Working Paper 39e

SYNTHESIS OF LONG-TERM CHANGE IN MARADI DEPARTMENT, NIGER, 1960-2000

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2001

Drylands Research
Crewkerne, Somerset, United Kingdom

The research reported in this working paper forms a part of the Kano-Maradi Study of Long-term Change, which is funded by the Economic and Social Committee on Research (ESCOR) of the Department for International Development (DFID), United Kingdom (Project R7221) and the Leventis Foundation. DFID and the Leventis Foundation can accept no responsibility for any information provided or views expressed.

ISSN 1470-9384

Typeset at Drylands Research and printed at Press-tige Print, Crewkerne.

Preface

Drylands Research Working Papers present, in preliminary form, research results of studies carried out in association with collaborating researchers and institutions.

This working paper is part of a study which aims to relate long-term environmental change, population growth and technological change, and to identify the policies and institutions which are conducive to sustainable development. The study builds upon an earlier project carried out by the Overseas Development Institute (ODI) in Machakos District, Kenya, whose preliminary results were published in a series of *ODI Working Papers* in 1990-91. This led to a book (Mary Tiffen, Michael Mortimore and Francis Gichuki, *More people, less erosion: environmental recovery in Kenya*, John Wiley, 1994), which was a synthesis and interpretation of the physical and social development path in Machakos. The book generated a set of hypotheses and policy recommendations which required testing in other African dryland environments. Using compatible methodologies, four linked studies have been carried out in:

Kenya	Makueni District	
Senegal	Diourbel region	
Niger	Maradi Department	(in association with ODI)
Nigeria	Kano region	(in association with ODI)

For each of these study areas, there is a series of *Working Papers* and a *Synthesis*, which has been reviewed at a country workshop (excepting Nigeria). An overall synthesis was discussed at an international workshop at London on 17 January, 2001.

In the Niger-Nigeria series the authors focus on linkages between long-term change and investments by small farmers in Kano-Maradi region in the period 1960–2000. The Research Leader for these studies is Michael Mortimore. He, Mary Tiffen or Yamba Boubacar may be contacted at the following addresses.

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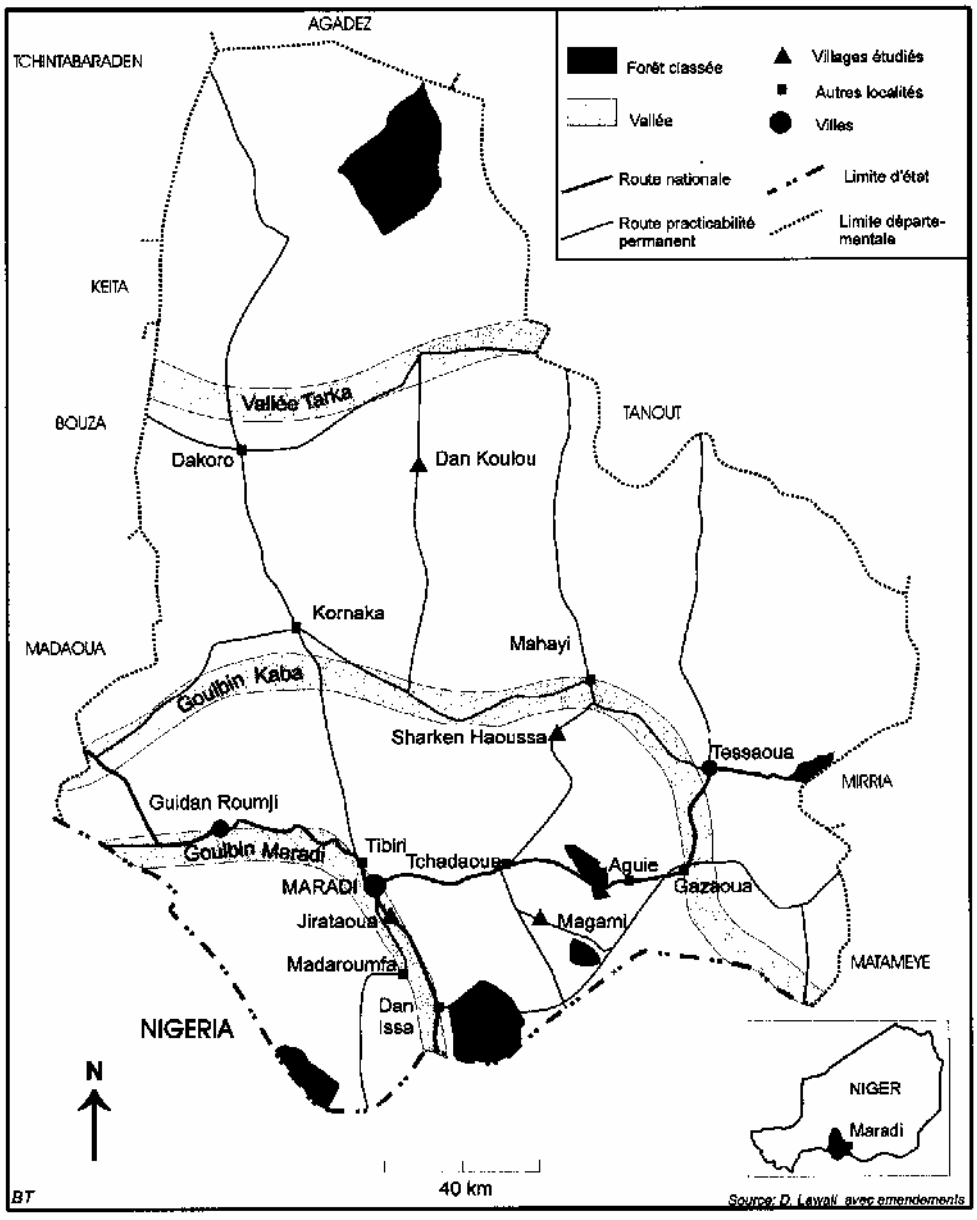
Preface map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Goulbin Maradi
Dakoro
Dan Koulou
Kornaka
Mahayi
Sharken Haoussa
Tessaoua
Guidan Roumji
Tibiri
Tchadaoua
Aguie
Gazaoua
MARADI
Jirataoua
Magami
Madaroumfa
Dan Issa
N
40 km
BT
Forêt classée
Vallée
Route nationale
Route practicabilité permanent
Villages étudiés
Autres localités
Villes
Limite d'état
Limite départementale
NIGER
Maradi
Source: D. Lawali avec emendements

Abstract

This synthesis forms a part of the Kano-Maradi Study of Long-term Change in which six hypotheses on population density, markets, technological change, integrated agriculture, income diversification and resource tenure/institutions are tested in the context of dryland management. In Maradi Department, a pessimistic scenario of rainfall decline and drought, increasing population pressure, land scarcity, and degradation of natural resources was widely accepted in official and scientific circles in the 1970s and 1980s. The impact of policy on dryland management and the livelihoods of small farmers and livestock producers is examined, focusing on economic management and prices, land tenure and forestry.

The evidence for a transition in natural resource management, investment, livelihood strategies and sustainability is examined. Crop and livestock production trends have been positive, particularly in view of the decline in rainfall and closure of the land frontier, and food sufficiency has been maintained on average, though not in poor households. Income diversification has been vigorous; technology has adapted to both ecological change and new market opportunities; farm incomes have been re-invested to a significant extent; and there are indications of improved productivity per hectare in some situations. Soil nutrients are managed sustainably on a significant proportion of farmland, and where this is not so, farmers aspire to do so; trees on private farms are conserved and harvested, in contrast to woodland of open or common access. Livestock production is taking more intensive forms and becoming more integrated with crops. Private title to natural resources has adapted to changing circumstances. In the family, greater individualisation is a slow trend in response to market participation, and attitudes to a defective education curriculum are strongly pragmatic. In conclusion, the six hypotheses (with one unproven exception) are upheld in a framework which recognises a major system transition from extensive to more intensive production systems, together with income diversification and greater participation in markets, linked with the influence of Kano and the Nigerian market system. While not discounting the continuing existence of poorer households, this transition offers an opportunity for development policy to create the conditions for them to mobilise their resources.

A French translation of this paper is available as WP 39f. See the inside cover for details.

About the authors

Michael Mortimore is a geographer who taught and researched at Ahmadu Bello University, Zaria, Nigeria between 1962 and 1979, and was Professor of Geography at Bayero University, Kano from 1979 to 1986. Subsequently he carried out research studies as a Senior Research Associate in the Department of Geography, Cambridge University, the Overseas Development Institute and as an Honorary Fellow of the Centre of West African Studies, University of Birmingham. His research and publications have focused on environmental management by smallholders in the drylands of Africa. In 1998 he and Mary Tiffen set up the Drylands Research Partnership.

Mary Tiffen is a historian and socio-economist with a PhD from the London School of Economics. Consultancy in the Middle East on irrigation agriculture led to her appointment at the Overseas Development Institute, 1983–1994, first as a Research Fellow in charge of its Irrigation Management Network, then as chairman of the Agricultural Administration Unit. From 1990–1994 Dr Tiffen was mainly engaged in the multi-disciplinary study of Machakos District. In 1998 she and Michael Mortimore set up the Drylands Research Partnership.

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Acknowledgements

The authors and their collaborators in Niger gratefully acknowledge the encouragement and support of the Prefect of Maradi Department and his staff, the chiefs and people of Jiratawa, Magami, Sharken Hausa and Dan Kullu, and of CARE Niger. Claude Raynaut generously provided access to his extensive Maradi archive in Bordeaux. The work and interest of Claude Raynaut, Philippe Jouve and their colleagues provided a major inspiration for this study.

Acronyms and abbreviations

NRM:	Natural resource management
PDRM:	Projet de Développement Rurale de Maradi
UBT:	Tropical livestock unit (*unité de bétail tropical*)
FCFA:	Franc de la Communauté Financière Africaine

1 INTRODUCTION

The Kano-Maradi Study of Long-term Change was set up in order to understand the impact of policy on natural resource management (NRM) and rural livelihoods, by using a long-term analytical framework (40 years, 1960–2000). From this understanding it is hoped to derive policy recommendations which will facilitate sustainable NRM and rural livelihoods, in particular through motivating private (small-scale) investments in the conservation and enhanced productivity of natural resources, human resources and other businesses underpinning rural livelihoods.

The study forms part of a four-country project designed to test, validate or modify the theoretical findings of a long-term study of environmental change in Machakos District, Kenya (Tiffen *et al.,* 1994) in other African dryland areas, and in particular the West African Sahel region. To this end, four district-level studies have been carried out in:

- Makueni District, Kenya, 1980–90 (this study updates and extends the Machakos study)
- Diourbel Region, Senegal, 1960–2000
- Maradi Department, Niger, 1960–2000
- Kano region, Nigeria, 1960–2000

Six hypotheses have guided the Kano-Maradi Study, which together offer a radical re-interpretation of some conventional views on the relationships between population growth, environmental risk and natural resource degradation. These are:

- an increase in rural *population density* can facilitate agricultural intensification, through increased farm labour per ha, market growth, and lower interaction costs;
- improved access to profitable urban or export *markets* can provide both incentives and funds for rural households to invest in enhanced productivity and conservation of natural resources;
- *technological change* and a diversity of appropriate technical options are promoted by increasing population density, urbanisation, interaction and information flows;
- under conditions of increasing land scarcity, the drive for agricultural productivity promotes crop-livestock *integration* and tree conservation on rainfed farmland; and
- *income diversification*, associated with access to education and temporary or permanent migration, can provide investment funds for agriculture; as well as forming an essential part of an integrated livelihood strategy for households;
- *resource tenure and social institutions* can adapt at the local level to the demands made by the new economic conditions.

In essence, the debate is about whether neo-Malthusian interpretations of NRM provide the best basis for policy (e.g., Young, 1998), or whether there are grounds for re-evaluating the capacities of small farmers and livestock producers to achieve a transition from extensive forms of land use (which were a rational response to abundant land and scarce labour, characteristic of most African drylands in the past) to more intensive and sustainable forms (in response to a contemporary growing scarcity of land resources, a relative abundance of labour, and growing market opportunities).

In this synthesis of the studies in Maradi Department, we shall first show the essentials of the extensive phase of NRM, as diagnosed in studies carried out during the earlier

part of our period, and then identify elements of a new dynamic which the historical comparative method reveals, discernible from the present studies and other contemporary sources. The reader is referred to the thematic *Profiles* for additional detail (*Drylands Research Working Papers* 24–31).

2 MARADI DEPARTMENT: THE PESSIMISTIC SCENARIO

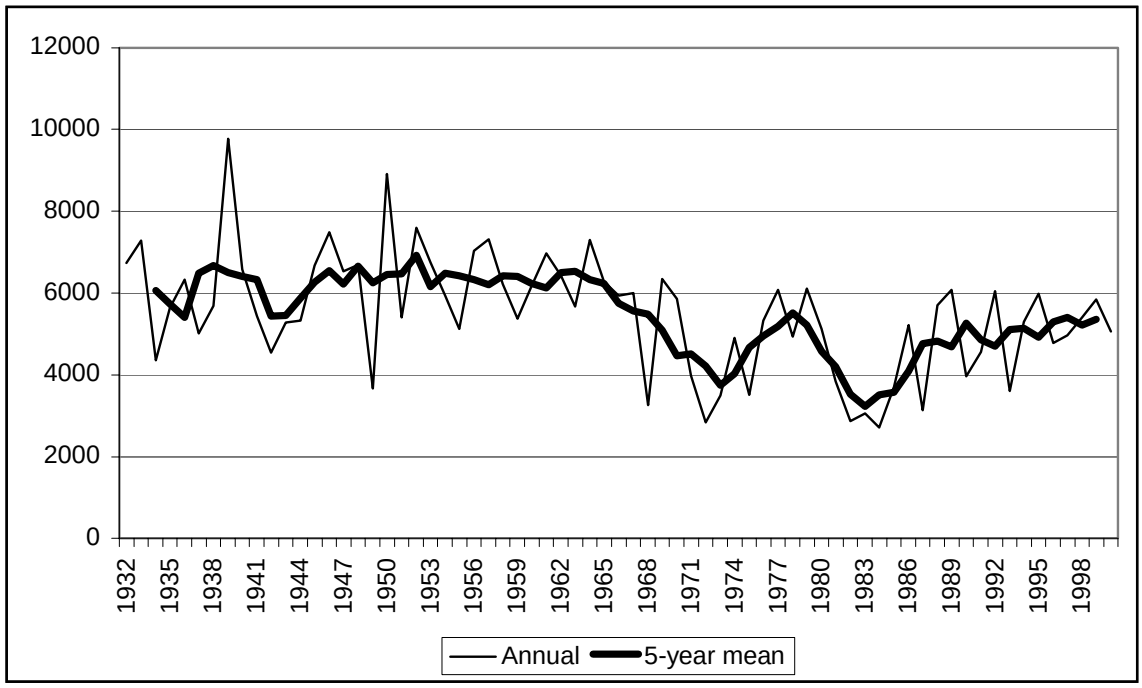
During the period since the 1970s, some authors have suggested that production systems in Maradi Department have been facing an impending crisis, under a combination of trends, including: declining rainfall; increasing competition for land because of population growth; growing shortages of animal manure and crop residues needed to maintain soil fertility; and labour shortages attributed to the rapid extension of cultivated areas (Raynaut, 1975; Raynaut *et al.,* 1988; Miranda, 1979; le Gal, 1986; Barral, 1986; Koechlin, 1980). Fragmentation of landholdings, a deepening level of market participation and of migration, increasing individualisation of incomes, a commercialisation of production relations and an undermining of the extended family seemed to threaten the social fabric. Jouve (1997) has called this the pessimistic scenario and contrasted it with a more optimistic theory of transition. Increased population density was a necessary but not sufficient condition for the transition; it depended also on access to finance for investment, and the possibility of obtaining this through marketing. It is important to ask, therefore, if there is now evidence of a collapse in production systems; or of a transition to a more intensive system. While Jouve called attention to the more intensive systems in Kano described in Mortimore (1989), he raised the question as to whether the conditions for a transition would be found in the drier Sahel.

2.1 Declining rainfall and increased frequency of drought

After the mid-1960s, a persistent downward trend in Sahelian rainfall culminated in two major drought cycles in 1969–73 and 1982–4. After 1984, rainfall fluctuated around a mean which is as much as 30 percent lower than that of the 1950s (Agnew and Chappell, 2000). This pattern is clearly shown in the rainfall during the farming season as recorded at Maradi (Figure 1). The 5-year running mean of seasonal rainfall suggests that rather than continuing a downward trend, rainfall may be characterised in terms of a transition from a higher to a lower average, subject to high variability. While total rainfall has diminished on average, the season has tended to become shorter, with diminished reliability of early (May and June) and late (October) rainfall.

