIN

On the trail of Lake Chad's last elephants

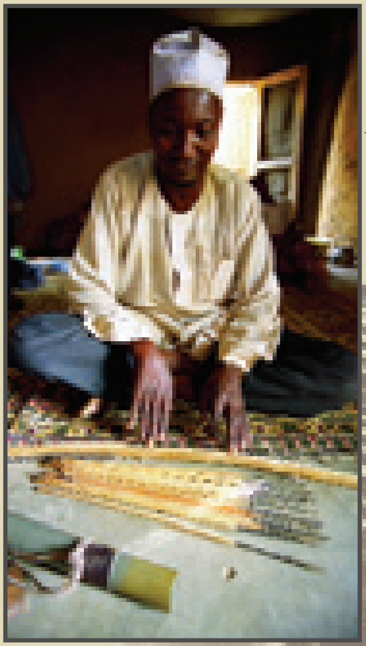
6 October 2001
N'Guigmi, the Niger

We are a few kilometres south of N'Guigmi, in the Niger, close to the shores of Lake Chad. Here elephants were sighted in great numbers up until the 1930s. Some of the old farmers of the area still remember them, and they describe for us their slow progress, as they moved between the Tal Desert and the lakeshore, swaying their big heads. Today, the only evidence of those former times is two giant elephant skulls – without their precious tusks – which adorn the entrance to the *Prefecture*, a pleasant colonial-style building.

Today around Lake Chad just a few herds remain in Cameroon and Chad, maybe a hundred elephants in all, chased from cultivated land, pursued from park to park. They are a problem: a herd of just 20 elephants can wreak havoc on fields and pastures, uprooting trees and plants, eating all the freshest shoots and trampling on crops as they go. The trail of destruction is not unlike that left by a whirlwind, as we ourselves witness in Cameroon, on our way to Dum Dum, crossing a wadi recently visited by a small herd of elephants.

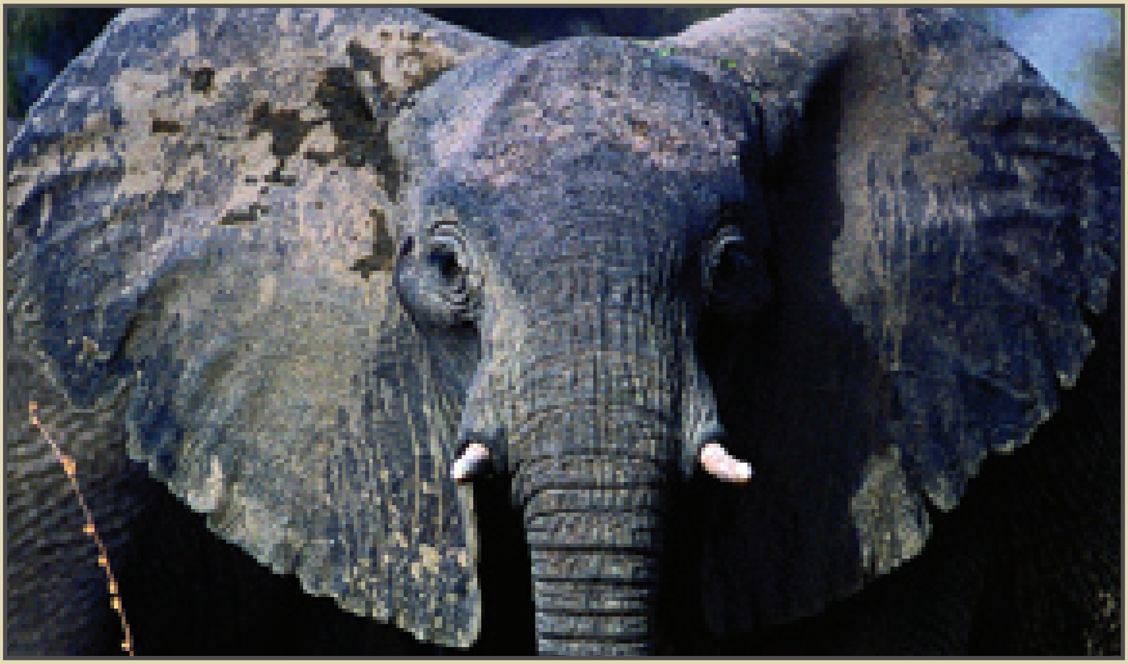
21 March 2002
Kousseri, Cameroon

In both Cameroon and Chad, elephants are a protected species. As long as they do not poke their long noses outside the confines of the parks and reserves, no one will kill them. Even farmers, who are in constant battle with them, simply try to scare them off their land with noise, banging saucepans, shouting and throwing stones. But as soon as they stray, it becomes a good opportunity to organize a shooting party for white tourists.



KALAMALOUÉ VILLAGE, CAMEROON

HAMMADOU GLIN EXPLAINS THE TRADITIONAL ELEPHANT HUNTING METHODS


KALAMALOUÉ NATONAL PARK, CAMEROON

IT IS QUITE DIFFICULT TO PERSUADE ELEPHANTS TO RESPECT THE BOUNDARIES CREATED BY STATES AND PROTECTED AREAS

Just outside the small protected area of Kalamaloué, in Cameroon, a few kilometres from the lake, there are about 30 elephants, many of them mothers with their babies. Two European hunters are waiting patiently for the elephants to stray beyond the confines. They have paid $1 500 for the privilege of shooting one specimen at will.

In the nearby village of Maracò, we make a stop at the house of Hammadou Glin. An experienced game warden, once a great hunter himself, he now works as a guide for tourists. His competence is beyond question, his stories riveting. He recalls how his own father hunted elephants on horseback. The hunters, always in a group, would choose a good target, maybe the weakest, least aggressive member of the herd, and would gallop alongside it. Then, at the right moment, they would thrust their spears into the belly of the animal. Three, four, five spears whose tips had been dipped in poisonous latex from the *Ficus* plant, and the pachyderm would end his run in a matter of minutes, the hunters closing in for the kill. The spoils of the hunt would be shared among the whole village, recalls Glin, and a big celebration would follow. "It meant meat for everyone, for several days at a stretch."

Among the followers of a hunting party, there would be people endowed with special powers; if an attacked elephant turned violent, they were able to calm the beast with magic spells. "I saw one elephant lift a hunter into the air with its trunk, but when it was ordered to put him down, it did so at once!" (The group of listeners nods emphatically: "Ah yes, it's true, there were some people who had these powers!") "Of course, we never attacked a mother with its baby, nor a dominant male; one could say the selection was almost natural," he added. "These days, the elephants and the farmers manage to get along, though it isn't always easy."

The situation seems rather more fraught in Chad, where the parks are much further south of the lake, making it more likely that the elephants will damage the crops. It is all too easy to track a small herd of elephants – all we do is follow the trail of demolished trees and bushes as well as huge dum palms that have been completely uprooted. (Elephants are particularly fond of the tender roots of these palms, and the only way they can get at them is to simply pull the whole tree out and devour the roots before moving on to the next one). This herd of 40 to 60 elephants is now wandering along the southern shore of the lake, close to the village of Kuludia, moving in the direction of Dum Dum in Chad. We are told that the idea is to persuade them – or force them if necessary – to join up with another much larger herd living in the Lake Fitri Basin, and then push the whole group further south, into the Zakouma National Park.

CHAPTER 9

ATROUN AND DIHÉ

"...women are fearless
...women are strong
...women can do
everything!"

[From a popular Chadian tale]

9

ATROUN AND DIHÉ

WADI TALA (BOL), CHAD

WADIS DOT THE LANDSCAPE OF THE LAKE CHAD BASIN. SOME OF THEM ARE RICH IN TWO HIGH-VALUE NATURAL RESOURCES: *ATROUN* AND *DIHÉ*

INTRODUCTION

The Lake Chad Basin has been blessed with two high-value natural resources that have sustained local people for centuries, both as a food source and as a means of generating income. The first, *atroun* (or natron), is a sodium carbonate complex, rich in minerals, used in large parts of Africa as salt. Generations of miners have extracted this precious substance from beneath the earth's surface and traded it through the desert to the north, south, east and west of the Lake Chad Basin. The second, *dihé* (or *Spirulina*), is an alga that has extraordinary nutritional powers, grows naturally and is gathered from the wadis of the northeastern Lake Chad Basin, mostly by women.

Although very different from each other, *atroun* and *dihé* have much in common. For centuries, both have been harvested and processed by the poorer sectors of the community: *atroun* by the Haddad caste and *dihé* by the Kanembu Haddad or

ATROUN WADI - LIWA (BOL), CHAD

CAMEL CARAVANS HAVE BEEN USED FOR CENTURIES TO TRANSPORT *ATROUN* ACROSS THE DESERT

Kanembu Kadjidi. Both play a fundamental role in the preparation of food by the people living in the region; *dihé* is chiefly used as a sauce, while *atroun* replaces salt in cooking and is a food supplement for animals. Both are natural resources, whose continued production depends heavily on the preservation of the environment in which they thrive.

Perhaps most important, both *atroun* and *dihé* hold out great hopes for the future. In both cases, there is considerable scope for boosting production and for improving the quality of the end product in order to make it more saleable. Demand for both products is increasing and, with the right support, there is a strong potential for developing the markets, especially at national and regional level. However, any efforts to increase production and trade in *atroun* and *dihé* can only be successful if attention is also paid to solving problems such as:

- seasonality of production
- variable quality
- fluctuations of production
- fluctuation of prices on the market
- traditional trade and distribution chain

Especially for *dihé*, the real challenge is finding a way of developing technologies and regional markets while at the same time leaving the key role, and the relevant benefits, with the groups of women who produce it.