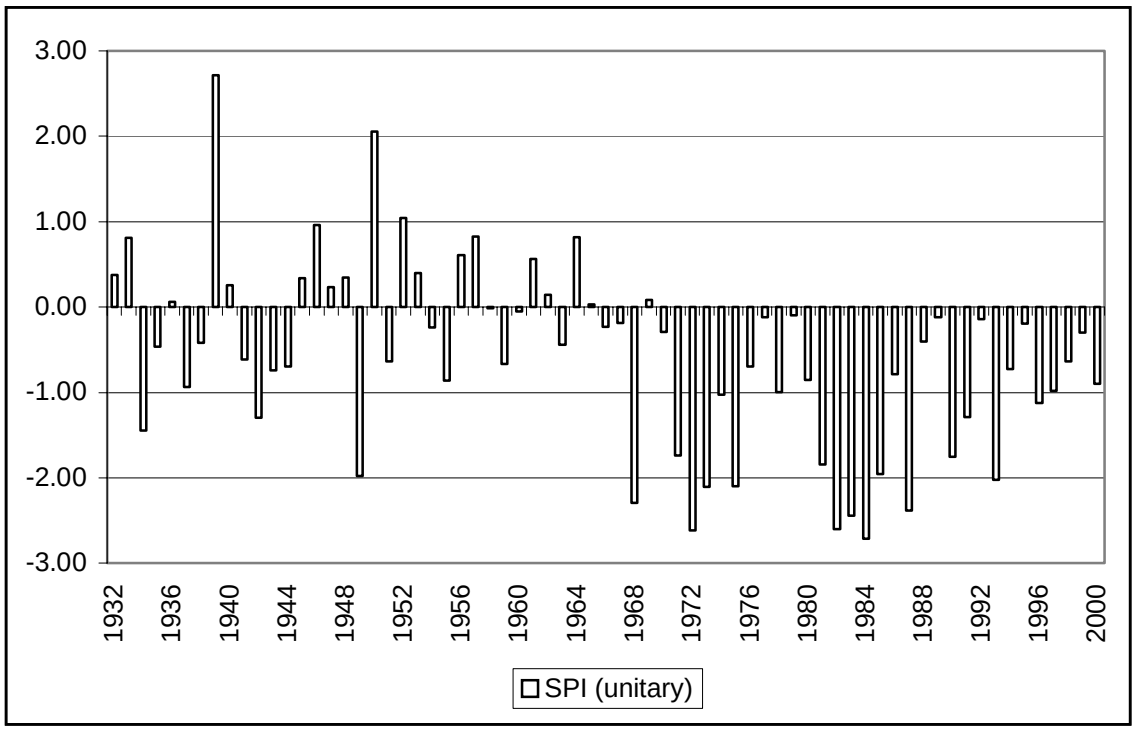
High variability disguises the long-term trend and has more practical immediacy for farmers and livestock keepers. Figure 2 shows the variability of seasonal rainfall at Maradi, measured in terms of a drought index based on standard deviations from the long-term mean. During this period, Maradi suffered four moderate, six severe and four extreme droughts. However, the impact of these droughts was often intensified by a tendency to occur in runs. The worst of these were in 1971–3 (moderate, extreme and severe droughts in successive years) and in 1981–5 (moderate, three extreme and a severe drought in succession). In 1987 there was another severe drought. The intensity of a particular drought varies from place to place, even within a small area, but this experience is typical of the region (Mortimore, 2000).

Figure 1: Maradi seasonal rainfall and 5-yr mean, 1932–2000



Source: Mortimore, 2000, derived from Figure 2.

Figure 2: Variability of seasonal rainfall (SPI), Maradi, 1932–2000



Source: Mortimore, 2000: Figure 4b.
SPI: standard precipitation index obtained from the formula, seasonal rainfall for the year minus average seasonal rainfall 1932–2000, divided by standard deviation. Moderate drought: PI = <-0.84; severe drought: <-1.28; extreme drought = <-1.65 (Agnew and Chappell, 1999).

The pessimistic diagnosis was made in the late 1970s and early 1980s when the farmers were having to adjust to some very dramatic downward shifts in rainfall (Figure 1). The impact of drought on productivity in the short term is often confused with that on degradation in the longer term. However, between droughts there are sometimes years of good rainfall when crop production and the natural vegetation recover. While we are attempting to distinguish the relative influences of rainfall, population density and policy, we acknowledge that the impact of declining rainfall on bio-productivity is very difficult to separate from the management methods of farmers. What is certain is that average potential productivity has been reduced by a fall of one-third in the average rainfall (Hulme, 1992; Hess *et al.*, 1994), and that an increase in the frequency and severity of droughts puts household incomes and asset accumulation at risk.

2.2 Increasing rural population densities

During the period 1960–88, according to an official estimate for 1960 and the censuses carried out in 1977 and 1988, the population of Maradi Department increased from 561,000 in 1960 to 949,747 in 1977 and to 1,389,433 in 1988. This represents an unusually high rate of annual growth of 3.52 percent in the latter part of the period, which may have been due to undercounting in the earlier years (Tiffen, 2001). Nevertheless, rapid growth has occurred throughout the 40 years, and this is often considered to militate against sustainable NRM.

The average density of population, including both the town of Maradi and the sparsely populated *zone pastorale* in the north, increased from 24/km^2 to 35/km^2 between 1977 and 1988. However, it is more meaningful for present purposes to compare *rural* population densities in the area to the south of the *zone pastorale*. The rural population was 905,288 in 1977 and 1,278,694 in 1988. The *zone pastorale* had 12,651 inhabitants in 1988 and perhaps 8,000 in 1977. Making these deductions, we find that average rural population densities increased from 23/km^2 to 33/km^2 during this period. In 1988 however, average densities in the three southern *arrondissements* of Gidan Roumji, Maradi and Aguié were 49/km^2, compared with 23/km^2 in the three northern ones of Dakoro, Mayahi and Tessawa (Tiffen, 2001). If they continued to grow at the same rate, by 1999 the average rural density would have reached 44/km^2, and in the three southern *arrondissements*, 68/km^2.

Table 1: Population density in Maradi Department (persons/km^2) by *arrondissement*, 1977 and 1988

	Area km^2	1977	1988	Change %
Maradi Department	41,796.00	22.7	33.2	46
1 Dakoro	17,670.00	10.1	14.6	44
2 Mayahi	6,952.00	24.1	32.8	36
3 Tessaoua	5,471.00	26.4	39.1	48
4 Guidan Roumji	4,929.00	28.2	42.7	51
5 Aguié	3,001.00	41.7	57.6	38
6 Madarounfa	3,773.00	37.6	51.8	38

Source: Tiffen, 2001.

These changes are illustrated in Table 1. According to census data, the average population density of the department increased by 46 percent in only 11 years, from 1977 to 1988. However, it is still considerably lower than in climatically comparable areas of Nigeria, where northern Jigawa State had rural densities of 118/km^2 in 1991.

In Maradi, in addition to increasing their numbers in the southern areas, farmers have moved north and even transgressed the line that is intended to demarcate the exclusively pastoral zone. The rainfall regression that has occurred since the mid-1960s increases the risks they take.

2.3 Land use 'saturation'

The increases in population density which have occurred since 1977 are the last stage of a historical process of settlement in Maradi Department which has been continuing since the early 19th century, when the independence of the Hausa kingdom of Maradi from the reforming *jihadists* of the Sokoto Caliphate attracted migrants from the south. French colonial rule consolidated the northward progression of land-hungry pioneer communities, and the infilling of interstices that had so far remained unoccupied (Raynaut *et al.,* 1988: 49).

During the early phase of settlement in Maradi Department, under low population densities, the migrant communities established shifting cultivation or bush fallowing systems whose most important characteristic was the use of long fallows (10 years or more) between cultivation cycles. These fallows were long enough for woodland vegetation to regenerate vigorously and for soil nutrients to be replenished from decaying organic matter and weathering (Moussa, 2000).

Village settlements soon became permanent, and fields close to the house came under more frequent cultivation while some land which was inconveniently far away was left uncultivated. In some parts of the Department, such as the Tessaoua area, well-established villages and market towns, surrounded by such land-use *aureoles*, were observed in 1851 (Barth, 1857). Permanent fields were near the settlement, fallowed fields further out, and uncultivated bush was left in the interstices between village *terroirs.* This land was used for pasturing livestock herds belonging to Peulh (Fulani) or Bouzou (Tuareg servile) groups (Grégoire and Raynaut, 1980: 103–15). Between 1900 and 1929, most of these interstices were occupied by new Hausa and Bouzou villages, and between 1929 and 1975 the frontier of settlement extended northwards into drier areas around Dakoro. At the same time, the villages grew in population, and increasingly engaged with the market for groundnuts, all putting pressure on the supply of cultivable land. Other than a small number of government forest reserves, few obstacles impeded this appropriation of unoccupied land.

Analysis of air photographs showed that between 1957 and 1975, in two large samples, the greater part of the area progressed from lower cultivated fractions to higher ones (except where all land was already cultivated). Regression was rare (Raynaut *et al.*, 1988: carte 6; Stigliano, 1983). By 1996, cultivation had increased to 73 percent of the total area, as shown in Table 2 (Mahamane, 2001)[1].

[1] However, estimates of the area of cultivation in 1975 differ. Raynaut *et al.* give 46.5 percent for two large sample areas in central and southern Maradi. Mahamane gives 59 percent for a

Table 2: Land cover in central and southern Maradi Department, 1975 and 1996 (percent)

Land cover type	1975a	1996b
Dry woodland (*forêt sèche*)	4	1
Open woodland (*forêt claire*)	2	5
Grassland with trees (*steppe boisée*)	2	6
Grassland + shrub woodland (*steppe arborée/arbustive*)	25	8
Grassland with shrubs (*steppe herbeuse/arbustive*)	8	7
Cultivation	59	73
Total	100	100

Source: Mahamane, 2001: Table 1 – a. Air photo interpretation (Stigliano, 1983**),**
b. Earth satellite (Resurs) imagery.

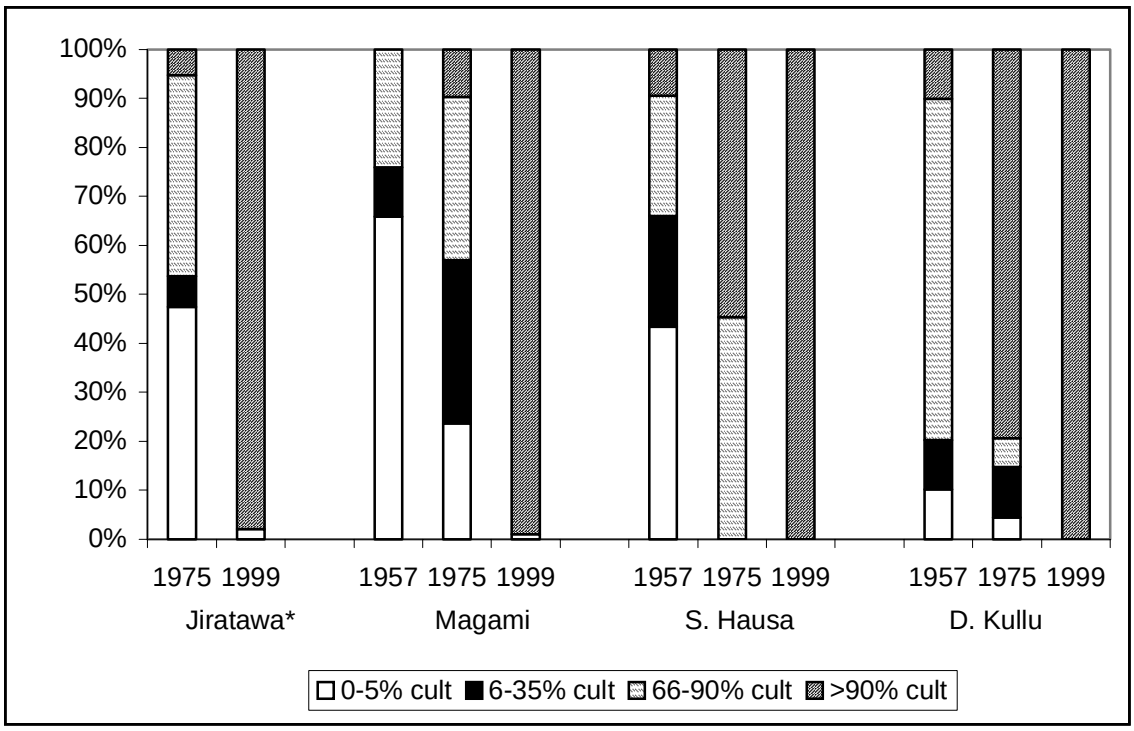
Raynaut *et al.* (1988: 32) estimated that south of the Tarka Valley, that is, outside the *zone pastorale*, the cultivated land per person was about 1.5 ha in 1975. Assuming that the rural population continued to grow at the rate recorded in censuses (40 percent in the 11 years, 1977–88), the amount of cultivated land available per person in 1996 would be only 0.714 ha, a reduction by about a half. Raynaut *et al.* (1988: 103) found a significant relationship between population density and the cultivated fraction at the level of the individual *terroir*. In the department, the fastest rate of population growth has been in the least populated areas (at 4–6 percent/year), reflecting the high rate of in-migration, while in older places the growth was slower, at 1–3 percent/year (Moussa, 2000).

During the longer period, 1957–99, the cultivated fractions of four village *terroirs* have increased dramatically (Figure 3). These represent respectively peri-urban (Jiratawa), southern (Magami), central (Sharken Hausa) and northern (Dan Kullu) agro-ecological zones. Within two or three km of the village centres, virtually all land (excepting settlements) is now described as being >90% under cultivation. In earlier years, by contrast, all the terroirs had a proportion in the class 6–35 percent under cultivation, which allowed for fallowing, and some had a proportion in the class <5 percent under cultivation, which allowed for the creation of new farm land.

Land in the department is now at saturation point. Land saturation is defined as the exhaustion of the reserve supply of free cultivable land, which is available to members of the community on allocation by the chief. As fallow cycles became shorter, and rights of re-cultivation became better defined, saturation in a practical sense would be reached long before the whole surface passed under cultivation. Thus the existence of uncultivated land on air photographs or satellite images does not show that saturation had not yet been reached; but an absence of uncultivated land shows very clearly that it had.

larger continuous area. Both use the same data and are restricted to the zone south of the Tarka valley.

Figure 3: Expansion of cultivation in four *terroirs*, 1957–99*, in four cultivation frequency classes (percent of area)



Source: Mahamane, 2001: Tables 5, 7, 9, 11.
* No data are available for Jiratawa in 1957. An irrigation system was established there in 1981.

The dynamic by which human settlement and land development had expanded for more than 100 years has thus run its course. These estimates, together with those of rural population densities, indicate a powerful and growing constraint on NRM by fallowing. This in turn heralds either collapse, or a radical change in systems of farming.

2.4 Degradation of natural resources

Saturation is at the heart of the crisis diagnosed by researchers around 1980 (Raynaut *et al.*,1988: 32 *et seq.*; le Gal, 1986; Miranda, 1979). This was understood in terms of a disequilibrium between natural resources and production systems: 'L'intensité de l'exploitation de l'espace pose en terme aïgus le problème de l'équilibre du milieu naturel et de ses ressources' (Raynaut *et al.,* 1988: 33). During the period up to 1975, cultivation was rapidly extended, with the aid of ploughing technology brought in train with groundnut production, from the sandy dune soils that had been preferred earlier, to the less suitable compact soils. Less frequent and, eventually, no fallowing prejudiced the fertility of cultivated soils. In addition, there was not enough manure to compensate for the reduced fallows, for the livestock population was also under threat from a reduction of pastures – both natural and fallows as well as reduced by the droughts. The reduction in pastures meant that the remaining areas of natural vegetation came under intensified grazing pressure. This reduced the bio-productivity of pastures and, on the compact soils especially, exposed them to erosion. At the same time, diminished rainfall was causing a loss of biodiversity as Sudanian species of trees and grasses retreated

southwards before a more Sahelian flora (Raynaut *et al.*, 1988: 28; for recent data, see Luxereau and Roussel, 1997: 131–3). In the centre of the department, where population densities were highest, there was a 'crisis triangle' where degradation threatened to become irreversible. *Soil fertility decline, vegetational degradation*, and *loss of productivity* in crop and livestock production are the three key elements of this predicted crisis.

With regard to the first, *soil fertility decline* was construed from the collapse of the long fallowing system, and farmers' complaints, rather than from soil nutrient analyses on farmers' fields, which are rather rare. Before 1975, long-term fallowing was widespread across Maradi Department and manual fertilisation of fields using household manure was rare. Now, fallowing has more or less disappeared, except in the extreme north where population densities are low (Moussa, 2000). The decline in fallows did not lead to a corresponding increase in fertilisation. In fact between 1977 and 1984 there was a decrease in the percentage of cultivated lands in Maradi Department which were fertilised with either manure or mineral fertilisers, in spite of the fact that the Projet de Développement Rurale de Maradi (PDRM), which was active from 1978 to 1986, subsidised the distribution of inorganic fertilisers. Since 1988 the consumption of fertilisers has dropped considerably (Moussa, 2000). To most observers, it has seemed logical to conclude that a long-term decline in soil fertility must be occurring.

Three soil profiles on farmers' fields at Sharken Hausa were sampled and analysed in 1999 and compared with baseline analyses carried out in 1977 (Issaka, 2001). Contrary to expectations, no evidence was found of any significant decline in their fertility. But the sample is too small to allow generalisation.

On a much larger sample of soils, under differing management regimes, in the four *terroirs* of Jiratawa, Magami, Sharken Hausa and Dan Kullu, there is an expected decline in the key fertility indicators – carbon, nitrogen, phosphorus and exchangeable cations – as one goes from long fallow (land which has not been cultivated for 50 years), through grazing land, to fields cultivated without fertilisation (Issaka, 2001).

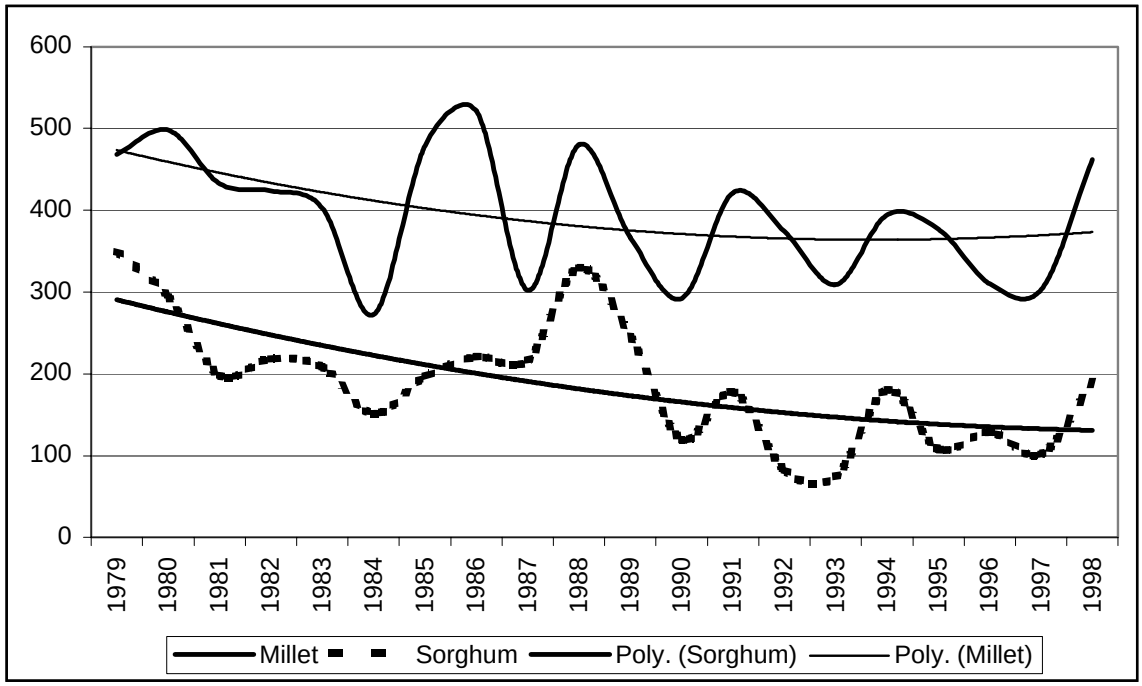
Vegetational degradation, both on grazing land and in woodland, is usually diagnosed in Sahelian ecosystems. On grazing land it is inferred from the diminution in area and the increasing livestock numbers, at least between droughts. Between 1975 and 1996, steppe formations (which contain a high percentage of herbage) decreased from 35 to 21 percent of the surface area (Table 2). There are many sites where evidence of water or wind erosion appears (Luxereau and Roussel, 1997). However it is difficult to separate the effects of grazing (and cutting) from those of the droughts which have ravaged the area since the early 1970s. There is little data on vegetation communities from before 1975.

If livestock depend primarily on natural grazing, such a decrease indicates a corresponding decline in the livestock supporting capacity. Animals have always been integral to the farming systems in the area, and more especially to the livestock herding systems practised by migrant Peulh or Bouzou. Such a decline would be made worse by the effects of lower rainfall on the bio-productivity of the pastures. When pasture became scarce, herders had to take their animals out of the area for grazing for some or all of the year. This lessens the availability of manure through grazing or herding contracts.

Deforestation is the second major component of vegetational degradation. A 1981 report listed many contributory factors, without citing evidence (CILSS, 1981). Our investigations show that since the 1950s, natural woodland has declined in total area as farming has expanded, and also in biodiversity (Awaiss, 2000). Tree mortality has also been caused by moisture stress, and de-branching by herders who have moved south from the *zone pastorale* seeking adequate forage for their animals (Moussa, 2000). Between 1975 and 1996, there was an increase of 13 percent in cultivation (at the expense of woodland and steppe), 6 percent of the total area suffered a decline from one woodland type to an inferior one, and wooded grassland (*steppe arborée*) declined from 25 to 8 percent (according to earth satellite and air photograph data: Mahamane, 2001: Table 2).

In Dan Kullu and Sharken Hausa *terroirs* in the northern and less densely populated part of the area, trees are generally younger, and encompass a larger number of species, than in Magami and Jiratawa in the south, where trees are larger, older, and less diverse by species (Awaiss, 2000). This is surprising in view of the drier conditions of the north, and may indicate that pressure from the human population has had more impact in some densely populated areas in the south.

Figure 4: Yields of millet and sorghum, 1979–98 (kg/ha)

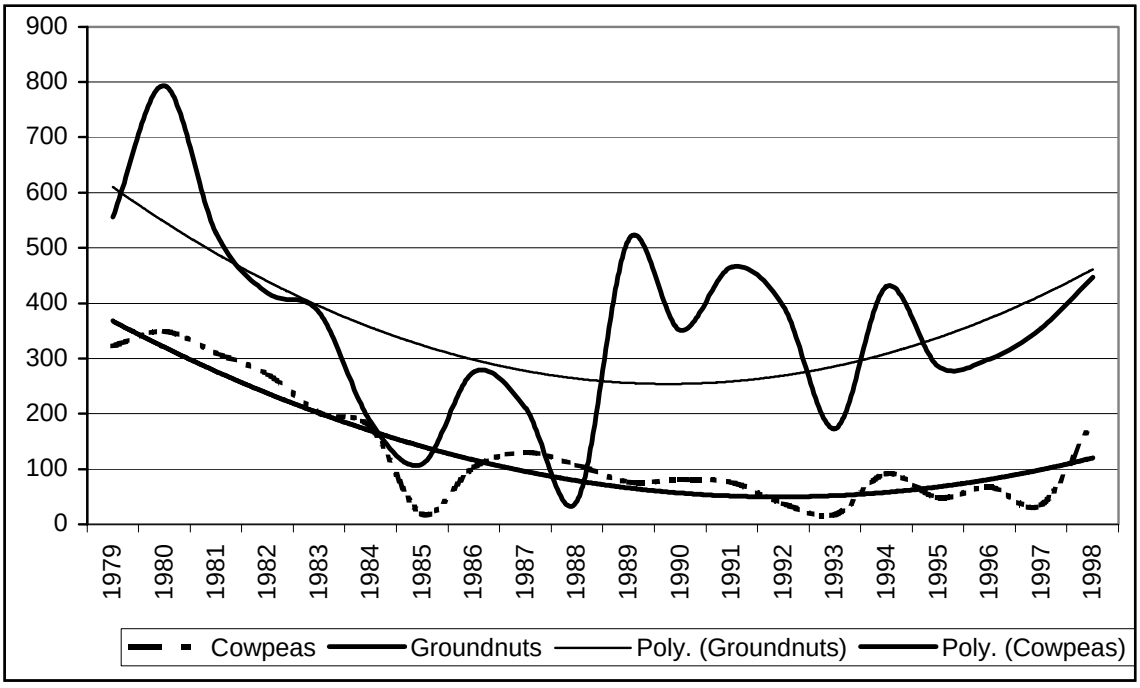


Source: Hamadou, 2000a: Figure 7.

With regard to the *loss of productivity,* crop yields per hectare were found in 1978 to be highly variable at rather low levels (from 30 to 554 kg/ha for cereals: Le Gal, 1986; see Raynaut *et al.*,1988: 150). Rainfall was not the only factor that determined the levels of output. Those who obtained better production per worker had access to more land than average and to ploughing technology. Given such variability, evidence suggesting trends in average yields should be treated with caution. According to official data, total

production of the four major crops planted in Maradi Department (millet, sorghum, groundnuts, cowpea) was maintained in the longer term through extension of the cultivated area rather than through improved yields. The yields for major crops all declined between 1979 and about 1990. Rainfall was very variable during the period (Figure 2).

Figure 5: Yields of groundnuts, and cowpeas, 1979–98 (kg/ha)



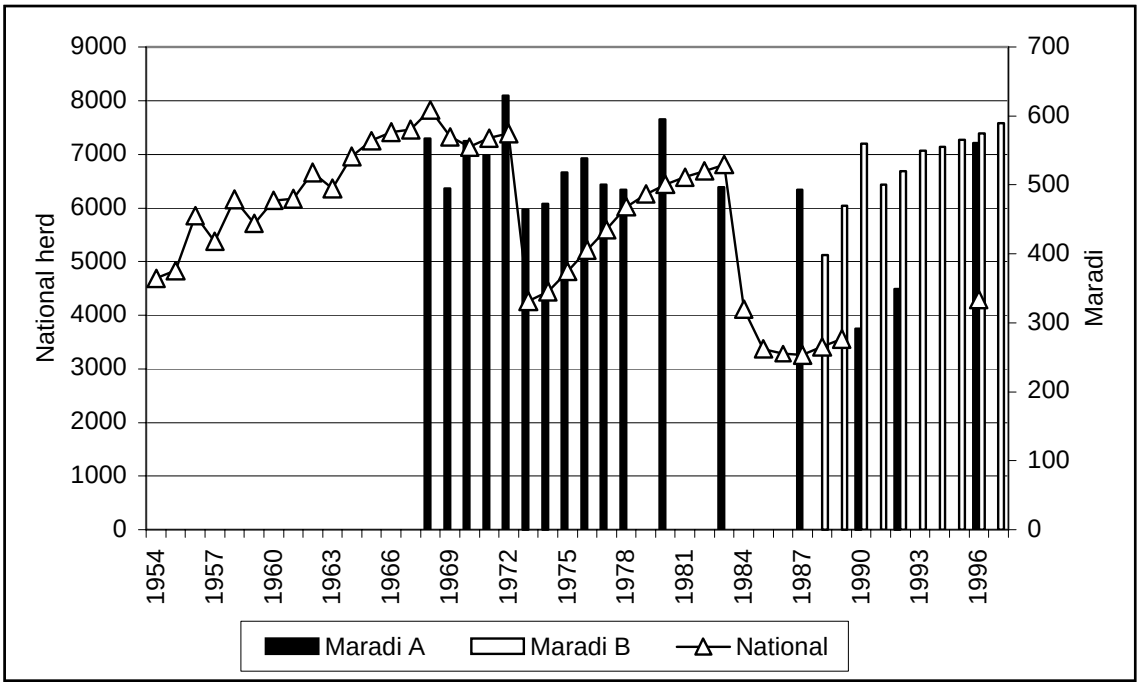
Source: Hamadou, 2000a: Figure 8.

Livestock productivity is linked directly with the availability of fodder, which in the *zone pastorale* means natural pasture. The edible dry matter/ha in the Sahel is primarily dependent on rainfall, and determines the year-round carrying capacity for livestock (Breman and de Wit, 1983; le Houérou, 1985). Using assumptions about food and income requirements, it is possible to model the human populations that can be supported year-round from livestock production (Peyre de Fabrégues, 2000). Since the 1970s, the trends in the livestock and livestock populations in the *zone pastorale* have diverged, with human populations growing rapidly while drought cycles in the 1970s and 1980s initiated a step-wise decline in the modelled livestock carrying capacity (Peyre de Fabrégues, 2000). This fell from about 4.5 million livestock units[2] in the period, 1964–72, to 2.75 million in 1973, climbed back to 4.6 million in 1983 and plunged even lower to 2.1 million in 1986, then climbing back to 3.2 million in 1999. Such modelling points to the conclusion that livestock production systems in the *zone pastorale* can no longer assure the increased animal production that is necessary to support increasing numbers of herders. Degradation of the grazing resources appears to be certain.

[2] One UBT (*unité de bétail tropical* – tropical livestock unit) is equivalent to one camel, 1.25 bovines (of 250 kg), or equine, or ten sheep/goats.

In fact, the national herd far exceeded these numbers in both good and bad years (Figure 6), which suggests increasing numbers of animals outside the *zone pastorale,* notwithstanding a decline in the natural pastures available, as shown in the Maradi land use data (Table 2). Such an increase results from a nearly universal preference of farming families for investing savings in livestock. If livestock were dependent only on natural pastures, this would indicate overgrazing, but of course this is not so. They use fallows, crop residues and (in some areas) tree browse. Estimating carrying capacity under such conditions is more complex, but it has been estimated that in the years 1994–7, crop residues generated from two to five times as much edible matter as natural pastures in the department (Banoin, 2000: 4).

Figure 6: Trends in the livestock population, national herd and Maradi Department, 1954–97 (in UBT*, thousands)



Sources: *National.* Annual data by species supplied by Ministère d'élevage, Niamey, converted into UBT values; *Maradi A.* Departmental data by species available to the authors, cited by Raynaut and Grégoire for the years 1968–78 (1980: 49–50), or supplied by Ministère d'élevage, Maradi, converted into UBT values; *Maradi B.* data by UBT values for the years 1988–97 (Banoin, 2000: 3). UBT values for horses are missing from *Maradi A* (equivalent to 30–40 thousand in most years), and values for donkeys are interpolated for the years, 1968–78.
*UBT = *Unité de bétail tropical* (tropical livestock unit). See footnote 2.

If the department is overstocked, the numbers of livestock should show a long-term decline. Livestock statistics are unreliable and incomplete[3], but Figure 6 shows major

[3] The livestock statistics are as difficult to obtain as they are to collect at the departmental level. We have collated data from several sources, all originating from the Ministère d'élevage, Maradi.

falls after 1972 and 1987. There is a gap in the Maradi series where the drought of 1982–4 occurred. Although there is disagreement between two data series for the years 1988–97 (*Maradi A* and *B*), a strong recovery is suggested to levels comparable with those of 1970 and 1980. In 1999, enquiries among small samples of farming households in four villages showed expanding ownership of cattle, goats and sheep in the two northern villages but decline in the two southern ones, where grazing is most scarce (Banoin, 2000).

2.5 Monetisation, individualisation, diversification and migration

Monetisaton of the rural economy is not new. The groundnut boom of southern Niger from the 1930s had extended the scope of monetary transactions (Collins, 1974). Inventories of markets at the beginning of our period showed that diversification and commodity specialisation characterised Hausa markets in eastern Niger in the early 1960s (Nicolas, 1962). Strong pressure was exerted by taxation demands, increased in the 1960s (Raynaut, 1977; Hamadou, 2000b). Factors of production – especially labour – became increasingly marketable. In the peri-urban zone of Maradi, monetary relations were embedded in social differentiation and exchange (Raynaut, 1973). Markets were most active in the south, endowed with more major roads, but there was a northward extension to Dakoro. Elsewhere in the north cattle markets, which did not rely on roads, were important, but between 1972 and 1976 some major cattle markets relocated to the south, due to Nigerian demand and perhaps an increase of livestock in the agricultural areas. (Raynaut *et al.*, 1988: 62–3).