ATROUN WADI - LIWA (BOL), CHAD

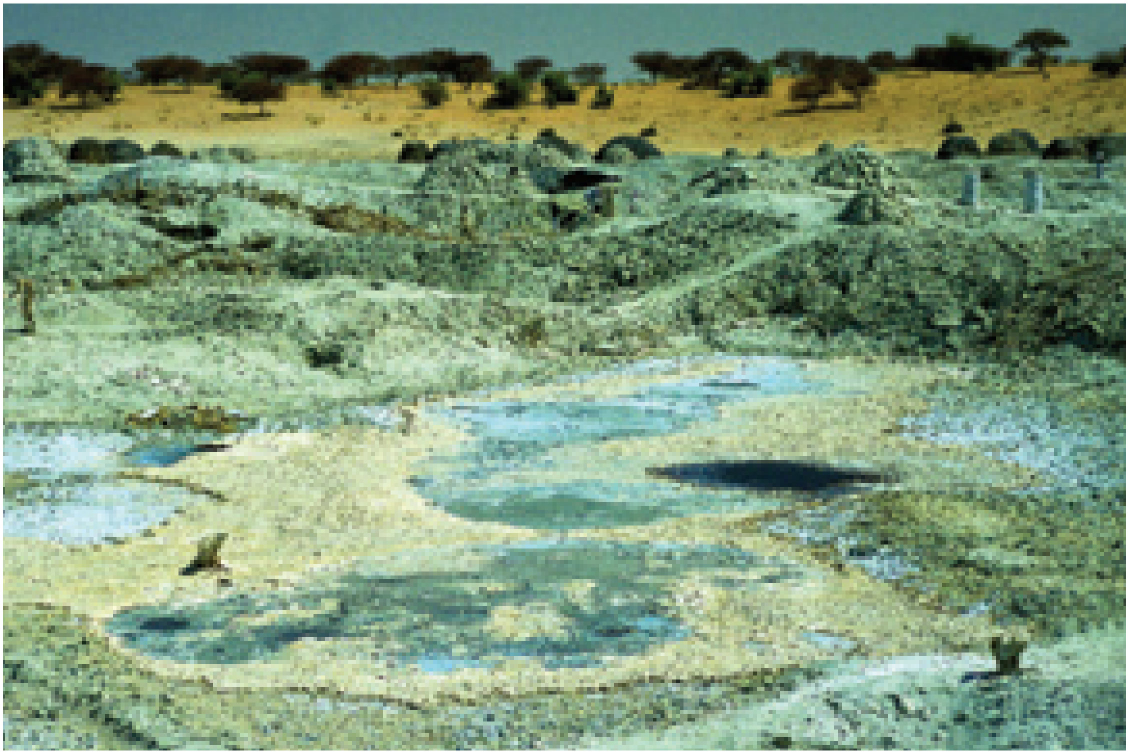
CHAD PRODUCES SOME 7 000 TONNES OF *ATROUN* PER YEAR – AN IMPORTANT SOURCE OF INCOME FOR THE COUNTRY

ATROUN

HISTORY

The origins of *atroun*, a valuable mineral found in the Lake Chad Basin, go back to the dawn of civilization. Its earliest use can be traced to the ancient Egyptians, who bought it from caravans coming from Cameroon and used it for embalming and mummifying their dead. The salt mines mentioned by the Arab travellers in the Middle Ages could have been *atroun* mines. Throughout history, this precious substance has been an important economic resource for local people, as well as a key ingredient of their own diet and that of their animals. Such is the importance of *atroun* that the nomadic pastoralists of the region traditionally planned their routes around supplies of the mineral, attaching almost as much importance to this as to the availability of forage for their livestock.

Today, *atroun* continues to play a significant role in the economy, diet and local practices of the people of the Lake Chad Basin. Given the potential of local and regional markets, it is a resource that could be further developed without damaging the environment. Chad produces some 7 000 tonnes per year, and this represents an important source of income for the country. Most of the *atroun* produced in the region comes from Chad and the Niger, and is exported to Nigeria and Ghana. It is transported either by truck or, as in ancient times, by camel and dug-out canoe [9.1].

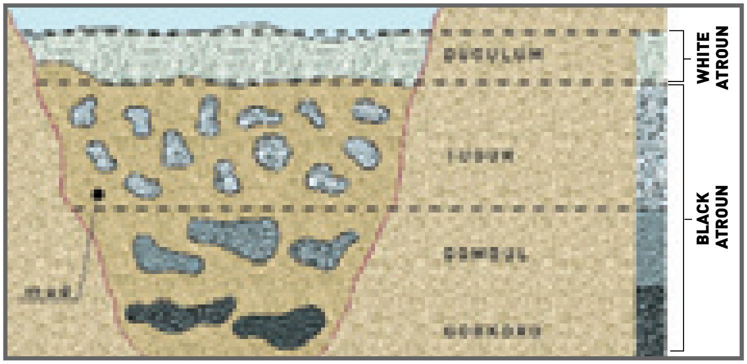


ATROUN WADI - LIWA (BOL), CHAD

ATROUN IS VISIBLE ON THE SURFACE, BUT THE BEST QUALITY SALT IS FOUND AT DEPTHS OF UP TO 3 M

EXTRACTION

The extraction of *atroun* is deeply rooted in tradition; this is the oldest economic activity of the northern region of the Lake Chad Basin. Natron forms naturally in the deepest part of wadis where the water stagnates. When the water evaporates, a crust of minerals, the *atroun*, is left behind. It is this substance that is subsequently collected. *Atroun* wadis come under the authority of the *canton*



SECTION OF A TYPICAL *ATROUN* MINEPIT

Source: C. Bouquet, 1990 [1.5]

DUGULUM, OR WHITE *ATROUN*, IS *ATROUN* OF INFERIOR QUALITY

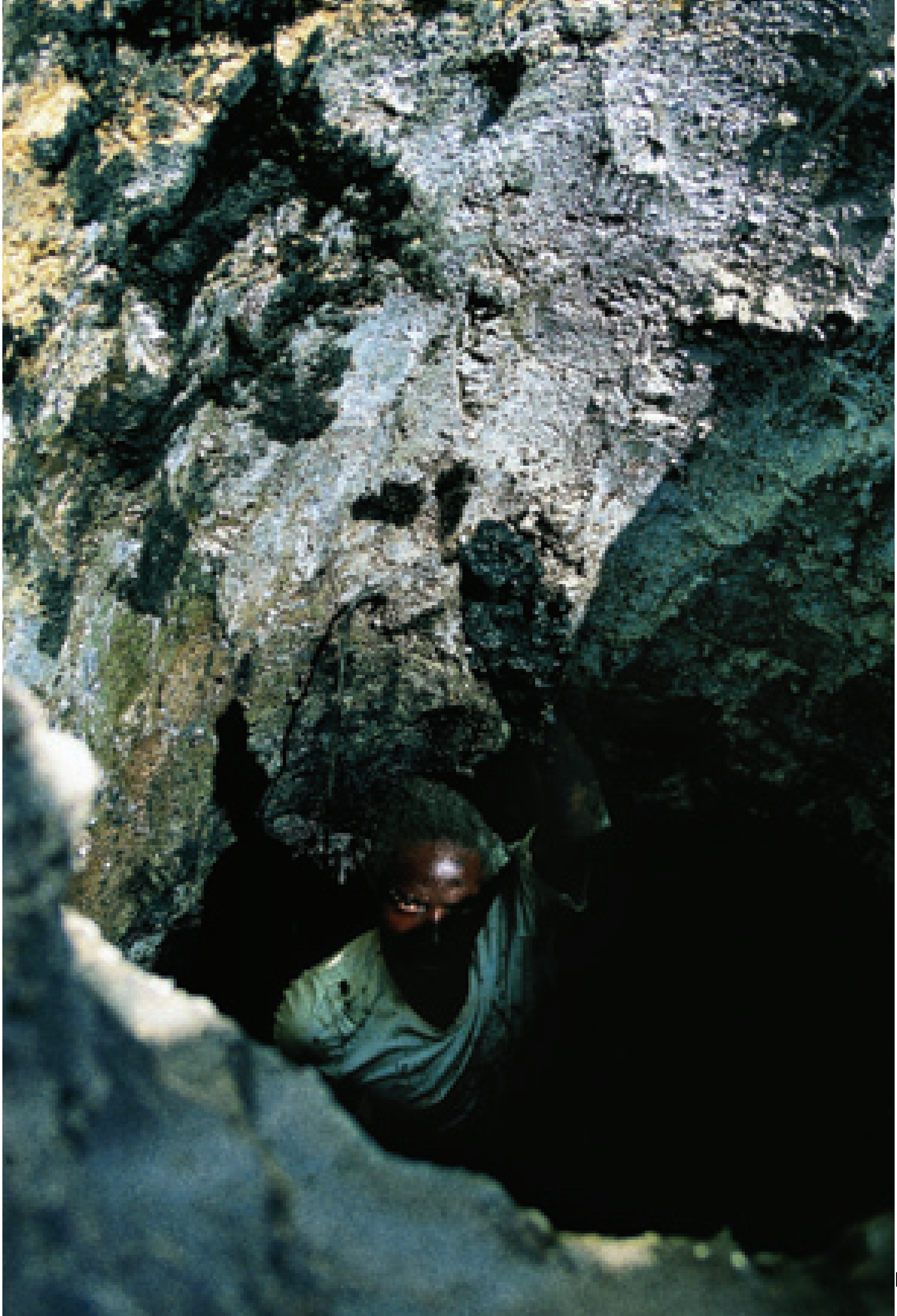
>> RIGHT: *ATROUN* IS EXTRACTED BY HAND OR WITH SIMPLE TOOLS. ITS EXTRACTION IS EXHAUSTING WORK

chief, the *Maï*. The mining season runs from December to June and is accompanied by rituals that date back for centuries. To open the season, the *Maï* sacrifices a bull on the shore of the wadi. Traditionally, it is believed that this offering will atone for the sins of the village and ensure that the *atroun* harvest will be plentiful and that there will be no accidents in the minepits.

The extraction itself is carried out by a special caste, the Haddad or salt miners, who are among the lowliest and poorest members of the community. This work is gruelling, dirty and exhausting. Several hundred miners live in special villages or quarters around the *atroun* wadis where they work. They generally operate in teams of three. One uses the *kormasie*, a long wooden-handled tool with a metal blade, another clears the earth with his bare hands, while the third passes the *atroun* out to the other colleagues.