Nevertheless, as groundnut prices stagnated, cultivable land became scarce, millet production more risky, and households needed more cash, this monetisation could be interpreted as a symptom of breakdown in production systems. Households became more often dependent on purchased food (Grégoire, 1980). Food insufficiency in Niger is widely believed to have become a persistent if not a structural feature of the economy during the 1980s (Somerville, 1986). The basis of this idea is found in data on grain imports, most of which entered as food aid. Food purchases at the household level, even where it was linked to specialisation in more profitable export crops, was taken by some as a diagnostic feature of system weakness, because of an assumption that self-sufficiency in food is an over-riding priority in African rural households.

Since the 1960s families in Maradi Department have tended to become more nuclear. Joint production by large extended households is giving way to more individualised forms of income generation and capital accumulation (Doka, 2001). This trend was first identified during the 1970s (Raynaut, 1975, 1977; Grégoire, 1980), though in the previous decade, the commercial foundations of such a change had already been noted (Mainet and Nicolas, 1972). The rising rural population density coincided with a tendency for extended farming households to break into smaller production units as young men looked for farm land further afield – a change partly prompted by the difficulties heads of extended families had in meeting the increased taxes (Boubacar, 2000). Change was also driven by increased reliance on non-farm income, particularly in the most vulnerable households, many of which have men who engage in migration

in order to supplement household income. In Hausa societies labour earnings belong to individuals, not family heads.[4]

Of a sample of short-term migrants in Maradi town interviewed in 1995–6, 44 percent said that they were driven by a shortage of food, and 32 percent were in need of money (Rain, 1998: 236). Migration is increasingly long-term and long-distance. Whereas, in the past, it was more important in the northern and drier parts of the department, it is becoming more widespread (Doka, 2001). As it is predominantly male, women have had to take on more responsibility for managing the family farms, while also supporting household consumption through alternative income generating activities.

Migrant incomes, many of them earned in Nigeria, extend monetisation to communities far from markets or from profitable crop producing opportunities (Grégoire, 1980; Rain, 1998). It has long been customary to portray short-term migration as an involuntary response to hardship, especially as its incidence rises dramatically during and after droughts, when food is scarce (Swinton, 1988). Recent droughts have provoked increased out-migration in certain villages studied (Doka, 2001).

Niger is considered to be one of the poorest countries in the world (*World Bank Data Base*, 2000). As expressed in such indicators as chronic food insufficiency (in poorer households), exposure to episodic food scarcities (in many more households), low and insecure monetary incomes, and poor access to government services in transport or water infrastructure, health provision or education, poverty was and still is widespread in eastern Niger, especially when compared with rather better-off Nigerians across the border. In Maradi Department during the 1970s, incomes were spent first on meeting consumption needs, then on a range of priorities, in which productive farm investments took a low place, even in peri-urban zones (Raynaut, 1975). Savings were considered to be low or non-existent in the long run, so projects such as PDRM were established to supply external inputs on favourable terms by the public sector. Before 1980, Maradi households were considered to be in a very weak position – unless assisted by subsidies and credit – to undertake the investments necessary for intensification. Indeed, it was argued that this was why many chose instead the 'extensification option' – though this appears to conflict with the logic of increasing land scarcity (Raynaut, 1980: 57).

In this co-evolution of the production and family system, therefore, monetisation, growing individualisation, the diversification of incomes out of agriculture and migration could be understood as symptoms of a failure which would lead to increasing poverty and breakdown.

3 THE IMPACT OF POLICY, 1960–2000

The sketch given in Chapter 2 depends mainly, but not entirely, on diagnoses which were made in the 1970s and 1980s, and reflected the impact of colonial rule, the penetration of commodity markets and the then level of population density (since

[4] This was also observed during the early 1980s in areas adjacent to Maradi Department (Arnould, 1985).

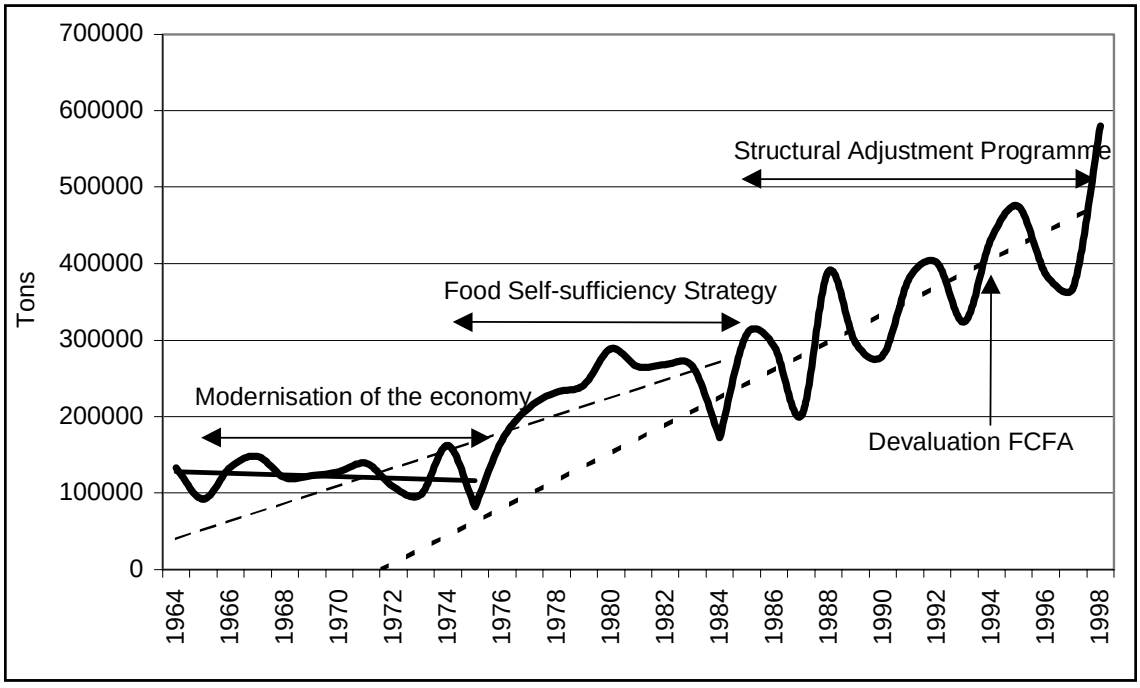
exceeded). In this section we review some specific policies which have had an impact on the management of income systems. Three areas of national policy have particular relevance: land tenure, economic management and prices, and forestry policy.

3.1 Economic management and prices

Pressures brought to bear on households by environmental variability have been compounded by economic pressures stemming from government policies, affecting how and when households were able to generate savings, and to make investments in income generating activities (Hamadou, 2000a). There have been three main policy phases.

At Independence the Government embarked on 'modernisation'. It aimed to increase the production and export of groundnuts through a system of public organisations, mainly co-operatives, which supplied inputs and provided marketing facilities (Collins, 1974). At the same time it increased direct taxes on farmers (Hamadou, 2000a). This programme failed to bring a durable expansion of production, which fell substantially as drought conditions prevailed.

Figure 7: Millet production in Maradi Department, 1964–98



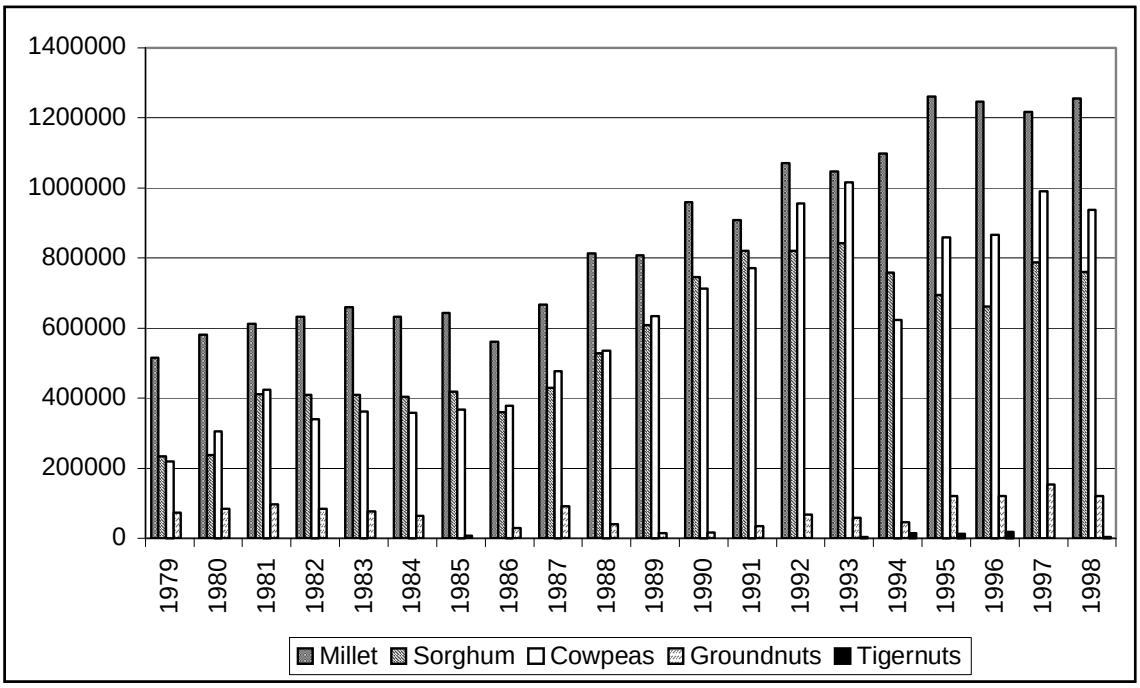
Source: Hamadou, 2000a: Figure 4; Data from Ministère de l'Agriculture et l'Elevage.

After the Sahel Drought of the early 1970s, the Government switched its emphasis to ensuring national food security, utilising uranium revenues. Additional funding was provided for cereal crop production through the Office des Produits Vivriers de Niger (OPVN), which undertook input supply and crop marketing. Continuing drought conditions meant that the government grain and groundnut marketing institutions were effectively financed by the revenue anticipated from the boom in uranium production and exports that occurred during the 1970s, but which did not last. Various large agricultural projects were initiated, amongst them the Projet de Développement Rurale

de Maradi (PDRM), 1977–84. This project made available, at substantial cost, additional extension staff, subsidised fertiliser, animal drawn equipment and other inputs, and credit. One effect was improved crop statistics. From 1979 data (on an *arrondissement* basis) included areas under cultivation as well as production (Figures 7 and 8).

During the 1970s, millet production (which had stagnated during the years of 'modernisation') assumed an upward trend, but throughout the 1980s, and even in the 1990s, a massive area expansion (Figure 8) was the main influence on total production. Grain yields, allowing for fluctuations caused by rainfall, stagnated (Figure 4).

Figure 8: Areas planted to major crops in Maradi Department (ha), 1979–98



Source: Hamadou, 2000a: Table A3 (Data from Ministère de l'Agriculture et l'Elevage).

During the 1970s, the Government took on a high level of external debt, which it was unable to service after the uranium boom ended, and in 1984 this led to the third policy phase and the imposition of structural adjustment reforms intended to reduce government expenditure in areas where the private sector was seen to be more effective. Two key outcomes were a dramatic reduction in the scale of government investment in rural development (Hamadou, 2000a), and the freeing up of the cereal market, the monopoly of the state buying organisation having ended. The Government also sold, closed or scaled down other public sector organisations previously involved in supplying agricultural inputs or marketing (Hamadou, 2000a: Table A3).

Liberalisation tended to improve prices, though the State's monopoly had never been complete. The prices offered to producers by the marketing institutions had tended to be lower than the market prices, while official consumer prices for grains tended to be higher, reducing incentives for the farmers to produce the targeted crops. Real producer

prices for many crops had remained stagnant (Hamadou, 2000a). There were leakages into the private sector, including trans-border movements into Nigeria. Prices in Maradi were also influenced by different levels of inflation in Niger and Nigeria, and importantly by differences in the exchange rate of the Naira and Franc de la Communauté Financière Africaine (FCFA). The FCFA was devalued in 1994. Unfortunately, we only have price data to 1996, and, therefore, were unable to see the full impact of the devaluation on local prices. Elsewhere in the FCFA zone it raised the profitability of local meat production against foreign imports (Jouve, 1997). Figure 8 shows rises in the areas under millet and particularly groundnuts since 1994.

3.2 Policies on land tenure

During the past 40 years the customary (*de facto*) land tenure system has been in competition with the *de jure* system of the State, initiated under French rule. After independence in 1960, the Government took a stance against the customary system, through a range of laws and decrees which limited the powers of chiefs in allocating lands in their areas. But these, on the whole, did not impede local systems of land allocation, and in most places the customary system of land tenure continued to operate. By 1970, the Government had moved to look for a way to accommodate both land tenure systems within one legal framework. This effort was partially driven by rising levels of conflict between farmers and pastoralists, and also amongst farmers, which led many parties to turn to the Government to resolve disputes, especially near urban areas. The State's increasing role in conflict arbitration was associated with an increasing role in the management of rural land not already settled (*terres sans maîtres*), of land in rural areas that was not already cultivated, and of other resources including trees in forests and on cropland (Boubacar, 2000).

The result was the *Code Rurale,* which was developed during the 1980s as a negotiated process, rather than a finished piece of legislation, in order to harmonise and clarify both the rules set out in the national law and those applied through the customary system. The process is not yet completed (Lund, 1998). One of the results was a push for titling, or least the recording, of exclusive land rights. Such rights, however, do not accommodate the flexibility that is an essential characteristic of the customary land tenure system. In addition, many rural households lack trust in the Government's attempts to impose its own rules on their land. As a result, the customary system of land tenure has continued to dominate in Maradi Department, in spite of rising conflicts over land, and the reduced powers of the chiefs (Boubacar, 2000). Population growth, working in conjunction with the uncertainty surrounding land rights, has contributed to the private appropriation of unoccupied land on a large scale.

3.3 Forestry policy

As in other former French colonies, the Government's forestry service took a pessimistic view of forest (mis)management by farmers and livestock keepers, imposing a *Code Forestier* with local forest police and draconian penalties for unauthorised tree cutting. This had the effect of undermining local ownership of tree resources and diminishing the motivation for their sustainable management, as shown in neighbouring Zinder (Thompson, 1976). Meanwhile, the regulatory system itself, torn by contradictory pressures, became corrupted. A belief that fuelwood demand, including that of the towns, was causing deforestation led to donor-assisted projects to

disseminate fuel-efficient woodstoves (World Bank, 1987), and to transfer the management of forest resources to resident communities.

In Niger there has been a continuing conflict between statutory land law, which tended to reward commercial development, and forest law, which remained sceptical about signs of commerce (Elbow and Rochegude, 1989). The *mise en valeur* principle, which allows vacant land to be appropriated by those putting it into production, has regularly conflicted with the forest law of 1974. This put all forested lands that were 'vacant and without masters' in the hands of the State, and also provided strict protection for a number of woody species. This conflict removed incentives for farmers to participate in the protection or planting of trees in forested areas, even on their own land. During the 1970s, many farmers in feared that the Government's effort to encourage tree planting was a way for it to gain control of them (Awaïss, 2000, Boubacar, 2000).

4 EVIDENCE FOR A TRANSITION

Chapters 2 and 3 have given a brief overview, first of a set of environmental conditions that have prevailed over the past few decades, and which acted as powerful constraints to agricultural production, and second, how the Government responded to its perception of these constraints through policies. The implementation of these policies provided the institutional and economic backdrop that tempered farmers' production decisions, and their ability to save and invest. A superficial analysis of the environmental and economic constraints set out above might conclude that, under these pressures, farming households in Maradi Department could not have been able to increase production to keep pace with demand, generate income surpluses or invest in income generation.

However, data collected during the 1990s shows that farmers have adapted to new situations in many ways. They have also identified new markets and new activities which provide new investment resources. In the southern part of the department, where population densities are highest, intensification of agriculture is well under way, and there are strong economic linkages between rural farming areas and urban market economies, through the trade of a widening range of crops, livestock and labour. In the northern part of the study area, intensification of agriculture is less well advanced, as adequate land resources exist and farmers can still increase production through the extension of cropped areas (Moussa, 2000).

4.1 Production

If production systems are not viable, either in terms of economic or of environmental sustainability, their performance in the longer term should show negative indicators. We therefore now examine the available evidence, for crops and livestock.