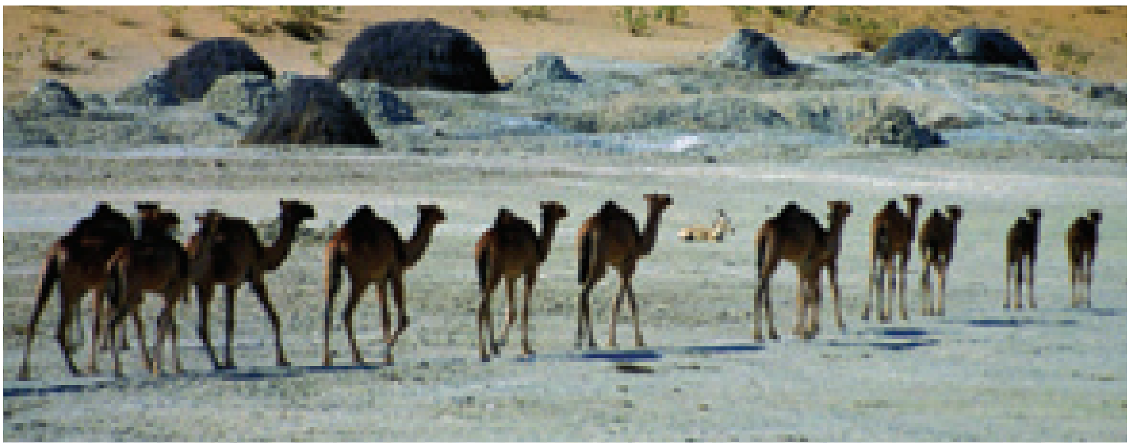
The mining begins with the excavation of a hole about 1 m in diameter, in a place where a hard stratum of *atroun* has been detected. First, an elliptical slab, usually weighing between 30 and 40 kg, is lifted out of the ground using levers. This is white *atroun*, or white *dugulum*. It is cleaned with a knife and left to dry for two weeks beneath a layer of sand or straw. White *dugulum* is *atroun* of inferior quality.

Working to recover *atroun* from about 1 m beneath the surface, the miner is forced to stand for long periods in a salty mud that is highly abrasive to the skin. As a result, the miners are covered with scratches and sores, although they try to reduce the effects by spreading their exposed skin with butter beforehand. The better-quality *atroun*, or black *atroun*, is found below this level. At this point, working conditions become extremely difficult because the white walls of the minepit reflect the



ATROUN WADI - LIWA (BOL), CHAD

ABOVE AND BELOW: *ATROUN* IS COLLECTED IN LARGE MOUNDS IN THE WADI AND SUN DRIED
ABOUT 94 WADIS ARE CURRENTLY EXPLOITED FOR *ATROUN* PRODUCTION, MAINLY IN THE NORTHERN REGION OF LAKE CHAD



intense heat. The quality of *atroun* improves with depth; closer to the surface, the first, smaller pieces of black *atroun*, weighing less than 1 kg, are extracted from the mud. This is called *tugur*. As the depth increases, the *atroun* gets harder, darker and more compact, and the pieces extracted get larger; this quality of *atroun*, known as *gombul*, weighs 1 kg or more. Finally, the miners reach the best-quality *atroun* – the dense, dark grey *gobkoro* – which is extracted in slabs of up to 30 kg.

SALT PRODUCTION FROM *ATROUN*

Some 94 wadis are currently being exploited for *atroun*, according to recent estimates. Most of them are in the northern regions of the Lake Chad shore, in the Niger and Chad. Average production is estimated at 9.3 tonnes per ha. Most of the *atroun* is marketed in its crude state, while a small quantity is turned into salt.

During the nineteenth century, the production of salt from *atroun* was the main industry in the region. The process, which continues today, albeit on a reduced scale, involves teamwork: men, women or even children [9.2] collect the *atroun* and place it in a large basket made of dum palm fibre, which serves as a filter. The women then pour water over the basket and the solution is collected in moulds made of terracotta or clay and left to evaporate for 24 hours. The salt dries into solid bars. This activity tends to be practised more in dry years when the crop harvests are poor and families need to find alternative sources of subsistence.

BOUDOU ANDJA VILLAGE (DUM DUM), CHAD

ATROUN REPLACES SALT IN ALL TRADITIONAL DISHES

COMPOSITION

Atroun is composed mainly of sodium carbonate, with some sodium chloride (Table 24).

TABLE 24 **CHEMICAL COMPOSITION OF *ATROUN***

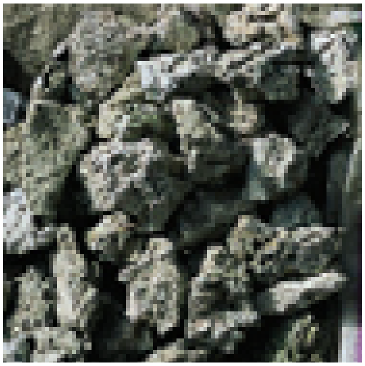
CONSTITUENTS	WHITE *ATROUN* *	BLACK *ATROUN* *
Calcium	6.0	6.0
Magnesium	12.5	12.5
Potassium	7.7	1.5
Sodium	1 320.0	1 360.0
Chlorine	40.0	100.0
Carbonates	1 280.0	1 310.0

* Milli-equivalents per 100 g

Source: C. Bouquet, 1990 [1.5]

USES

The mining of *atroun* is practised on a wide scale in the Lake Chad Basin. Around the lake and beyond, it plays an integral role in daily life in a whole range of settings. In food preparation, *atroun* replaces salt in all traditional dishes. It is used to flavour sauces and local cereal dishes, and to tenderize *niebé* and meat. A study in Chad estimated that annually 78 g per person are consumed by farmers, while 155 g per person are eaten by pastoralists [9.3].



THERE ARE MANY TYPES OF *ATROUN*, DIFFERING IN COMPOSITION, COLOUR, QUALITY AND PRICE

Atroun also has many other applications. It is used as a food supplement for livestock, particularly camels and horses. According to one estimate, between 12 and 15 kg of *atroun* are consumed annually by every camel in the Ati region [9.3]. The benefits are reportedly many. Herders regard *atroun* as an important tonic for their animals and claim that, if it is not consumed on a regular basis, cattle and small ruminants fail to thrive. It is also thought to stimulate growth and fertility in animals and to be an effective antiparasitic. In veterinary medicine, *atroun* is administered as a laxative and as a treatment for colic.

Generally, *atroun* is added to the drinking-water of livestock or is mixed with the residues of millet, maize or sorghum in their feed. However, too high a concentration of *atroun* can provoke rather than cure colic, and animals will refuse to drink from water that contains too much of it. As well as adding it to their food, local people mix *atroun* with tobacco for chewing or smoking. They also use it as part of traditional medicine to treat a whole range of conditions, especially stomach pains. *Atroun* is used for fixing the indigo dye in the manufacture of *boubous* local dresses, for tanning skins and, in Nigeria, for making soap.


NEAR LIWA (BOL), CHAD

A CAMEL CONSUMES APPROXIMATELY 12-15 KG OF *ATROUN* PER YEAR


N'GUIGMI, THE NIGER

A DEPOSIT OF *ATROUN*. THIS SALT IS ALSO USED FOR FIXING INDIGO DYE, TANNING SKINS AND MAKING SOAP


N'GUIGMI, THE NIGER

MODERN FORMS OF TRANSPORT FOR A VERY TRADITIONAL PRODUCT

PRODUCTION AND TRADING METHODS SHOULD BE FURTHER INVESTIGATED IN ORDER TO PROVIDE A BETTER QUALITY OF LIFE FOR PEOPLE WHOSE LIVELIHOODS DEPEND ON *ATROUN*

MARKETING

The price of *atroun* and the strategies for marketing it vary according to the quality of the mineral on offer. The highest grade of *atroun*, *gobkoro*, sells for 20 000 CFAF* per 75 kg bag, mainly for use in pharmaceutical preparations designed to treat human gastric and muscular ailments and in ophthalmology. *Atroun* is commercialized by traditional *canton* chiefs, important traders and Haoussa transporters.

Second-grade *atroun*, or *gombul*, is sold by the pile or in pieces. At source, it costs 1 000 CFAF a piece. It is highly valued for the preparation of sauces in many parts of the Sahel and 90 percent of it is exported to the Niger, Nigeria, Cameroon and the Central African Republic, and as far afield as Ghana.

The third grade of *atroun*, or *tugur*, which consists of smaller pieces, is sold at local markets in sacks, three chunks at a time. This is mostly bought by pastoralists, for a price of 500 CFAF a sack, to treat their animals, generally two or three times a year.

Central governments have little control over this activity and it is therefore difficult to monitor and include it in national budgets and in regulations.The production and trading of *atroun* should be further investigated and developed with a view to improving the extraction process and, above all, to providing a better quality of life for the people exploiting it.

* 1 000 CFAF are equivalent to 1,52 euros.

ATROUN-WORKER - N'DJAMENA, CHAD

***DIHÉ*-HARVESTER** - BOUDOU ANDJA VILLAGE (DUM DUM), CHAD

LAKE OF AMEROM (DUM DUM), CHAD

DIHÉ IS AN EXTRAORDINARY PRODUCT THAT GROWS NATURALLY IN THE UNIQUE WATER-POOL ENVIRONMENT TO THE NORTHEAST OF LAKE CHAD

DIHE'

HISTORY

In 1964, the botanist Jean Léonard first witnessed the strange spectacle of what appeared to be a blue-green alga growing in the wadis of the Bol region and began documenting this extraordinary natural phenomenon. He observed that as much as 70 percent of the food intake of the Kanembu tribe was accompanied by a sauce made with desiccated tablets of the alga, which they called *dihé*. He also noted that people who used *dihé* in their diet appeared healthier and in generally better physical shape than people who did not use it.

The alga itself became known by the name of *Spirulina*, and its nutritional value was confirmed in 1974 by the United Nations World Food Conference [9.4], which declared that it was an outstanding foodstuff for the future.

In the meantime, as had happened with other types of algae, a few companies, mainly in Japan and the United States, started to farm it commercially. In 1981, following an article in an American tabloid highlighting its dietary advantages, the international market for *Spirulina* took off and, since then, has grown almost continuously.

Unfortunately, the celebrity of *Spirulina* was not shared by *dihé*, which continued to be produced and consumed within the local market of the Lake Chad Basin and which did not experience any particular increase, either in quantity or in commercial value.

LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

KANEMBU HADDAD WOMEN HAVE DEVELOPED SIMPLE AND EFFICIENT METHODS OF HARVESTING AND PROCESSING *DIHÉ*

THE ENVIRONMENT

Dihé grows in the very peculiar and unique environment of the water pools that form to the northeast of Lake Chad at the end of the rainy season. These are characterized by the following conditions.

- An aquatic environment with a basic pH of 9.5–10.5.
- Saline or brackish water, particularly rich in sodium bicarbonate (10–20 g per litre).
- A daytime temperature of 35–37°C and a night-time temperature of 15–20°C.
- Abundant sunshine.

It is an ecological niche where hardly any other living organism can survive. The development of *dihé* in the Bol area excludes the proliferation of other organisms for the following reasons.

- By feeding on carbonates and bicarbonates, *dihé* increases water alkalinity from pH 9 up to pH 12.5.
- The deep blue filaments form a shield against sunlight, thereby inhibiting the proliferation of algae such as *Chlorella*.
- *Dihé* may possibly discharge defence molecules that are very active against a whole range of bacteria. (*Dihé* is traditionally used to treat gangrenous wounds.)

LAKE OF AMEROM (DUM DUM), CHAD

HARVESTING OF *DIHÉ* TRADITIONALLY STARTS AT THE END OF THE RAINY SEASON

Spirulina under the microscope

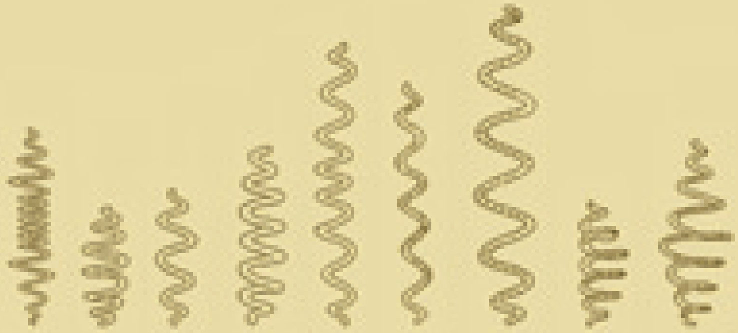
Spirulina is an organism with a nuclear structure but no membrane, belonging to the prokaryote group of blue-green algae known as Cyanophyceae. Classic taxonomic criteria show the difficulty in characterizing *Spirulina* species because of its extremely high morphological adaptability to different environments.

Cellular division is not mitotic. The usual organic tissues of the protoplasm are absent, yet it is considered an alga by many authors because it contains chlorophyll, like all green plants. The chlorophyll is located in the cytoplasm itself rather than in a chloroplast, and is stored in ultramicroscopic platelets that bear the complex chlorophyll pigment and carry out primary photosynthesis.

The size of the cyanobacterium cell is between 1 and 10 microns. Its wall is classic gram-negative. The granules contained in the membranes are called "phycobilisomes" and contain an essential pigment that transports energy to the PS-II, the phytocyanin that is a protein belonging to the prosthetic group. Under the microscope, it appears as a mass of intertwined unicellular spiral filaments, or trichomes, each of variable length (typically 100–200 microns) and with a diameter close to 8–10 microns. It grows and develops quickly, by cellular division, budding or even random fragmentation, in stagnant brackish and alkaline warm waters, where it forms a blue-green slime. Because of its intertwined filaments, it can be harvested and strained on the spot [9.5].

LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

DIHÉ NEEDS STAGNANT BRACKISH AND ALKALINE WARM WATER, ABUNDANT SUNSHINE AND A DAYTIME TEMPERATURE OF 35-37°C



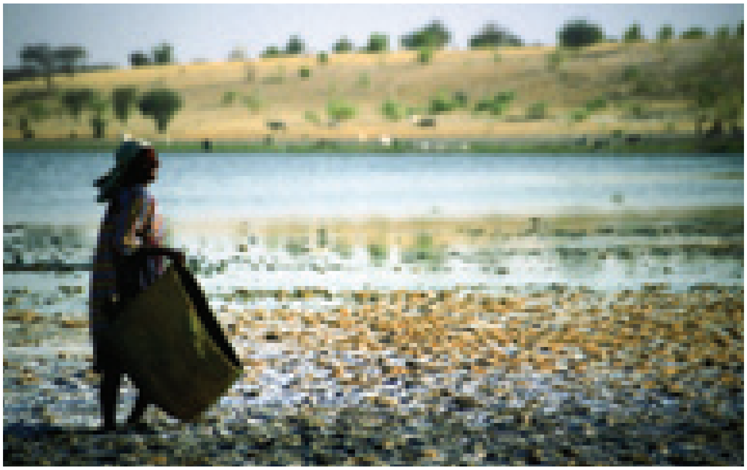
SPIRULINA IS COMPOSED OF INTERTWINED UNICELLULAR SPIRAL FILAMENTS

LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

LAKE OF SURU (DUM DUM), CHAD

LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

DIHÉ IS ALWAYS COLLECTED BY GROUPS OF WOMEN



LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

DIHÉ HARVESTING REQUIRES SKILLS THAT HAVE BEEN PASSED DOWN FROM MOTHERS TO DAUGHTERS FOR GENERATIONS

TRADITIONAL HARVESTING

Dihé is traditionally harvested by women. By local standards, this is a lucrative activity, although for only a few months each year. It has been calculated that, in the Kanem region, an expert female harvester – and this is a skilled job – can produce about two *coreaux*, or 3.2 kg, per day. A study for SODELAC in 2000, which examined 21 sites in the departments of Kanem, projected that, based on the current number of women actively involved in production and the average time taken for harvesting, total production at these sites alone could be around 250 tonnes a year [9.5].

WOMEN'S WORK

The harvesting of *dihé* requires skill and expertise, and the technique, which has been passed down from mother to daughter, represents the culmination of years of experience. It is a seasonal activity, taking place at the end of the rains. As the time approaches, tools and equipment are prepared, ready for the hard work that lies ahead. When the rains stop, the pools and wadis that have a crop worth harvesting are identified. This is very much a group activity and, when the time is right, the leader gives the order for work to begin. The women wade into the wadis or pools, their legs and arms bare, and stir up the muddy waters, taking care to eliminate as many impurities as possible, such as leaves, twigs, insects and sometimes animal dung, in the process.

First, the alga is scooped out and strained through a dum palm basket. If the concentration of alga is low, the women use a finer mesh for the initial phase of the harvest, which in turn accelerates the drying process. If the concentration is extremely low, it is not harvested at all, but is left to grow and develop for the following season. Next, a sand-filter basin is made ready and the concentrated solution is transferred there. After 10–20 minutes, the suspension, now in a more solid form, is sliced into squares or rectangles. The dried shapes are lifted out for more drying on frames, where they are left for five to six days in the sun. Once this process is completed, the sand is cleaned off the slabs. The final phase involves packing the slabs into sacks ready for the market.

LAKE OF SURU (DUM DUM), CHAD

A FILTER BASIN IS MADE IN THE FINEST AVAILABLE SAND

LAKE OF SURU (DUM DUM), CHAD

THE CONCENTRATED SOLUTION OF *DIHÉ* IS GENTLY POURED INTO A BOWL IN THE CENTRE OF THE SAND FILTER UNTIL IT OVERFLOWS

LAKE OF SURU (DUM DUM), CHAD

THE BOWL PREVENTS ANY DAMAGE TO THE SAND FILTER. ONCE THE SOLUTION HAS BEEN POURED, IMPURITIES SUCH AS LEAVES AND INSECTS ARE REMOVED

LAKE OF SURU (DUM DUM), CHAD

BEFORE THE SOLUTION SOLIDIFIES, IT IS SPREAD TO FORM A CAKE ABOUT 4-5 CM THICK

LAKE OF SURU (DUM DUM), CHAD

AFTER ABOUT 20 MINUTES THE CAKE IS SLICED INTO SQUARES

AMEROM VILLAGE (DUM DUM), CHAD

LOCAL PEOPLE AND CHILDREN SUPPLEMENT THEIR POOR DIETS WITH *DIHÉ* SAUCE, WHICH HAS A VERY HIGH PROTEIN CONTENT

COMPOSITION

Spirulina is very high in protein, very low in calories and cholesterol, and high in enzymes, minerals (iron, calcium, sodium and magnesium), and phenolic acids, which have antioxidant properties (see Table 25).

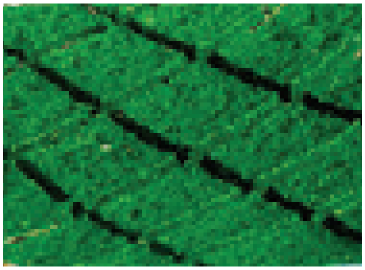


TABLE 25 **CHEMICAL COMPOSITION OF *SPIRULINA****

Content	Amount
Proteins	6.5 g
Betacarotene	14 mg
Vitamin C	2 mg
Thiamin (B1)	0.37 mg
Riboflavin(B2)	0.46 mg
Niacin	1.3 mg
Calcium	150 mg
Iron	18 mg
Vitamin E	0.4 mg
Vitamin B 6	0.07 mg
Vitamin B 12	0.02 mg
Phosphorus	67 mg
Magnesium	32 mg
Copper	0.1 mg
Phycocyanin	1 500 mg
Gamma-linoleic acid	100 mg
Chlorophyll	110 mg

* for 10 g dry weight

Source: SODELAC, 2000 [9.5]

USES

Human consumption

The benefits of *Spirulina* as a low-calorie, high-protein, mineral and vitamin food supplement are now well established and recognized worldwide. Studies have shown that *spirulina* can lower cholesterol levels, stimulate the immune system and be effective in the treatment of obesity, heart disease, premenstrual stress, arthritis, anaemia and osteoporosis. *Spirulina* is also a rich source of betacarotene, a natural antioxidant, which the body converts to vitamin A and which plays a protective role in the human organism. Recent studies have concluded that a diet rich in vitamin A and provitamin A can lower the risk of cancer. Betacarotene is considered a more effective antioxidant than synthetic *trans* betacarotene. Positive results have also been seen in performance and stamina levels when *Spirulina* is taken as a sports supplement; the blue-green alga has a high level of biotin, which is an inhibitor of lactic acid in muscles.