Production of cereal grains

The staple food crop in Maradi Department is pearl millet (*Pennisetum glaucum,* syn. *P. typhoides*). The production of this crop determines basic food sufficiency at the level of the individual farming household (as households *aim* to be self-sufficient), and also at the level of the system as a whole (where markets balance supply and demand between

differentiated households and localities). These levels of sufficiency have been held as policy objectives since the early 1970s, (that is, excluding substantial and permanent dependence on imports).

Government production data show that millet has continued to dominate cropping. Figure 7 shows total millet production fell very slightly from 1964 to 1975, reflecting the rainfall trend, but this decline was *less than the national average* (Hamadou, 2000a). There was *strong growth* in millet production between 1976 and 1984 (4.8%/yr). Production *continued to grow* between 1985 and 1998, albeit at a slower pace than in the previous decade, in spite of reduced government spending in support of agricultural production. The main food grains (millet and sorghum) and cowpeas have retained a continued and growing dominance of overall areas cultivated since 1979 (Figure 8).

Between 1986 and 1995 the expansion of the area planted to millet (Figure 8) had a major impact on millet production. This was nevertheless a declining influence on output as unused land available for cultivation disappeared. 'Saturation' was reached as early as 1975, in some areas (Stigliano, 1983), and everywhere by 1999 (Table 2). Figure 8 shows that at the departmental level, a plateau was reached by the major crops in 1995, which is unlikely ever to be exceeded.

The growth of millet production is also officially attributed to the long-term impact of new methods of cultivation and soil management that have been promoted by public sector investments, through programmes such as the PDRM, and taken up by cultivators. This is undoubtedly significant, and is discussed later (section 4.3). However, there is no marked effect in departmental statistics on yields (Figure 4). At best, the decline in millet yields has been halted.

Sorghum (*Sorghum bicolor*) has been disadvantaged by the trend in rainfall, and shows high inter-annual variability. Yields are consistently below those of millet (Figure 4).

Production of pulses

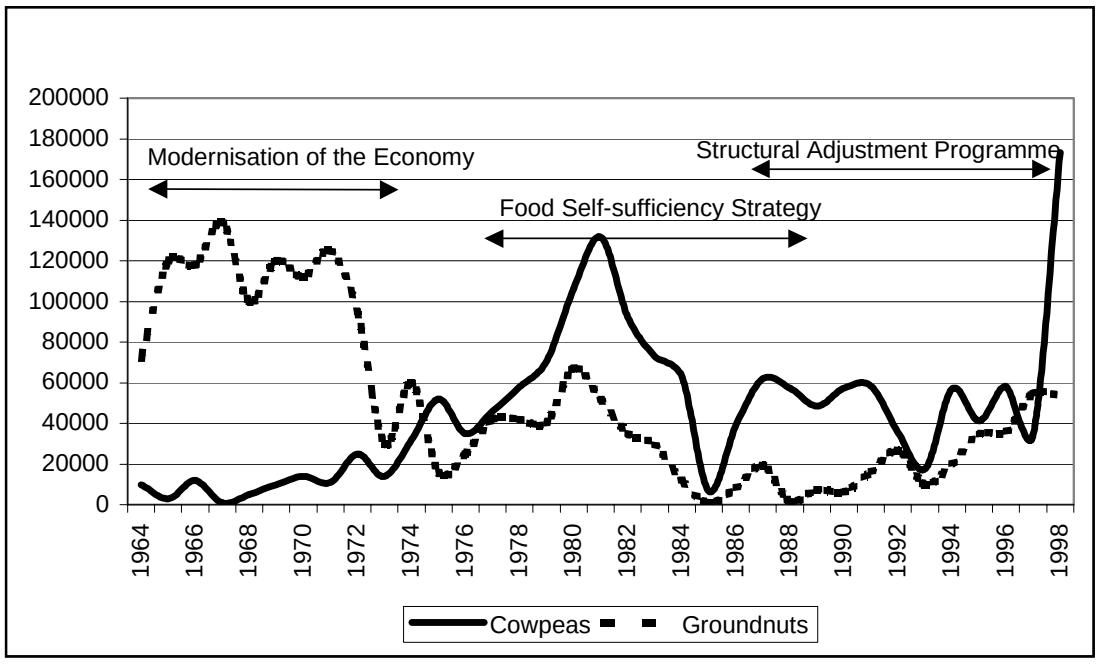
During the 1960s and early 1970s groundnuts (*Arachis hypogea*) were a key cash crop, supported by intensive government campaigns. Production was then averaging 110,000 tonnes/yr. After the Sahel Drought, the crop remained extremely vulnerable to drought and rosette disease, farmers' priorities changed, and the Government promoted food production. Groundnut production never recovered after the collapse of 1973–5, reaching its lowest levels in the 1980s (Figure 9), though recovering after 1993. The trend for groundnuts in Maradi has mirrored the national trend.

Unlike the case with cereals, there has been an upturn in yields, shown at the departmental level in Figure 5, which is particularly marked for cowpeas.

Since 1964, cowpea (*Vigna unguiculata*) has increasingly taken the place of groundnuts as the key commercial crop in farming households (Figures 8 and 9). Data collected during the preparations for the PDRM indicate that in 1970, 59% of the cultivated area was under cereals, 18% under cowpeas, and 23% under groundnuts (Niger, MER, n.d.). During the period 1994–8, the comparable figures were 65% cereals, 28% cowpeas and 4% groundnuts. (Niger, n.d) The preference for cowpeas can be attributed to persistently high prices in Nigeria, and the introduction of early maturing varieties. This

substitution continued after 1985, even though groundnut production in Maradi has begun to rise once again (Hamadou, 2000a). Growth in production has been consistently higher than for groundnuts, and in 1998 it reached record levels[5].

Figure 9: Cowpea and groundnut production, Maradi Department, 1964–98



Source: Hamadou, 2000a: Figure 6 and Table A3; Data from Ministère de l'Agriculture et l'Elevage.

Production of other crops

Tiger nut (*souchet*: *Cyperus esculentis*) has become an important crop in Maradi. It was noted as important in a limited area as long ago as 1980 (Raynaut *et al.,* 1988: 57–8). It is now produced in a much larger area of southern Maradi, to meet a demand from Nigeria, where it has gained popularity as a cheap street snack, and for making beverages. It was promoted by government extension as an alternative to groundnuts after 1975. Few data on this crop are available, but it is highly visible in the producing areas, where there has been an increase in the area planted (Moussa, 2000), mostly in the south of the department**.** Other minor crops which are produced for urban markets are sesame, cotton and *bissap* (*Hibiscus sabdariffa*). Sesame has only recently appeared in official reports. CARE (1997: Table 6) shows it concentrated in some southern villages in 1996, which may indicate it was still an experimental crop[6]. We found it as far north as Dan Kullu.

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[5] It is possible that official statistics on cowpeas underestimate production in the 1960s, since it was not then a crop receiving much government attention. Unfortunately, systematic data for areas under different crops are not available before 1979.

[6] Departmental statistics record 2-10,000 tonnes/yr in 1993-98, but with gaps in the data for some years from the producing *arrondissements* (Madarounfa, Aguié and Guidan Roumji).

Farmers have varied the mix of these crops over time in order to respond to new markets in Nigeria, price changes, and the introduction of new drought-resistant crops and other agricultural production technologies (Hamadou, 2000a). Yield declines for major crops, according to official data, are lower than the national average.

Livestock production

The livestock sector has been buoyant in the longer term, notwithstanding a high risk of loss (both from increased mortality and from depressed prices) during drought cycles. The available data do not suggest a long-term decline in livestock populations (section 2.4). During the period 1993–7, numbers of livestock units offered for sale were on an increasing trend, and cattle (more than half the total) formed an increasing share. Estimates of milk production from cows and small ruminants show a rising trend. A large proportion is marketed. Average nominal prices of cattle, sheep and goats rose strongly from a 1993 base to peak in 1995, stabilising by 1998 at levels about 50 percent higher (Banoin, 2000: 5–7). The Nigerian market actually drives the prices for livestock in Maradi, as large numbers of cattle, sheep and goats are sold there every year (see Ariyo *et al.*, 2001).

Prices of cattle are on average eight to ten times those of small ruminants (Banoin, 2000: 7), closely reflecting the body weight ratios used in calculating unit (UBT) values. So the choice of animals depends less on their market value per kg meat than on their capital, feeding and management requirements in relation to the circumstances of individual households. There is, therefore, considerable variation in ownership patterns between households, within households over time, between villages, and between *arrondissements* (the last shown in official statistics). In the four sample villages of this study breeding as a major strategy is more important in the north, and that of fattening in the south (Banoin, 2000: 15). During the 1990s the two northern villages (Dan Kullu and Sharken Hausa) had both larger numbers of animals/livestock units per household and higher productivity, as measured by an output term, than the southern villages (Jiratawa and Magami: Banoin, 2000, 16–7).

The buoyancy of the livestock sector is not difficult to explain on the demand side. Animals provide investment opportunities, growth through breeding and fattening, recurrent incomes from milk and its by-products, draft energy, manure, meat and hides. While mobile herding systems are threatened by the disappearance of natural pastures (Table 2), the strength of markets, both in the towns of Maradi Department and Nigeria, guarantees an income to any who can invest in, and maintain livestock production.

The multiple-use value of livestock (for savings, breeding, farm energy, milk, meat and manure) explains why people in Maradi see them as an indicator of wealth. The Peulh (Fulani) tend to have larger holdings, especially of cattle, but the value of livestock is appreciating amongst the Hausa too since they are increasingly integrated with the cultivation of crops. This is particularly so in the southern areas where manure is highly valued, animal traction is widespread, and crop residues are most important in livestock feeding (Bouzou, 2000; CARE, 1997). However, cattle in particular are unequally distributed, ranging from 6 per household among the better-off to zero in poorer households (CARE, 1997). Sheep range from 1–2 in better-off households to zero in the poorer ones. A majority of goats, unlike sheep and cattle, belong to women. These are the animals most often sold.

Livestock owners in Maradi Department (south of the Tarka Valley) are predominantly farmers. It is therefore not surprising that integrated production systems increasingly drive the parameters of livestock keeping. For example, small ruminants are more compatible with the small investment resources of poor households and of women; fattening can be combined with saving and realising a regular income (at festivals); improved management of crop residues as fodder and of manure recognises their growing value, indeed they have become marketable; and the greater grazing efficiency and flexibility of small ruminants (and their lower capital costs) encourages a shift away from cattle in some areas. Small ruminants produce more milk than cows in the department (Banoin, 2000: 6).

These trends are notwithstanding the risk of high mortality and the necessity of increased sales during drought cycles, when not only livestock numbers, but also beneficial aspects of crop-livestock integration, may be severely reduced. According to the official statistics, for example, the number of cattle fell from 510,000 to 360,000 between 1972 and 1973 (Grégoire and Raynaut, 1980). Although a 75 percent recovery in cattle holdings had been achieved by 1978, recovery is quicker with small ruminants.

4.2 Food, incomes and poverty

Food sufficiency

Taken as a whole, the farmers of Maradi Department have maintained average food grain output (per capita, including the urban population) over the longer term (Figure 10), at a level well above the commonly used requirement of 200 kg/person after threshing and storage losses. The value of 260 kg/person in 1996 is confirmed by survey data from 466 households in that year, which yielded an average of 267.5 kg/person (CARE, 1997: Table 8.4). This achievement, which of course could not apply in every year or every locality (on account of rainfall variability), challenges the perception of a worsening crisis in food production. Moreover, the rate of population growth, according to census data, was more than 3 percent/yr between 1977 and 1988 (though possibly exaggerated by under-counting in 1977).

However four qualifications are in order. First, average achievements disguise marked fluctuations from year to year, especially in the great drought cycles of the early 1970s and 1980s. During these cycles, increased distress resulted from failure to produce food on an adequate scale. Second, in so far as this achievement has been bought at the price of exhausting the supply of unused land for farming, a question arises as to its future trajectory (this question will be discussed in section 4.3).

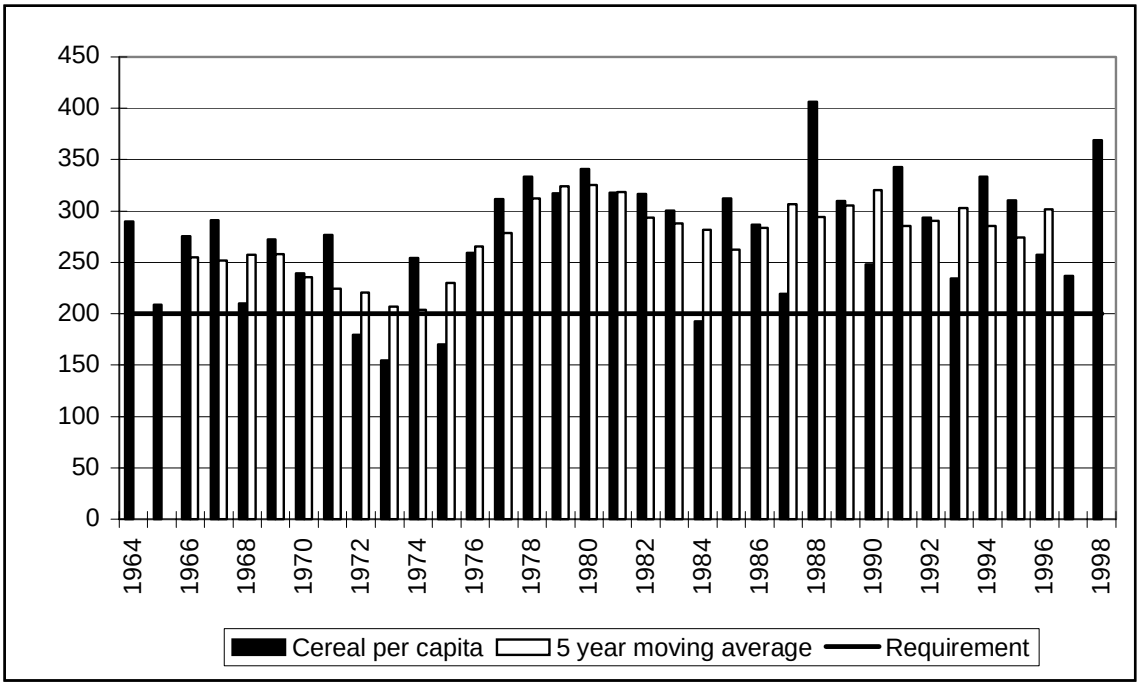
Third, as always, average performance hides differentiation amongst households. It is very common for rural Hausa people to divide themselves into three categories: (1) those able to cope (17 percent), (2) those in the middle (27 percent), and (3) those who are most vulnerable to risk (56 percent). In 1996, the CARE survey employed this classification in Maradi.[7] Those in category (3), the most vulnerable, did not produce

[7] In Hausa these categories are *(1) masu hali; (2) kadarin kadahan; (3) mai rashi.* CARE used *(1) moyennement vulnérable, (2) vulnérable and (3) très vulnérable.* This is a little confusing and in regard to (1), does not convey the sense of coping, present in the Hausa. However, even the 'copers' in Maradi are poor by global standards.

sufficient millet for their needs (Figure 11). They are often obliged to sell animals and animal products to buy cereals. Data from the survey (CARE, 1997: 156) show that 27 percent of young children suffer from severe malnutrition problems and that 33 percent of boys and 29 percent of girls have some under-nutrition. Malnutrition is present even in category (1) but is lowest there.

Fourth, millet provides only energy and a minimum of nutrients. Others still need to be found.