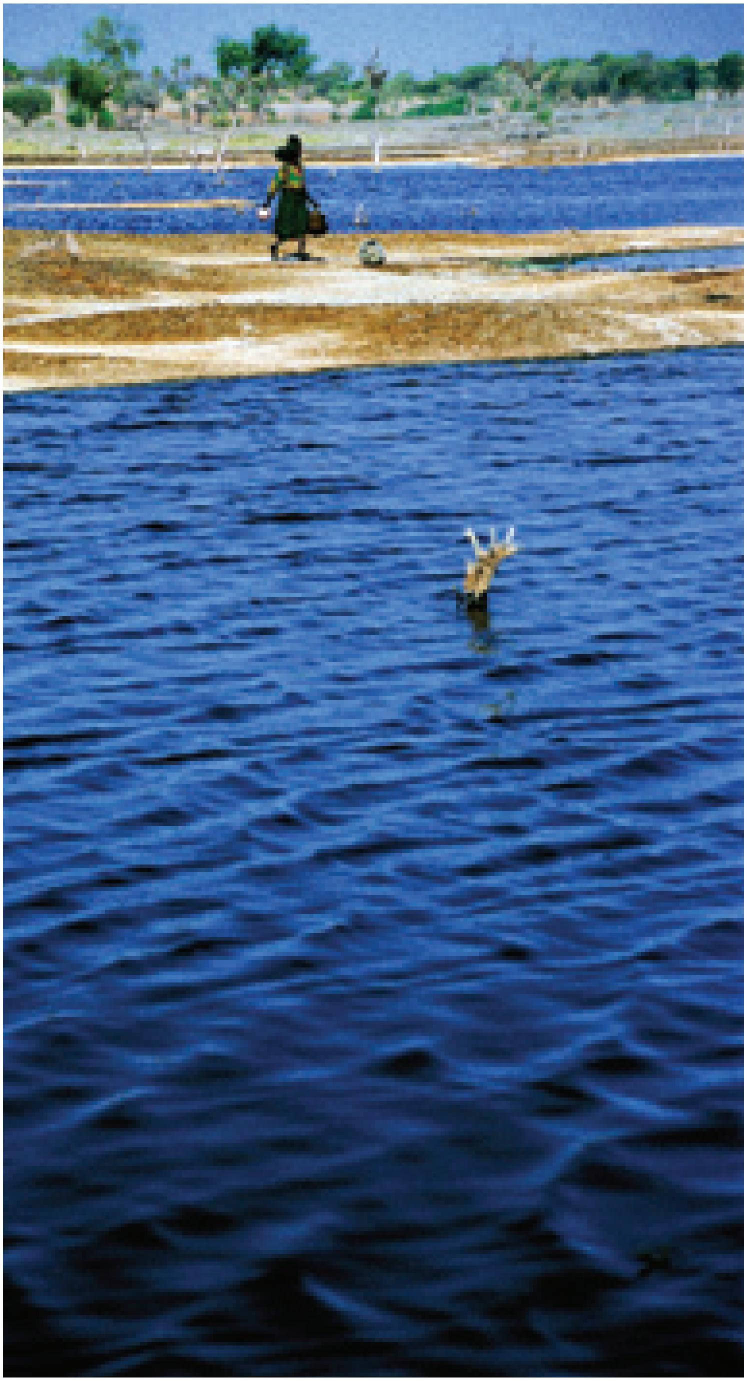
Extracts

As well as being marketed in the form of tablets or capsules, *Spirulina* is used as an additive in pasta, drinks, cakes and a number of dietary products. *Spirulina* produces phytocyanin, a naturally blue-coloured protein complex used as food colouring in pastry, ice creams and drinks. It is also used as a fluorescent marker in immunology.

Tests in Belgium (*Laboratoire de photobiologie* and *Laboratoire de biotechnologie algale*) have demonstrated that *Spirulina* has healing, antiseptic and antibiotic properties, as well as the power to enhance cell regeneration. *Spirulina* extracts are used in a range of cosmetics, skin creams, anti-acne treatments, dermatological shampoos, skin cleansers and make-up removers. A special cream is produced for veterinary medicine to heal wounds in horses.

Animal feed

Spirulina is used to feed ornamental carp and, in aquaculture, shrimps, mussels, trout and salmon. It enhances the colour of egg yolks and chicken meat, and is also widely used as a food additive for birds to brighten the colour of their feathers. It is fed to horses and cattle in order to foster growth and muscle tone and to improve the condition of pregnant females.



LAKE OF AMEROM (DUM DUM), CHAD

FOOD SECURITY AND MARKET EXPANSION

Given its high content of protein, vitamins and minerals, and its high digestibility, *dihé* represents an important source of food for children and adults in one of the world's poorest regions, where malnutrition is common. As such, *dihé* offers considerable potential in terms of food security for local communities. It also holds out hope as a source of income, especially for the women who traditionally harvest it and who are among the most neglected members of society.

At present, production levels in the Lake Chad Basin are not well known since a large proportion is produced for domestic consumption and is therefore difficult to measure. According to different sources, production could be around 250 tonnes per year (this figure is approximately 10 percent of total world production). Just a small fraction is sold and exported to neighbouring countries. However, estimates show that, in the Kanem department of Chad alone, the average consumption of *dihé* could be as high as 50 g per person per week. On that basis, even the local market has the potential to absorb 1 400 tonnes per year – seven times the current production levels.

Locally, the market price of *dihé* ranges between $0.80 and $2 per kg, which is very low compared to the wholesale factory prices in industrialized countries of $25 per kg and retail prices generally between five and ten times the wholesale figure.

It would be advisable to promote a development strategy based upon the following.

- Introduction of sieves and other simple technologies to reduce the amount of residual sand in the desiccated product.
- Dissemination of information on the nutritional qualities of *dihé* on local and regional markets (*dihé* is still considered "food for the poor").
- Training of local women and promotion of women's associations.
- Access to microcredits.
- Testing of new forms of packaging and local uses, including the feeding of animals and fish.

AMEROM VILLAGE (DUM DUM), CHAD

DIHÉ REPRESENTS AN IMPORTANT FOOD SOURCE IN ONE OF THE WORLD'S POOREST REGIONS AND ITS DEVELOPMENT THEREFORE DESERVES INTERNATIONAL SUPPORT


BOUDOU ANDJA VILLAGE (DUM DUM), CHAD

DIHÉ BISCUITS ARE SUN DRIED ON HOUSE ROOFS BEFORE BEING CONSUMED OR TRADED


ESSEROM VILLAGE (DUM DUM), CHAD

THE LOCAL MARKET HAS THE POTENTIAL TO ABSORB 1 400 TONNES OF PRODUCT EACH YEAR

The green gold

10 March 2002
Chocram, Chad

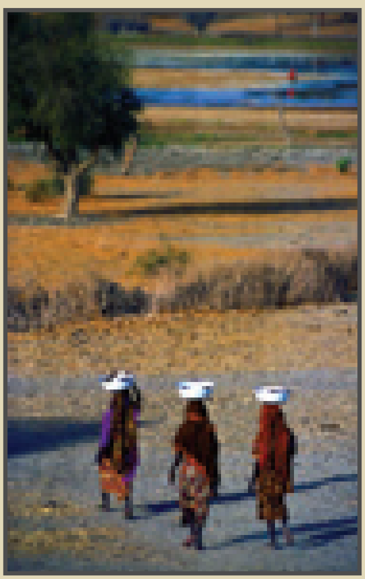
We arrive in the vicinity of the wadi of Suru at 8 a.m. after getting stuck twice in the sand, having a flat tyre, and enduring two hours of sandy track, which put a severe strain on our excellent driver, Jacob. But we arrive just in time to meet the women of the village of Chocram as they go, in small groups, to gather blue-green alga (*dihé*). On their heads they carry large and small enamelled basins as well as bags woven from dum palm leaves. They have no other work implements.

The day before we had paid a visit to the *Chef du canton*, Maï Alhaji M'Bodey, an old man still surprisingly full of energy and lucidity of mind. He had received us with the customary hospitality, and had answered our questions at length.

"Since time immemorial the women of the villages around here have gathered what you call "blue-green alga"; for us it is *dihé*; for others it is "green gold". In this season, every morning the women, organized by a leader, leave in groups before the wind rises. They will return before the noon sun, loaded with *dihé* water biscuits, which had been left to dry at the gathering place the day before. You can find great quantities of these *dihé* water biscuits in our Amerom market, even in bags, but only the merchants of Mao, *Mao la blanche*, just 25 km from here, buy them wholesale. Further away, in N'Djamena, it is already difficult to find them, because not everyone has this custom of eating *dihé*. Only we Kanembu love it and know its secrets ..."

"My father's father, in the last years of his very long life, lived almost exclusively on *dihé*. He didn't even mix it with other food anymore; he only took water and *dihé*, after carefully letting the sand settle to the bottom of his bowl. He used to say that it gave him great energy, and that every day he saw the hour of his death move further away… We think he was more than a hundred years old ..."

"We have no doubt that this blue-green alga is good for the body. Our pregnant women eat it every day and feed it to the youngest children as well. Normally we eat it two or three times a week, cooked slowly in *gombo* sauce with the usual spices, to accompany rice and millet. It's the remedy for all ills."



NEAR BOUDOU ANDJA VILLAGE (DUM DUM), CHAD

WOMEN MUST COLLECT *DIHÉ* EARLY IN THE MORNING BEFORE THE RISING OF STRONG WINDS

11 March 2002
Amerom, Chad

At 8 a.m. we are on the shores of the Boudou Andja wadi. About 20 women are busy in the shallow water of the lake with basins and all kinds of containers. With rapid and precise movements, they are trying to gather the largest possible amount of blue-green alga before the wind rises; the wind would make their work impossible.

When the job is done, Madame Harita Cierom, the *Chef des femmes*, stops to talk with us. She is a very assertive young woman, who asks us for very concrete things, items that are necessary and useful for all the women.

"You have come from far away. We do not know you but we know that you have come with an open heart. That is why we ask you to help us. We need sturdy clothes because our skirts are burned by the salty water, we need gloves because the salt eats away our skin, and we need rubber boots because the flesh of our feet is dry and cracked. If we were given a small credit, we could unite in a *regroupement* and be independent, and we would not have to ask anybody for anything. But now, as *Chef des femmes*, now I ask you not to forget us after you leave."

>> RIGHT: *CHEF DES FEMMES* MADAME HARITA CIEROM SAYS: "WE NEED TRAINING AND SUPPORT FOR OUR WOMEN'S ASSOCIATION"
NEAR LAKE OF BOUDOU ANDJA (DUM DUM), CHAD

CHAPTER 10

THE ECOSYSTEM APPROACH AND THE LAKE CHAD BASIN

"If you only look at what is in the calabash, you won't notice when the granary burns."

[Murum proverb from Chad]

THE ECOSYSTEM APPROACH AND THE LAKE CHAD BASIN

10

NEAR BOL, CHAD

THE INHABITANTS OF THE LAKE CHAD BASIN NEED AN UNDERSTANDING OF THEIR OBJECTIVES AND ASSISTANCE IN USING THEIR RESOURCES IN A SUSTAINABLE WAY

INTRODUCTION

Many traditional practices described in the previous chapters have survived the harsh tests of recent increased human pressures and intensification of agriculture. These practies are important because they provide the basis upon which new forms of agricultural, pastoral and fish production can evolve. There is a close relationship between such practices and the ecosystem approach, as defined by the Convention on Biological Diversity.

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, application will help to reach a balance of the three objectives of the CBD, namely:

1. Conservation
2. Sustainable use
3. Fair and equitable sharing of the benefits arising from the utilization of genetic resources

NEAR BOL, CHAD

NEAR DOUTHY VILLAGE (DAMASSAK), NIGERIA

ABOVE AND LEFT: WET AND DRY ECOSYSTEMS OF THE LAKE CHAD BASIN ARE COMPLEMENTARY TO EACH OTHER

The Conference of the Parties of the Convention on Biological Diversity

Extract from CBD COP Decision V/6 Ecosystem Approach [10.1]

The Conference of the Parties,

1. Endorses the description of the ecosystem approach and operational guidance contained in sections A and C of the annex to Decision V/6, and recommends the application of the twelve principles below, as reflecting the present level of common understanding, and encourages further conceptual elaboration, and practical verification;
2. Calls upon Parties, other Governments, and international organizations, to apply, as appropriate, the ecosystem approach;
3. Invites Parties, other Governments and relevant bodies to identify case-studies and implement pilot projects, and to organize, as appropriate, regional, national and local workshops and consultations aiming to enhance awareness, share experiences, and strengthen regional, national, and local capacities on the ecosystem approach;
4. Requests the Executive Secretary to collect, analyse and compare the case-studies referred to in paragraph 3 above and prepare a synthesis of case-studies and lessons learned for presentation to the Subsidiary Body on Scientific, Technical and Technological Advice …

THE 12 PRINCIPLES OF THE ECOSYSTEM APPROACH

The ecosystem approach is based on the application of appropriate scientific methodologies focused on the level of biological organization, which encompasses the essential structure, process, functions and interactions of organisms and their environment. It recognizes that humans, with their cultural diversity, form an integral component of many ecosystems. The Convention on Biological Diversity has developed 12 principles of the ecosystem approach. In the following text, each of these principles is stated and then related to examples taken from this book in order to demonstrate their relevance and potential in the design of new policies for a sustainable use of the Lake Chad Basin resources.

ABOVE AND LEFT: WET AND DRY ECOSYSTEMS OF THE LAKE CHAD BASIN ARE COMPLEMENTARY TO EACH OTHER

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PRINCIPLE 1: "The objectives of management of land, water and living resources are a matter of societal choice"

APPLICATION: **Pastoralists, fishermen and farmers view the ecosystem of the Lake Chad Basin in terms of their own economic, cultural and societal needs, and they utilize the natural resources and the fluctuations of the lake in many different ways** (Chapter 1)**.**
The importance of societal choices is discussed when describing the different animal breeds that have been developed through selection and adaptation to the environment (Chapter 3)**. The collection of kreb** (Chapter 4) **and wild vegetables** (Chapter 5) **is an example that confirms how food security and the long-term balance of the ecosystem are the objectives of traditional agricultural systems.**

RECOMMENDATION: The type of assistance that Lake Chad Basin inhabitants really need from researchers is an understanding of their objectives, so that they can be helped to make the best use of local resources in the given circumstances.

PRINCIPLE 2: "Management should be decentralized to the lowest appropriate level"

APPLICATION: **People have developed adaptive means for sustainable use of the ecosystem. Pastoralists move animals to find grasslands** (Chapter 2)**; traditional subsistence agriculture uses shifting cultivation** (Chapter 5)**; fishermen follow life cycles of fish** (Chapter 7)**; locally recognized leaders decide on the wise use and distribution of water from wells, ponds and polders** (Chapter 6)**. For these traditional management practices quick and flexible decisions are required, as well as agreements among different users and payments for the services. Decentralizing management and decisions so that all stakeholders are involved can lead to great efficiency, effectiveness and equity, because the ecosystem is used according to its capacity and its variations.**

RECOMMENDATION: Development and implementation of national and regional policies should be made with full awareness and respect of traditional management systems because these appear effective in regulating fishing, grazing, food collecting, and water harvesting.

PRINCIPLE 3: "Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems"

APPLICATION: **The Kanembu people graze their livestock in the semi-arid Massakori region (Dum Dum, Mourzougoui) and they arrive on the shores of the lake late in the dry season** (Chapter 3)**. The dams of traditional polders used to be breached every six to ten years to allow the water to leave the polders and to restore native vegetation and soil fertility. Today the continuous use of water to grow additional agricultural products can result in a scarcity of good grasslands for livestock and an increase in soil salinity in the polders** (Chapter 6)**.**

RECOMMENDATION: Intensification of production, particularly in humid ecosystems, should be carefully planned and the effects on the surrounding arid and semi-arid ecosystem should be closely analysed and predicted.

PRINCIPLE 4: "Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context"

APPLICATION: Improving the traditional production system of *dihé* by Kanembu women, rather than replacing it with large industrial processes, will directly benefit the women by promoting biodiversity conservation and sustainable use of the resource (Chapter 9)**. Other examples of the economic potential of biodiversity are the consumption of meat from the quelea bird and the ranching of the Nile monitor for skin and meat production** (Chapter 8)**, and incentives and payment of benefits to those farmers who own local varieties, such as different varieties of transplanted sorghum** (Chapter 5)**.**

RECOMMENDATION: Traditional practices can therefore be the starting–point in the creation of many local and original sources of income. New technologies can be integrated with local practices in order to reach new regional and global markets. Studies and monitoring programmes should quantify the invisible costs to the environment caused by the intensification of management, and these costs should be added to production costs.

PRINCIPLE 5: "Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach"

APPLICATION: Lake-level fluctuations are one of the most important features of the Lake Chad Basin ecosystem. Throughout this book, it is shown how people have learned to manage them for their food security, because the fluctuations affect fish production, farming and the conservation of native vegetation and wildlife.

RECOMMENDATION: The ecosystem approach is a strategy for managing land, water and living resources in an integrated manner, and the links, interactions and conflicts between agriculture, fisheries and pastoralism must be taken into consideration by adopting a cross-sectorial approach.

PRINCIPLE 6: "Ecosystems must be managed within the limits of their functioning"

APPLICATION: Factors limiting the natural productivity (low and unreliable rainfall patterns and poor soils) of the Lake Chad Basin are compensated for by other characteristics, such as solar energy and large spaces. Traditional practices such as pastoral and agricultural mobility (Chapters 2 and 5)**, have been developed to manage these limitations while, at the same time, preserving the functions and biodiversity of the ecosystem. Security and sustainability have been the selection criteria of agricultural, pastoral and fishery activities.**

RECOMMENDATION: Slow and fast variables, such as the large population increase over the last 30 years, the reduced size of the lake after the 1970s, vegetation and wildlife changes, intensified agriculture, and probably long–term climate change, are increasing the pressure on the ecosystem. New solutions must be sought in order to respond to the new situation, but attention should be paid to the environmental conditions that limit natural productivity.

PRINCIPLE 7: "The ecosystem approach should be undertaken on the appropriate spatial and temporal scale"

APPLICATION: Farmers use and manage gene diversity by planting different varieties according to their resistance to different stress factors, such as drought, salinity and pest attacks (Chapter 5)**. Farmers also manage species diversity by cultivating one crop while, at the same time, allowing useful wild vegetables to grow in the same fields. They also manage the ecosystem by consuming wild fruits, collecting firewood, constructing tools and houses, and obtaining medicaments from natural grasslands** (Chapters 2 and 4)**.**

RECOMMENDATION: These traditional management choices made by farmers at gene, species and ecosystem level are based upon their knowledge of the hierarchical nature of biological diversity.

PRINCIPLE 8: "Recognizing the varying temporal scale and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term"

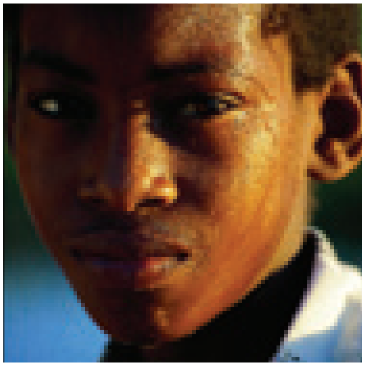
APPLICATION: The traditional fallow systems practised in a dry and poor ecosystem such as the Lake Chad Basin used to last for ten years or more and these were necessary for rebuilding the soil structure and biota, and for maintaining the genetic resources of the native vegetation. Farmers using long fallows prefer the balance between crop and livestock production and maintenance of soil fertility to the short-term high gains from specialized agricultural production, which exhausts soil fertility, requires high inputs and hinders the integration of animal production with agriculture (Chapters 3, 5 and 8)**. Today, most fallows have been reduced in length or dispensed with entirely.**

RECOMMENDATION: Any programme aimed at intensifying production should take into account the possible lag-effects that can lead to loss of productivity and desertification in fragile and marginal land.

PRINCIPLE 9: "Management must recognize that change is inevitable"

APPLICATION: The traditional practices described in this book have the potential to respond to the new changes and challenges of the Lake Chad Basin ecosystem. The management of traditional sorghum varieties (Chapter 5) **shows how climatic conditions and human needs constantly change and how genetic resources are maintained and developed to adapt to these changes. Kouri cattle, as well as many other local breeds** (Chapter 3)**, are another example of how pastoralists select and maintain their breeds within a changing ecosystem.**

RECOMMENDATION: Adaptability and flexibility are the keywords for sustainable development in fragile ecosystems.



PRINCIPLE 10: "The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity"

APPLICATION: The harvesting of *kreb* (Chapter 4) **is a traditional practice, commonly used in many arid and semi-arid environments, which integrates agriculture and pastoralism, uses the biodiversity of natural vegetation as a food and feed resource, protects fragile soils and preserves local genetic resources. Traditional fishing schemes** (Chapter 7) **pose no immediate threat to fish stocks, but any pressure to harvest more fish should be balanced by a profound understanding of the ecosystem and all its varied and conflicting uses.**

RECOMMENDATION: An international initiative for enhancing *kreb* production is recommended, as well as the fair and equitable sharing of the benefits derived from ownership of a traditional practice that arose from the maintenance and utilization of natural grasses.
The development of appropriate strategies to balance any increased fish production with the maintenance of fish biodiversity and fish stocks is an important starting–point for the future. A major challenge will be further to empower the Lake Chad Basin Commission in its support of policy development and implementation.