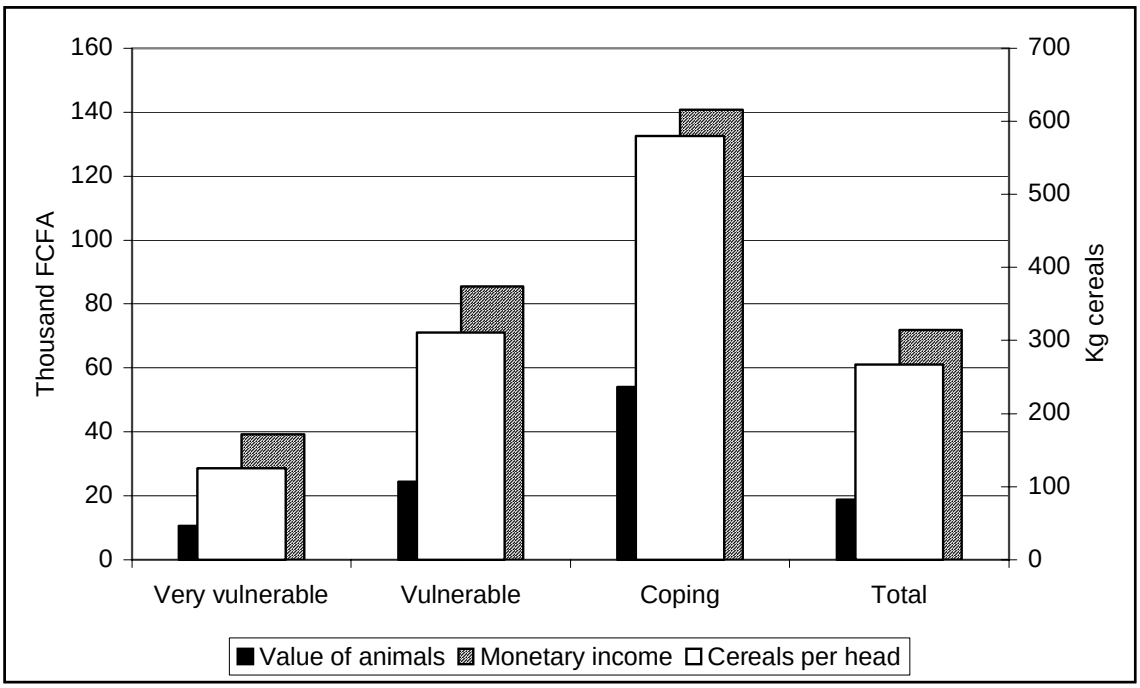
Figure 10: Cereal production (kg/yr *per capita*), 1964–98



Sources: Hamadou, 2000a (production data from Ministère de l'Agriculture et l'Elevage); Tiffen, 2001 (population projection based on rates of annual growth between official estimate of 1960 and censuses of 1977 and 1988).

Nevertheless, this response in a region of poor soils, low and unreliable rainfall calls for a review of certain ideas about poverty – that it is inevitable in a marginal environment, that it is necessarily worsening, and that populations of poor farmers cannot respond to demographically-driven changes in demand (including subsistence demand) by producing more. Production has increased in line with population, but the capacity of the poorest to buy what is produced remains a severe problem. It is not known how much food insufficiency, which affected more than half the population in 1996 (year of moderate drought: Figure 2), varies from year to year, nor what is its long-term trend. Nor is it known to what extent food insufficiency results from producing higher value crops for the market.

Figure 11: Value of animals owned, cereal production (kg), and monetary income by socio-economic category, per capita



Source: CARE, 1997, Table 8.4.

Agricultural incomes

Farmers *respond quite quickly to relative price changes*, and to exchange rate fluctuations with Nigeria, by varying the crops offered to the markets for sale. They also respond to government policies that impact directly upon prices, including those concerning tariffs, taxes, subsidies and import/export controls (Hamadou, 2000a). Cereals, cowpeas, and tiger nut have now become the key trading crops, in place of a former dependence on groundnuts.

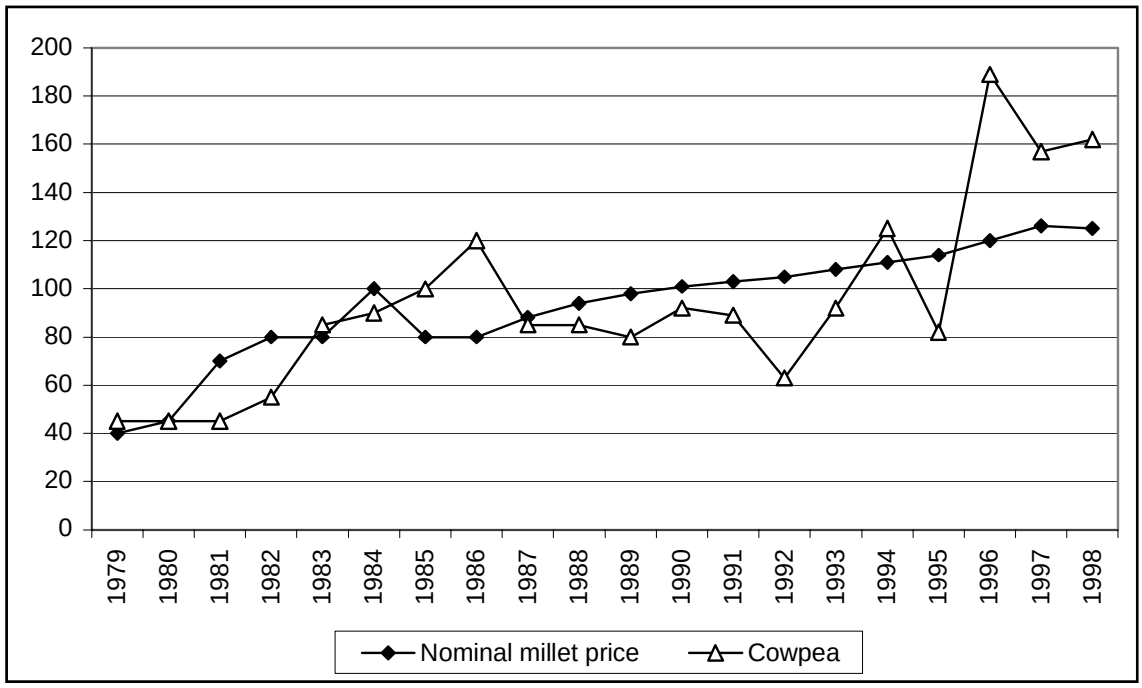
Figure 12 shows nominal prices for millet and cowpeas. In January, 1994 the FCFA was devalued by 50 percent. This does not appear to have affected millet prices very much, as it is mainly traded internally. It had a greater effect on cowpeas, which are exported to Nigeria. The rise in price may have affected production, which increased substantially in 1998 (Figure 9), but annual fluctuations in production due to rainfall or pests make it impossible to be sure. Hamadou (2000a) calculated real prices for millet, which were quite stable from 1985 to 1995[8].

Statistical data are not available to relate price and production trends for groundnuts and cowpeas over time to demonstrate that the switch from groundnuts to cowpeas was related to price factors. Diversification out of groundnuts was under way in the 1980s (Raynaut *et al.*, 1988).The rapid replacement of a state-supported crop, with official marketing outlets, by other crops in demand, both locally and in Nigeria, shows the

[8] Unfortunately, owing to changes in the deflator in the 1990s, it is difficult to track real prices in this decade (see Hamadou, 2000a: Figure 9, Annexe 2).

vigour of the local trading sector (see Ariyo *et al.*, 2001), and it is fair to assume price responsiveness.

Figure 12: Nominal prices for millet and cowpeas, 1983–98 (FCFA/kg)



Source: Hamadou, 2000a, using an FAO series for 1983–9 and prices from 10 Maradi markets 1990–8.

Market responsiveness is also shown by women's investments in small ruminants as income-generating enterprises. The speed of market response always depends upon farmers' short term capacity to do so, and their capacity to take on new and possibly risky ventures depends on rainfall and other factors such as access to new inputs. There has been a growth in the number of markets 1960–2000, and therefore in their density (Hamadou, 2000a). As already noted, the location of crop, input and consumer goods markets is related to roads.

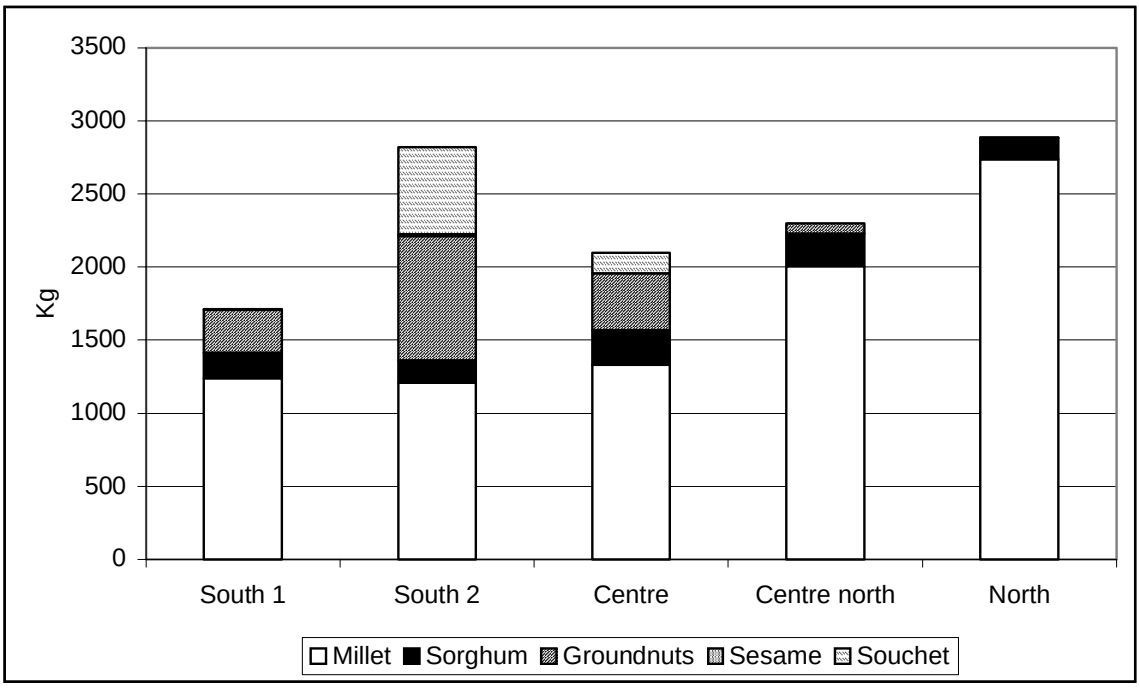
CARE (1997) reported that most households sell cereals. Sales of groundnut, cowpea, tiger nut, sesame and cotton are common. A significant proportion of these crop incomes are used to purchase cereals or to invest in animal herds, especially goats and sheep (Hamadou, 2000a). Thus farmers' market behaviour is flexible and opportunistic, and there are now wider opportunities, and higher levels of monetisation; though those with least resources have the fewest opportunities.

The particular mix of activities and sales adopted by a farmer depends on agro-ecology as well as on technical and economic factors and, in certain privileged locations in the south, on the availability of *fadama*[9] or irrigable land. The main rainfed crops are shown by agro-ecological zone in Figure 13, which shows how the range of cropping

[9] Low-lying ground retaining moisture in the dry season.

options becomes more restricted in the north. Output (in kg) differs from value (Figure 14). The farmers in the South 2 zone, for example, are better able to grow tiger nut which has a higher market value than millet. Hence, although they produce less tonnage than the northern villages, they derive a higher monetary income from their crops sales. They are also well situated in relation to the Nigerian market. However, farmers in the north have the advantage of larger than average farms (Figure 13)[10].

Figure 13: Average crop output per household by agro-ecological zone, 1996 (kg)



Source: CARE, 1997, Table 6.1 for crops and Table 5.2 for cultivable land held.
Agro-ecological zones are arranged from south (left) to north (right)

Livestock are entering increasingly into monetary circulation among farmers. Raynaut *et al.* (1988) observed this change as far back as 1972, in reporting a perception that the livestock market had been dominated previously by pastoralists. In some villages, livestock are said to come second after crops as a source of income (Moussa, 2000). CARE (1997) agreed that livestock were the second source of income, which could be seen by the capital value of the livestock and the importance of commercial transactions Livestock revenues varied from 27% to 43% in the different ecological zones, being highest in South 1[11] (CARE, 1997: 87). Although they reported more families sold livestock products than animals themselves in 1996 they do not give clear figures on

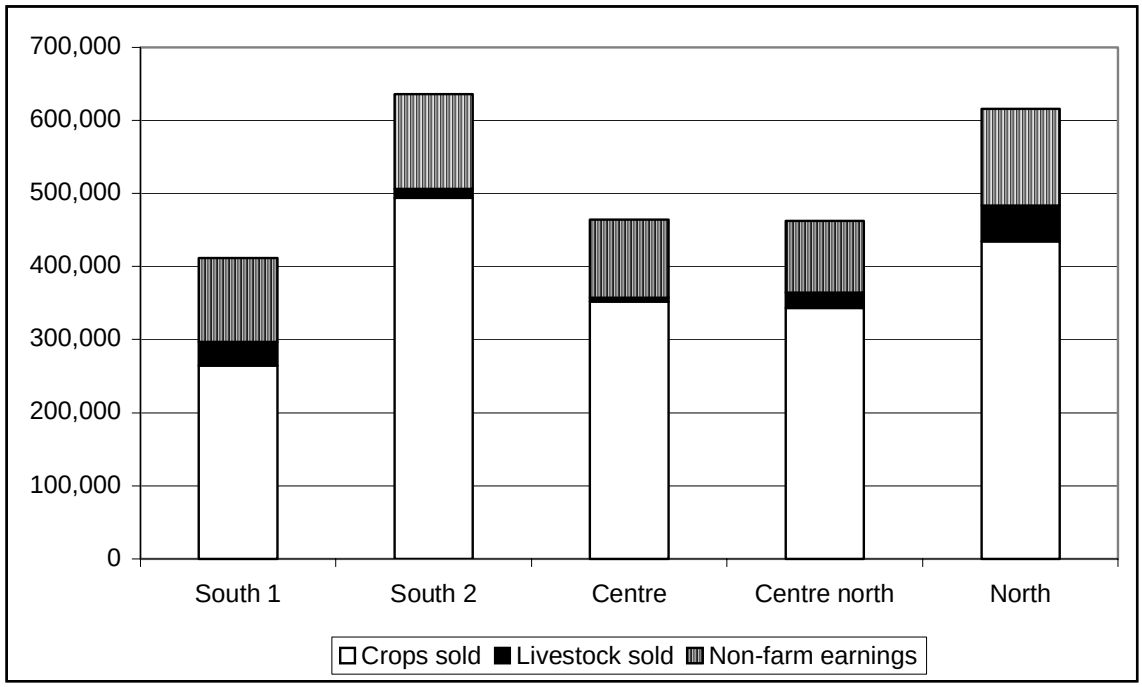
[10] CARE's agro-ecological zones took in both rainfall and soils. Both South 1 and South 2 had rainfall around 600 mm, but South 1 had sandy dune soils with hydromorphic soils in the valleys, while South 2 had more compact soils which had begun to be exploited more recently (CARE 1997, Table 2.2), still leaving open areas of pasture. Unfortunately, the zones do not coincide with the *arrondissements* for which we have statistical data.

[11] Their sample villages in South 1 included a Fulani encampment where households had very high livestock ownership, which affected averages in this area.

these receipts. Figure 14 therefore gives only average cash income from animals sold. This was highest in the north, followed by South , as shown in Figure 14[12]. Animal sales averaged 80,000 FCFA in the coping households, compared with 10–11,000 in the other two groups. They averaged FCFA 60,000 amongst Fulani, FCFA 40,000 for the Tuareg, and FCFA 17, 000 for the Hausa majority.

Figure 11 does not represent the full value of crops and livestock to households, as it reflects only monetary income, and does not include products consumed.

Figure 14: Average cash incomes per household by agro-ecological zone, 1996 (FCFA)



Source: CARE, 1997, derived from Tables 7.2a (average crop sales for 460 families, 7.2b (average non-farm income for 421 families and Table 6.5 (average animal sales).

Income diversification

Our enquires in the four selected villages in 1999–2000 showed that people are involved in a wider range of income-generating activities now than they were in the past. They include small-scale trading, especially with Nigerian markets; and such skilled activities as pot making and butchery. New non-farm activities are coming in, such as the sale of water and of bricks, the repair of motor cycles, radios and bicycles. Older people continue with such activities as mat-making, or tailoring; women with hair-dressing and food processing and sale, younger men are more likely to migrate seasonally in search of work (Doka, 2001). Like Rain (1998) this study finds that the activities undertaken are mostly informal, poorly remunerated ones that do not require

[12] CARE data was often presented as averages per household taking part in an activity, rather than average for the whole sample of 466 households. This presented difficulties when trying to extract differences between agro-ecological zones, as attempted in Figure 15.

formal education. Nevertheless, participation in range of off-farm activities is an important source of monetary income in all four study villages. In the CARE sample 80–90% of households reported non-farm activities. It is not constrained by distance from markets; in Dan Kullu, the northernmost and most remote of our villages, commerce comes second after crop sales, and ahead of livestock (Moussa, 2000). Figure 14 shows that average household non-farm earnings do not vary much between agro-ecological regions.

Women are increasingly implicated in generating monetary incomes, for example, by selling their labour to other farmers, small-scale trading, and the sale of processed food. Many feed themselves and their children during the eight-month nonagricultural season (when many husbands are absent). In recent times, women's income has become more important in maintaining household viability. In the stricter Islamic households where wives do not have free access outside family compounds children often act as couriers between their mothers and the market (Doka, 2001).