PRINCIPLE 11: "The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices"

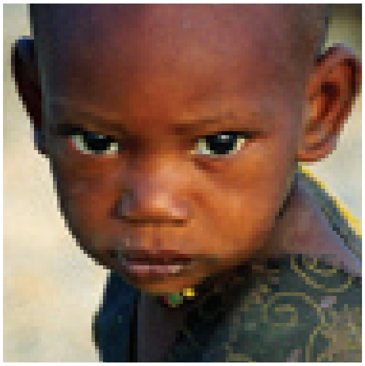
APPLICATION: The problems of the management of "invasive" *Prosopis* (Chapter 5) **highlight how lack of local knowledge and experience can result in severe damage to the environment. *Prosopis* was introduced into the Sahel in the 1960s because scientific knowledge indicated that it was able to stabilize sand dunes. However, because local pastoralists and farmers were insufficiently informed about its use and management, they are now losing control of it and consider it a pest. *Calotropis*, another plant often regarded as an invasive weed in the Lake Chad Basin, is used for cheese production by the Peul people in Benin** (Chapter 5)**. This traditional activity should be further investigated and possibly introduced to the inhabitants of the Lake Chad Basin, provided that it is accompanied by the appropriate information.**

RECOMMENDATION: The effectiveness of ecosystem management strategies greatly depends on the transfer of information between the policy-makers, with their scientific knowledge and familiarity with innovations and new practices, and the concerned stakeholders with their traditional knowledge and practices.

PRINCIPLE 12: "The ecosystem approach should involve all relevant sectors of society and scientific disciplines"

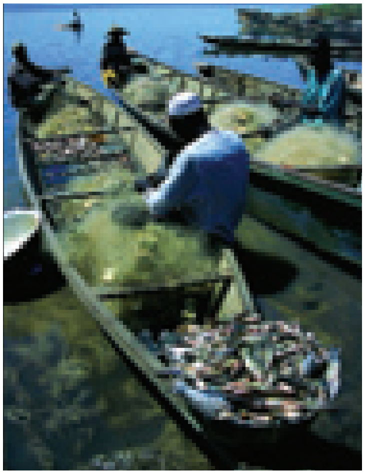
APPLICATION: The daily lives and activities of the farmers, pastoralists and fishermen in the Lake Chad Basin are closely interrelated (Chapter 1) **and are complementary to their use of the natural resources.**

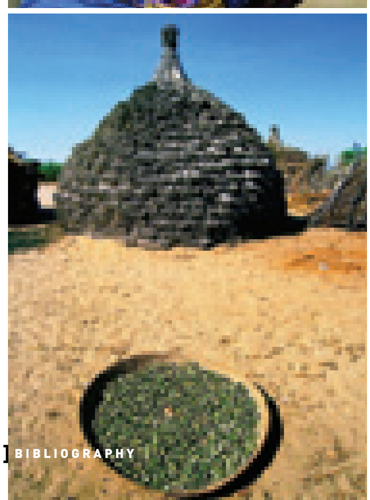
RECOMMENDATION: One of the aims of this book is to help the stakeholders of the Lake Chad Basin identify new ecosystem management strategies by providing greater knowledge of local techniques that have been developed through experience, observation and adaptation to the environment.
Additional information on the functions of the Lake Chad Basin ecosystem, and on the impact of human use, should be acquired by setting up local, regional, national and international networking, field activities and strategies, taking into account the people, their needs and their practices. Bridges should be built between traditional and new technologies in order to meet the new demands of today's society.



"The young man
walks faster
than the old man,
but the old man
knows the way."

[African proverb]



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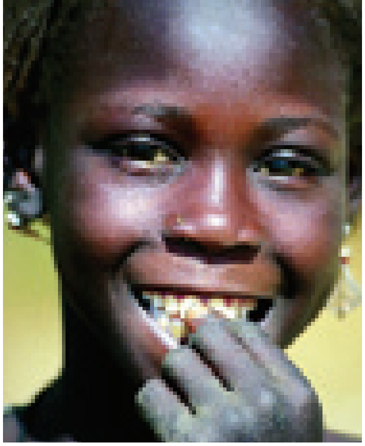

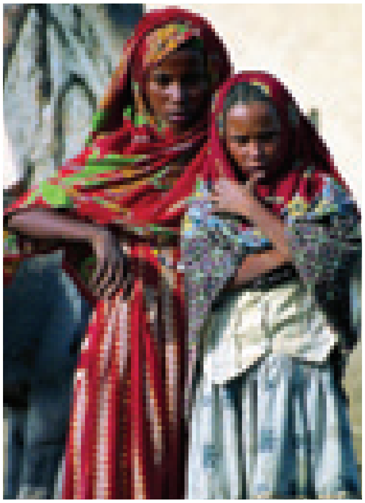

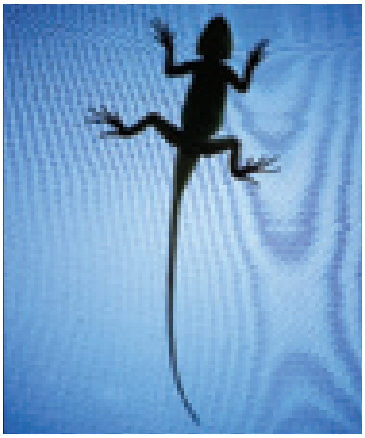




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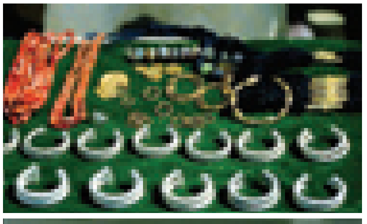

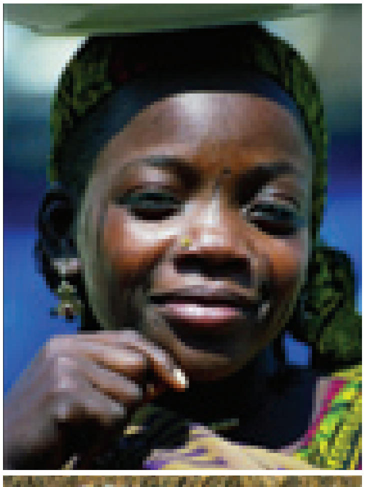

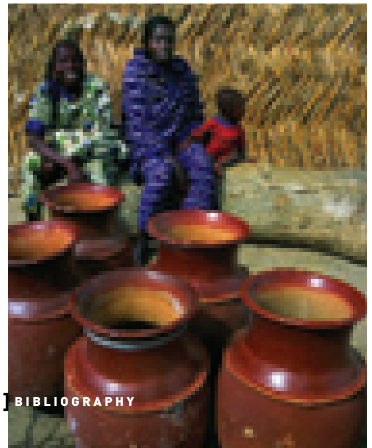

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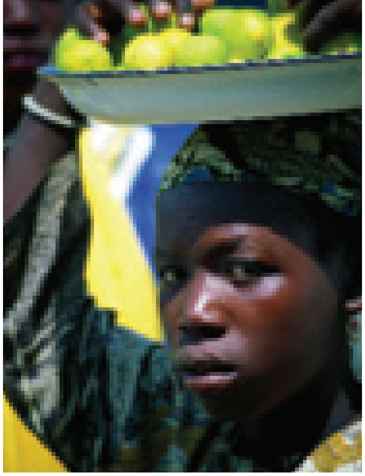

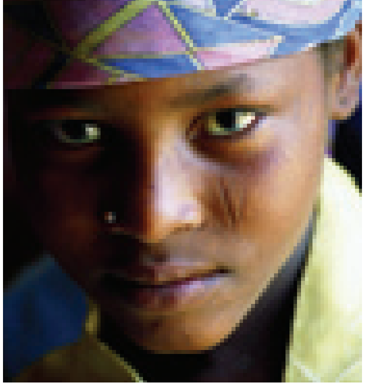

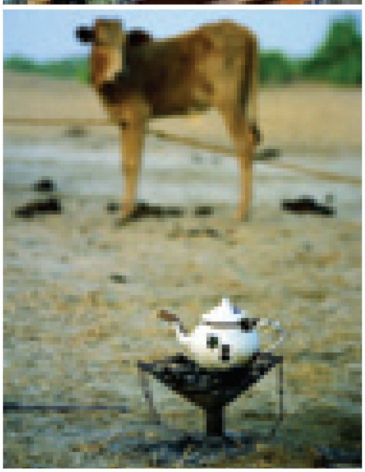
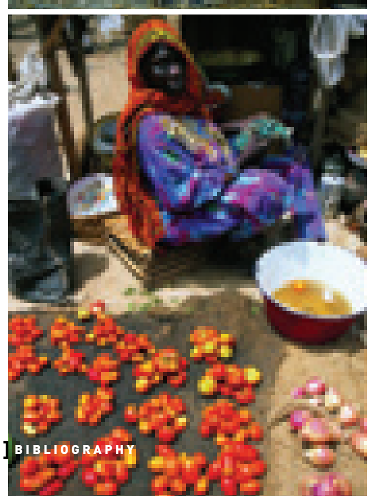

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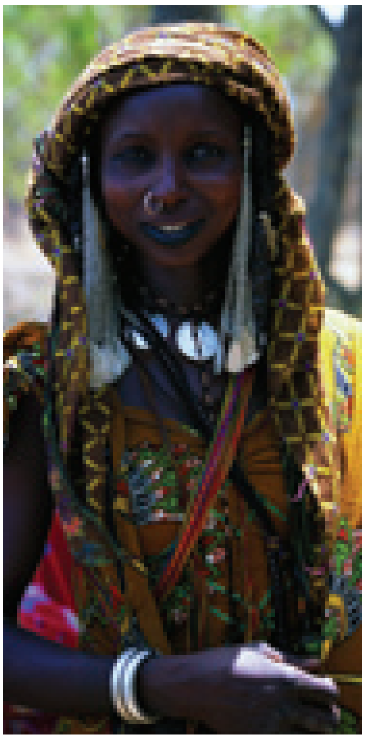