Many income generating activities of women (e.g. animal fattening) are financed through traditional savings systems (*biki, adashi*) or agricultural activities. Up to now the main benefit of these activities has not been capital accumulation, but the maintenance of social status through the financing of marriages, baptisms, etc. In the long-term these activities provide a sound economic basis for women to build upon. A shortage of large blocks of capital is a key constraint to women's investment (Doka, 2001).

Over the past 30 years, the causes of migration have moved from social to economic ones. Many families now rely upon migration income. The migrant is often a younger man, who supports himself while away, and the family receipts are what he can spare. Daily earnings amongst 133 dry-season migrants in Maradi in 1995 ranged from about 500 to 1,500 FCFA. They generally returned to their villages in the wet season (Rain, 1998: 274). Migration is increasingly international, mainly to neighbouring countries, including long-term migration to Libya. Migration has become widespread throughout the district; during the 1960s it was more common in northern parts. In Magami (near the Nigerian border), short absences of a week or so are common in the rainy season, in order to support household consumption through labour earnings (Doka, 2001). CARE (1997) notes that men go from the central region to the tiger nut-producing areas during harvest, for the same purpose, particularly if they have had a poor millet crop.

Large extended families with big labour forces have greater flexibility in the distribution of labour. Yet there is a trend to smaller families. This may seem strange, but the answer lies partly in the greater importance of non-farm monetary income to the poor. As this type of income is generally controlled by the individual rather than the family head, it provides an incentive for young men to separate from a head who cannot provide their monetary needs.

More people reported their participation in local activities to CARE (1997) than incomes from external activities, or from remittances sent by relatives. Around 20% of families (30% in the poorest group) reported earnings from activities away from home and 20% reported some remittance income (CARE, 1997, deduced from Table 7). The most frequently reported strategies for dealing with a food shortage were the sale of farm labour, petty commerce, and sale of livestock (CARE, 1997: Table 9.10).

4.3 Technology and investment

Farming technology has faced a triple challenge during the past 40 years: first to adapt to reduced rainfall and increased drought; second to change practices in response to new markets and third, in the south from inheriting smaller farms. Notwithstanding much poverty, investment is far from negligible in Maradi Department.

Adapting to reduced rainfall and increased drought

In adapting to reduced rainfall, adjustments have been made in the use of the crop genetic resources (Table 3; Amoukou, 2000).

Table 3: Changes in the numbers of cultivated varieties during the past 30–40 years

	Jiratawa	Magami	Sharken Hausa	Dan Kullu
Millet:				
disappeared	7	4	4	5
diminished	1	0	2	1
increased	3	7	0	2
Sorghum:				
disappeared	7	3	2	-
diminished	1	1	1	3
Increased	5	8	1	6
Cowpea:				
Disappeared	3	1	2	3
Diminished	2	2	1	2
Increased	4	5	3	4
Groundout:				
Disappeared	4	2	4	2
Diminished	-	-	-	1
Increased	2	3	1	2
*Others, rainfed**:				
Disappeared	-	3	-	-
Diminished	1	-	-	1
Increased	2	13	4	3
Others (irrigated/valley) **:				
Disappeared	4	1		
Diminished	2	-		
Increased	20	4		

Source: Amoukou, 2000.

* maize, cassava, tiger nut, sesame, hibiscus, bambara nut (*Voandzeia subterranea*)

** wheat, tomato, pepper, vegetables

Among the major rainfed crops, while many long-cycle millets, sorghums, cowpeas and groundnuts have gone out of use during the past 30 years, a significant number of better adapted varieties have increased in popularity with farmers. They are derived from the local gene banks, research stations, and imported from adjacent territories. Meanwhile,

minor crops ('others') which have growing market niches are highly dynamic in terms of the numbers of increasing varieties. The four villages in Table 3 are arranged from left to right in decreasing order of moisture availability. It is not surprising, therefore, that Jiratawa has developed its biodiversity resources effectively in irrigated/valley crops (20 increasers) and that Magami, which has very little wetland, has done better in rainfed ones (12 increasers). What is counter-intuitive is the finding that several minor rainfed crops (varieties of tiger nut, sesame, Hibiscus or *oseille* and Bambara nut) are increasing in popularity in Dan Kullu, the most drought-prone of all the villages studied. This ability to respond to market signals, even on the frontier of farming and under high risk, with the drought adjustments already mentioned, indicates that cultivated biodiversity is a managed artifact, not merely a residual element in a process of degradation.

Farmers use crop mixtures and rotations, and over 80 percent of them explain these practices in terms of maintaining soil fertility, or maximising output in the face of a shortage of land. Mixtures make best use of available moisture and nutrients, and spread the risk of low harvests across two crops.

Changing practices in response to new markets

The new market niches have called for adaptations in agronomic and land use practices. For example, tiger nut is planted in sole stands at high densities and in rows, using horse- or donkey-drawn seeders adapted from groundnut models which were originally promoted during the groundnut boom. As it rapidly exhausts the soil, the crop has to be rotated with other crops or with fallows.

Animal traction was promoted by the extension services and the PDRM, and during the past ten years, the frequency of animal-drawn ploughs and carts has increased to become widespread across the department, but especially in or near the areas where the PDRM was active. Households continue trying to acquire them. The rate of ownership of these items is higher in Maradi Department than in other parts of Niger (Moussa, 2000). The use of ploughs and seeders has made it possible for farmers to extend their operations to additional land, or to break fallows earlier, a change which perhaps owes as much to an increased risk of low yields as to an opportunity to profit from markets. Carts (of a type originally developed and promoted by the extension service) are common and are used both for on-farm activity (such as manure distribution) and marketing.

The market, as well as the needs of subsistence, is now driving the choice of crops, methods of cultivation, expenditure on inputs, and farm investments.

Non-farm and farm investments

Rural households in Maradi Department are used to making productive investments in livestock and new crop production technologies. Current priorities for household investment still include investments in livestock and, increasingly, land (Hamadou, 2000a). Investments are now more diversified than before. Many people invest in land. Women's focus is on livestock, while men's is on agricultural production, especially for the market. Many young men invest in migratory strategies (Doka, 2001). With income

diversification, and devaluation, investment in prestige items has increased (Hamadou, 2000b).

Much investment goes into domestic structures. The methods of house building are starting to change, from circular mud huts with thatched roofs to rectangular mud *soro* houses (where a source of clay exists). Cement and metal sheets are being used for roofs (Doka, 2001). These changes involve greatly increased costs, and as improved houses are first constructed by the well-to-do, their appearance in any number provides an indicator of increasing wealth in the community.

If farm investment is restricted in meaning to major fixed cost items obtained through markets or on credit, such as ploughs or other new technologies, it should not surprise us that the capacity of poor rural households to invest has been rather limited. Le Gal found an association between holdings of more than 10 ha and the use of animal traction, modern inputs (fertiliser, improved seeds and chemical treatments), and hired labour (Grégoire and Raynaut, 1980: 144–7). However, some farms of two hectares or less used modern inputs, and some without animal traction nevertheless hired labour. This absence of a clear distinction between 'modernising' and other farms points to the presence of a perception that investment is essential, notwithstanding the constraints under which small and poor farmers work.

A view of farm investment which is confined to 'lumpy' technological innovations, often financed by credit, is inappropriate for understanding capital management by poor farmers, men or women. In livestock keeping, the growing importance of goats relative to large animals shows poor peoples' need to invest incrementally in small units, with an assured output market. In the same way, much of the expenditure in crop production takes the form of one-off labour hiring, small quantities of inorganic fertiliser, hand tool repairs and replacements at the local blacksmith's workshop, or other transactions. These are not usually picked up in surveys.

An alternative view of investment should also take into account the productive or conservationary land improvements created by labour, as well as those created by finance, such as the control of natural regeneration, the planting of field boundaries, the building of storage structures, and soil improvement. The clearance of natural woodland for farming, especially when it results in the creation of permanent, manured, fields, represents a substantial investment. The conversion of a natural landscape into farmland and villages, therefore, created as it is by labour spent over (perhaps) several generations, is a process of adding value. It is misleading to represent it as a form of degradation[13]. The statistics of land use change presented in Table 2 are the measure of this process in Maradi. Between 1972–73 and 1994–5 an additional 1,400,000 hectares were cleared (Hamadou, 2000b, Table 11).

Farm investments occur on the frontier of technological change and adaptation. In changes in agronomic practices, a division may be made between those that require significant monetary funds and those that do not (Table 4: Amoukou, 2000).

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[13] In an ecologically comparable area of Nigeria, an experimental study found that total production of plant biomass on farmland equals or exceeds that produced by natural vegetation according to a model based on rainfall (Mortimore *et al.,* 1999).

Table 4: Trends in the use of certain agronomic practices from more than 30 years ago to the present

Practice	Jiratawa	Magami	Sharken Hausa	Dan Kullu
Requiring few funds:				
Bush clearing	=	=	=	=
Tillage, hand	-	=	=	=
Dry sowing	-	=	=	+
Sow after rain	=	=	=	=
No. weedings*	=	=	=	+
Hand weeding	=	=	=	=
Requiring funds:				
Tillage, plough	+	+	none	+ (one)
Treating seeds	+	+	+	+
Sow by seeder	+	+	none	+
Improved seeds	+	=	+	+
Weeder/ridger	+	+	none	none

Source: Amoukou, 2000.
= no change - decrease + increase
* Normally two, increasing to 3 in villages shown +

From these data it may be seen that the trend to capitalisation (requiring funds) has been strongest in the southern, wetter and more market-accessible villages, but that in the most risky village (Dan Kullu) some farmers have both capitalised and intensified using additional labour (more dry sowing and weeding).

Table 5 shows that in acquiring major farm equipment, credit played a minor (even insignificant) role alongside private finance. Amoukou (2000) reports that the majority of major farm investments were made during the last 10 years. Hamadou (2000a) found investments increased after the devaluation of the FCFA in 1994, which had resulted in a rise in farm prices (Table 6). Credit was then less available, though some was provided by CARE. The sources of this private finance were agricultural incomes (Table 6: Amoukou, 2000), though the possibility that off-farm incomes also contributed is not excluded by the data.

Table 5: Mode of acquisition of major farm investments during the past 20 years, four villages

Investment	Credit	Purchase	Lease
Plough	3	17	1
Seeder	0	7	1
Cart	3	15	0
Weeder/ridger	0	4	0
Oxen	3	16	3
Total	9 (12%)	59 (81%)	5 (7%)

Source: Amoukou, 2000.

Table 6: Year of acquisition of new capital equipment

	Plough oxen	Ox cart	Heavy plough	Light plough	Bicycle*	Motor cycle**
To 1994	1	8	10	4	2	0
1995 onwards	18	9	2	34	6	4

Source: Hamadou, 2000a.
*1 in Dan Kullu (remainder in Jiratawa) ** All in Jiratawa

Table 7: Rankings of investment sources for agriculture, from 30 years ago to the present

	Jiratawa	Magami	Sharken Hausa	Dan Kullu
30 years ago	crop sales	crop sales	large rum.	large rum.
	large rum.	large rum.	small rum.	crop sales
	small rum.	small rum.	Trade	small rum.
	fattening	trade	fattening	fattening
	trade	fattening	crop sales	trade
20 years ago	crop sales	crop sales	large rum.	crop sales
	large rum.	large rum	small rum.	large rum.
	small rum.	trade	Trade	trade
	fattening	small rum.	fattening	small rum.
	trade	fattening	crop sales	fattening
Last 10 years	crop sales	large rum	large rum.	trade
	large rum.	crop sales	small rum.	fattening
	small rum.	small rum.	Trade	crop sales
	fattening	trade	crop sales	large rum.
	trade	fattening	fattening	small rum.
Selling cereals	0/10	2/10	5/10	5/10

Source: Amoukou, 2000.
rum. = ruminants

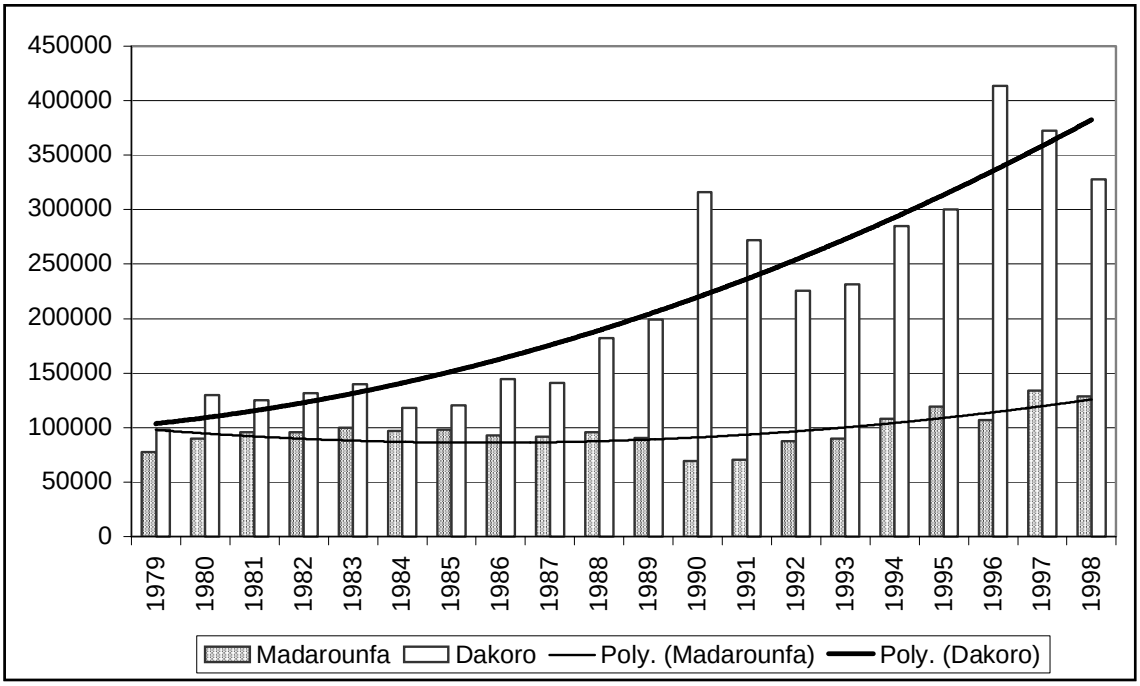
The profiles of private investment financing varied significantly among villages. Farmers in Jiratawa, with irrigation, ranked their sources in the same order for the past 30 years, with crop sales at the top. Farmers in Magami, mainly rainfed, though starting similarly, shifted animal sales and trade to higher rankings during the past ten years. Farmers in Sharken Hausa, less market-accessible, drier and rainfed, ranked animal sales first and scarcely changed the rankings of their other options. But those in Dan Kullu, the driest and least accessible, switched from animal sales to crops and then to trade as their first, raised animal fattening from fourth to second ranking, and depressed crop sales. Nevertheless, the proportion of farmers selling cereal grain (mostly millet) at the present time increases northwards. These rankings conform accurately to what we know of the constraints and opportunities facing these differentiated communities. In all four, mineral fertilisers were the most important purchased input, hired labour the second, and new or treated seed the third. These rankings did not change during the 30-year period.

Although these findings result from a very small sample, they dispel the myths that no farmers can finance investment and that they do not know how best to manage their investments in a dry, high-risk environment. Not every farmer, of course, has investment capacity, and that of the most successful is still less than they would wish. Investing farmers are better off, but by no means wealthy, and they include women.

Impact of changes on land productivity

From the point of view of both land productivity and soil fertility (next section) the department is split into two: in the south and central zone a process of intensification is being undertaken by farmers as land becomes more scarce, while in the northern parts extensive agriculture still exists, although some intensification is beginning to occur (Moussa, 2000). The differences can only be shown after statistics at the *arrondissement* level are available, from 1979.