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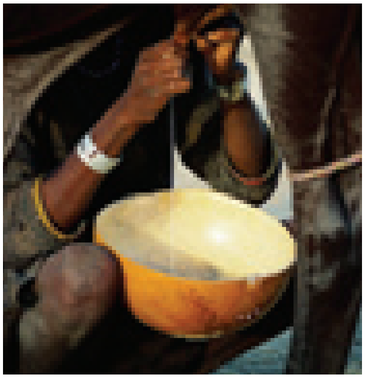

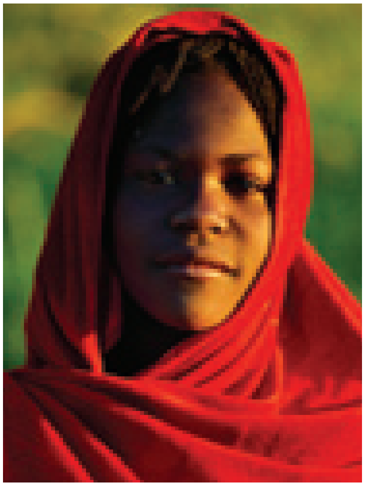

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THE NIGER
CHAD
KANEM
NORTHERN FLOATING ISLANDS
NORTHEASTERN ARCHIPELAGO
NORTHEASTERN FLOATING ISLANDS
NORTHERN FREE WATERS
GREAT BARRIER
SOUTHEASTERN ARCHIPELAGO
EASTERN ARCHIPELAGO
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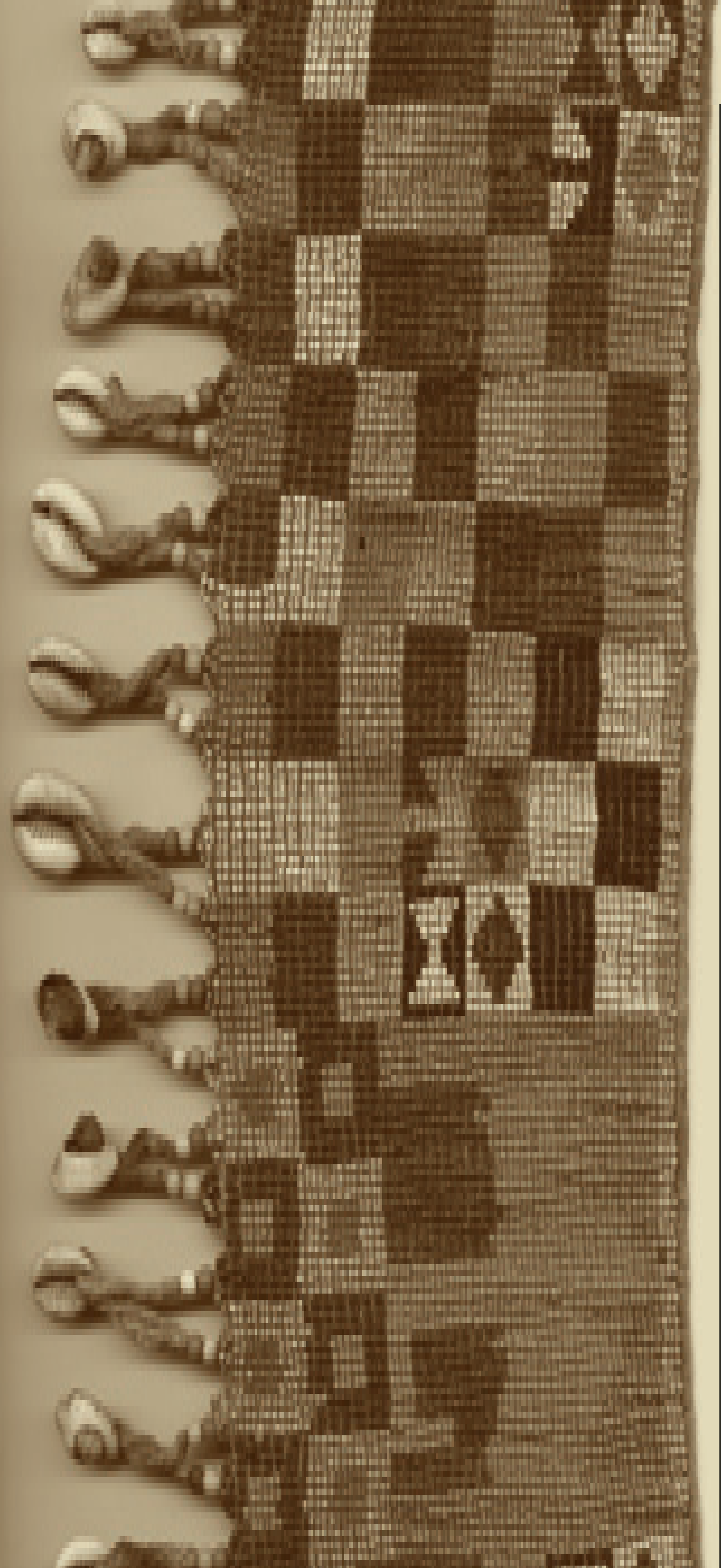


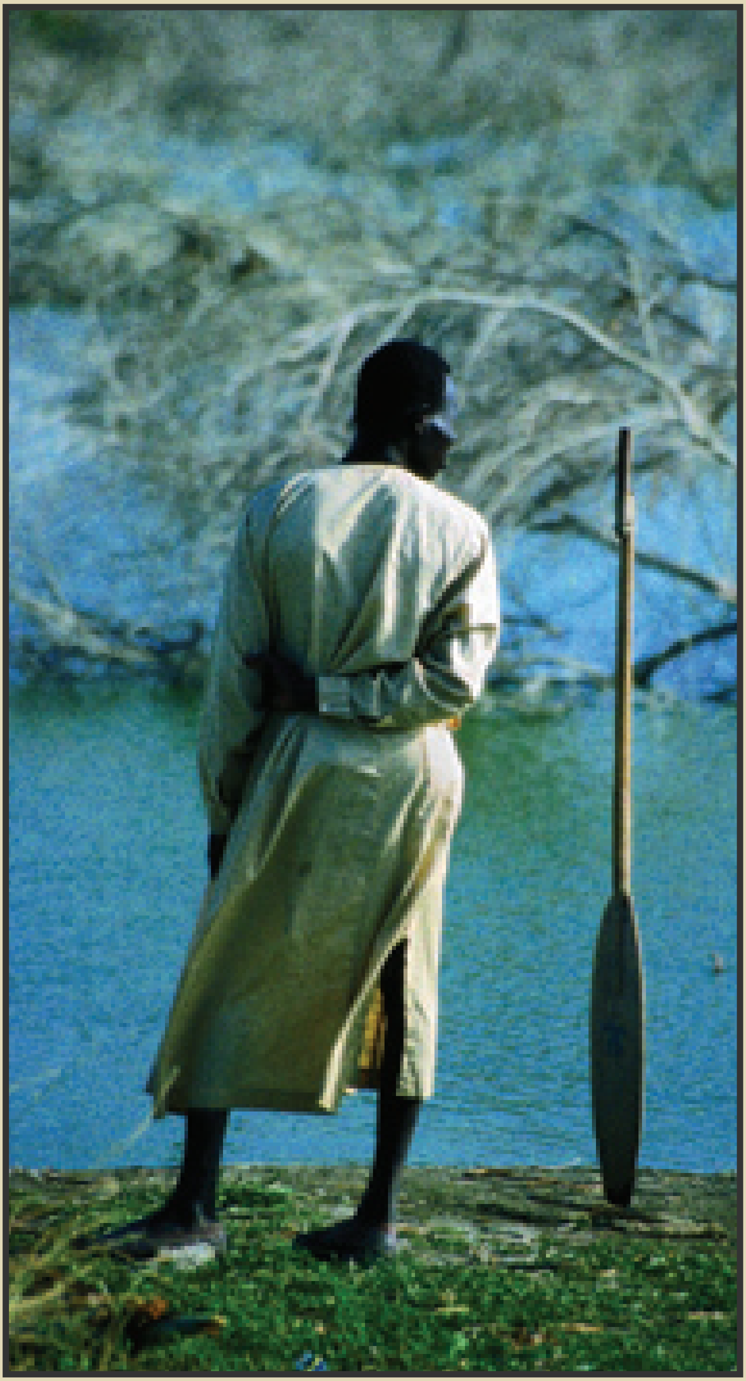
Since its foundation in 1945, the **Food and Agriculture Organization of the United Nations** has worked to alleviate poverty and hunger through agricultural development, improved nutrition and food security.

Agriculture began around 10 000 years ago, when the first farmers and farming communities all over the world domesticated and developed the animal breeds and crops on which food security depends. Modern agricultural production stands on their shoulders, and utilizes the agricultural biodiversity that they developed in their farming systems. But this diversity (our farm animals and crops) cannot usually survive in the wild: it depends on human management within living farming systems. Farmers have a right to development and to a better life, but as their farming systems modernize, these crucial genetic resources risk being lost.

FAO promotes the sharing of experiences and awareness related to the role of people in conserving and sustainably using agricultural biodiversity. Building on the local knowledge and social organization of farmers is indispensable. The images in this book are a tribute to the knowledge and work of farmers and their care for the land.

This publication has been supported by the FAO/Netherlands Partnership Programme on Agrobiodiversity.

← OPEN FLAP TO SEE MAP OF LAKE CHAD



"History has recorded a period of complete disappearance of Lake Chad. Yet the ecosystem has regenerated itself and civilization continues to flourish.

The challenge today is to reverse the land and water degradation in the Lake Chad Basin ecosystem, by means of both modern methods and traditional skills, in order to support the sustainable exploitation of natural resources for the benefit of millions of people today and in the generations to come.

This book is a wake-up call for everyone to identify, document and transmit knowledge and practices that will enable the present and future inhabitants of the Lake Chad Basin to sustain and improve their living conditions."

Engr Muhammad Sani Adamu
Executive Secretary
Lake Chad Basin Commission

The book contains over 350 photographs by Marzio Marzot, documented information on traditional food production systems, scientific details and notes from a journey through one of the world's outstanding region: the Lake Chad Basin in Africa. It provides an insight into the life and customs of the local farmers, fishermen and pastoralists who foster, maintain and utilize biodiversity in their traditional agricultural systems, thereby deploying the knowledge and techniques that they have accumulated over many centuries.

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