Figure 15: Areas planted to millet in Madarounfa and Dakoro Arrondissements, 1979–98

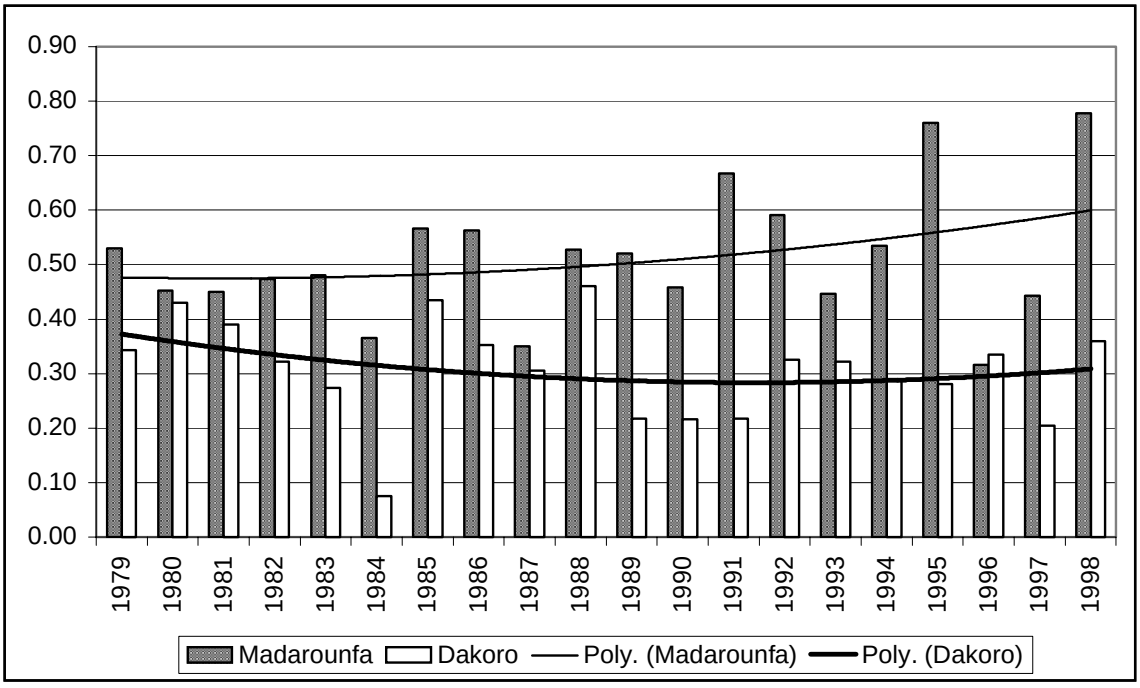


Source: Departmental data collected by Hamadou, 1999.

Figure 15 shows that in the southern, long-settled and relatively densely-populated *arrondissement* of Madarounfa, areas sown to millet increased slowly between 1979 and 1999. In these southern areas, as elsewhere in the Sahel (Boulier and Jouve, 1988; Raynaut *et al.,* 1997), low-lying soils have been brought from neglect into intensive use, sometimes under irrigation. The dry valleys of Maradi Department (in particular, Goulbin Kaba), which supported much woodland fifty years ago, are now entirely under cultivation for a great variety of crops (Mahamane, 2001). The Goulbin Maradi, whose river flows seasonally, has seen a rapid expansion of intensively cultivated and enclosed farms, benefiting from proximity to markets and roads (Moussa, 2000). By contrast, in

northern areas like Dakoro, cultivation expanded very rapidly after 1987, as farmers developed abundant areas of previously uncultivated sandy soils.

Figure 16: Millet yields/ha in Madarounfa and Dakoro Arrondissements, 1979–98



Source: Departmental data collected by Hamadou, 1999.

Farmers in the south have had to increase output from smaller farms, using new and more intensive farming practices (Moussa, 2000). A measure of the farmers' achievements is provided in Figure 16**,** where millet yields per hectare are shown from 1979 to 1999. It is to be expected that yields would be lower in Dakoro, which is likely to receive less rainfall. The interest lies in the trends: a slow improvement in Madarounfa, amounting to 20 percent over the last ten years, compared with stagnation in Dakoro.

4.4 Natural resource management

The achievement of 'saturation' in land use reflects an increase, both in the demand for land and its products, and in the ratio of resident family labour to land (that is, unless labour is withdrawn from the natural resource base and directed into off-farm income generation). The labour may therefore be available for a transition to conservationary management of natural resources. There are four aspects of such a transition: nutrient management; tree management on farms; livestock feeding and integration; and institutions of resource access.

Nutrient management

There is both an expert and a farmer consensus that soil fertility under continued cultivation tends to fall, and this conforms with theoretical expectations, which are

based on nutrient budgeting models showing a deficit of critical plant nutrients after their removal in crops. The special situation of semi-arid soils, in a scenario which has been projected to almost all of Africa (Henao and Baanante, 1999) is that natural processes of fertility reconstitution may take a long time under low and sharply seasonal rainfall, and start from a very low base. Thus the fertility of fallows and rangelands may also be low. The difficulty of maintaining, or improving, fertility has led some researchers to propose inorganic fertiliser applications as the only practicable solution, where possible in combination with organic methods (Breman and Sissoko, 2000).

Government intervention between 1976 and 1984 included a high level of support for fertiliser use, through subsidy and the supply of input credit. The PDRM was a major fertiliser supplier (Hamadou, 2000b). Gains made under the PDRM have, however, been largely lost as subsidies have been removed. For the past 10 years, there has been a greater use of both manure and mineral fertilisers than before; most households now apply manure to their fields (Moussa, 2000). Crop residues are used for mulching crops and for compost making (though these have to compete with other uses, such as fencing, fuel, forage and sale).

But such improved practices are dependent on farmers' capital resources, as inorganic fertilisers and sometimes even manure and composting materials have to be purchased. The important finding of this study is that the *technologies are known and practised* under current conditions; so their further extension depends on the relaxation of supply and price constraints. It is not expected that price liberalisation will reduce the cost of inorganic fertilisers to farmers in the near future, especially in remote areas. Therefore understanding the evolution and realising the potential of organic nutrient management should be a developmental priority.

Table 8: Techniques for managing soil fertility in three *terroirs* in Maradi Department

Technique	Years of adoption	Percentage of farmers using in 1999		
		Jiratawa	Magami	S. Hausa
Cutting clearing, burning	35–>60	90	0	90
Fallowing	>50	0	0	0
Manuring	>30	98	95	96
Livestock 'parking'	>15	0	20	40
Crop residues	>20	30	40	20
Défrichage amelioré	>10	97	93	97
Composting	>30*	10	0	0
Mineral fertilisers	>15	45	40	30

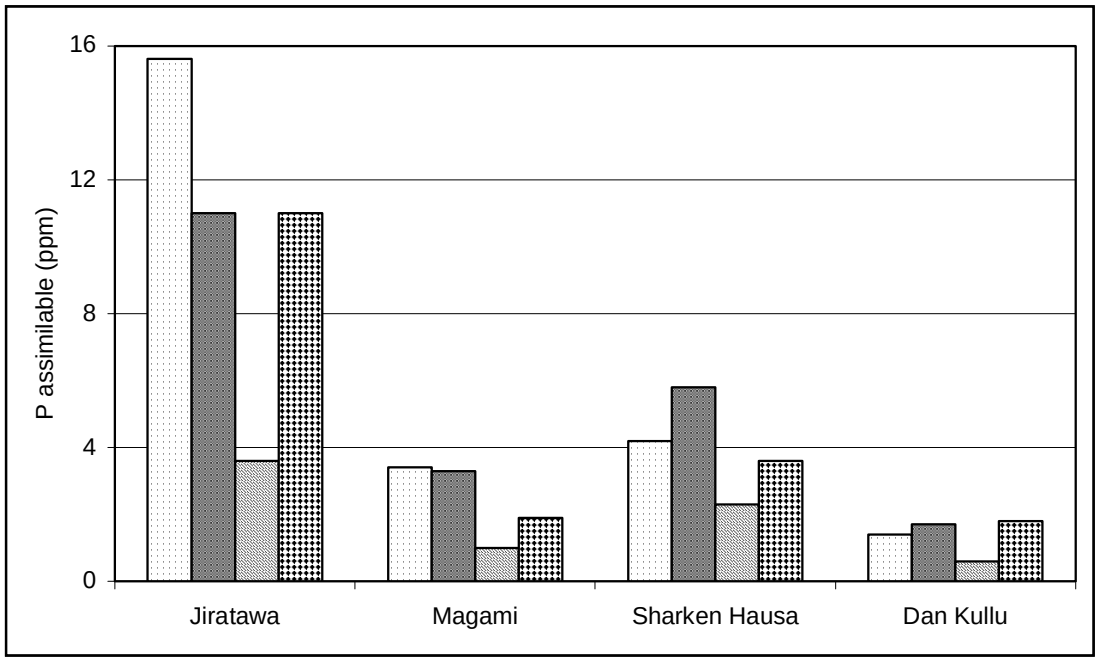
Source: Issaka, 2001: Tables 5,6,7 and 8.
* One *terroir* only

However, even in the south, manuring annually cultivated fields was only possible close to the village, producing the well-known *aureole* effect (e.g., Grégoire, 1980). A lack of manure, or of transport, prevented outlying (*daji*) fields from benefiting. On these fields, plant nutrients are low, and they decline under cultivation without fertilisation; but on

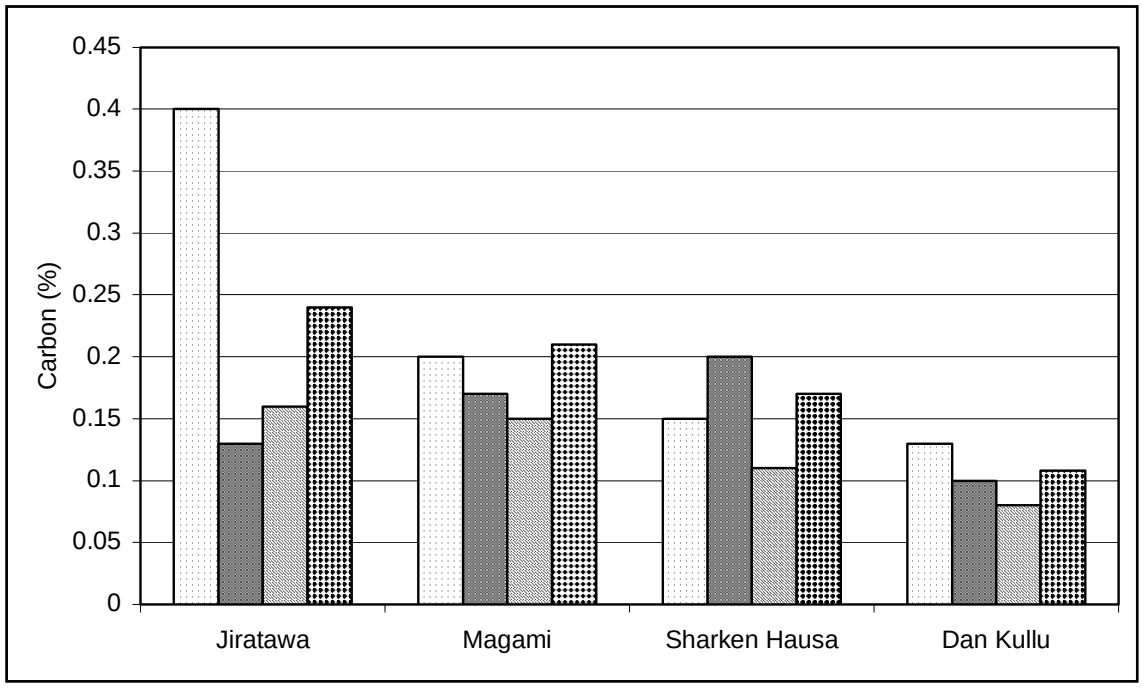
the inner or *karkara* fields, the nutrient balances can be sustained under existing technologies, as listed in Table 5 (Issaka, 2001).

Figure 17a–d: Soil nutrient status under varying management, four *terroirs*, Maradi, 1999

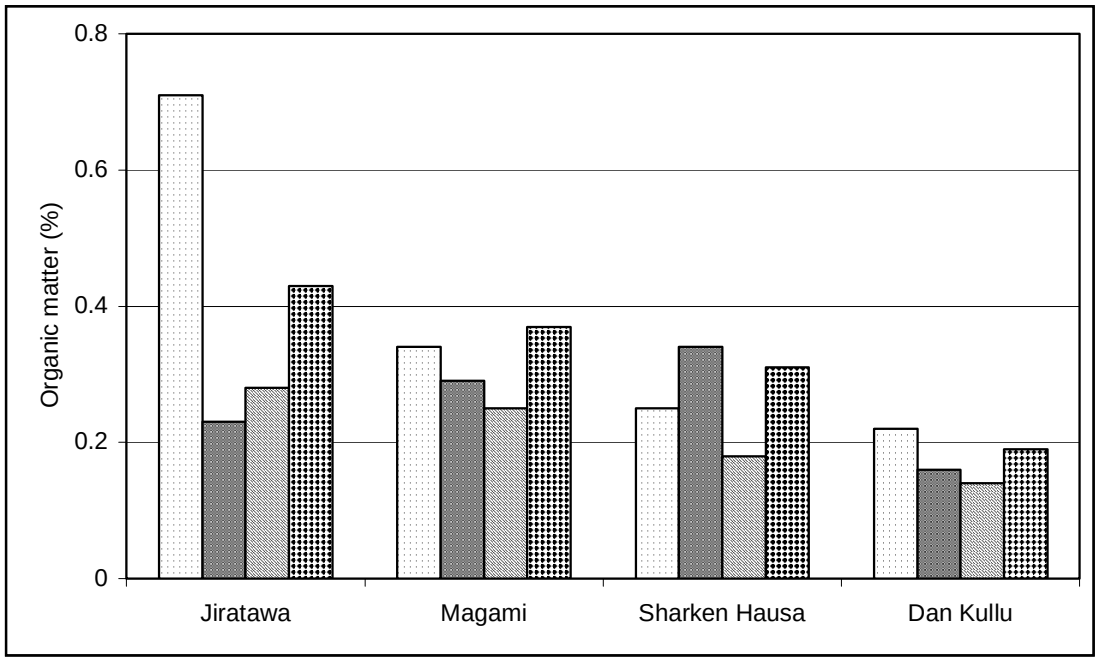
a. Phosphorus



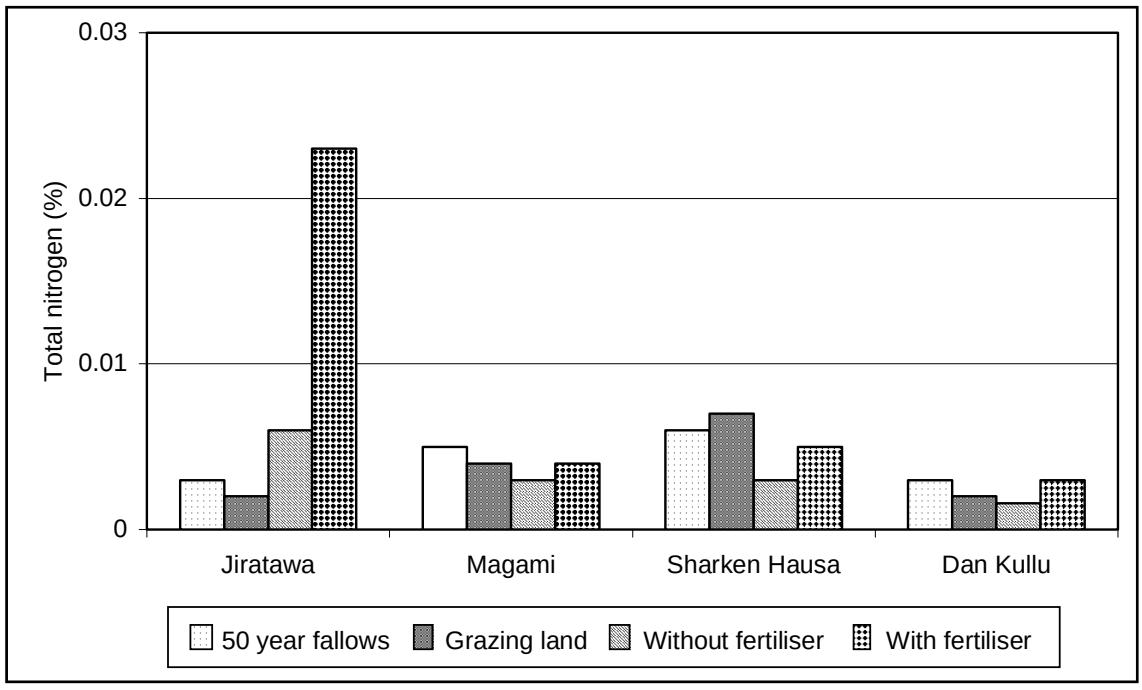
b. Carbon



c. Organic matter



d. Nitrogen



Source: Issaka, 2001, Figures 7, 8, 9 and 10.

The techniques used by farmers for fertility management vary in popularity from village to village and reflect specific circumstances (Figure 17 a–d). On 90 sampled topsoils in the four *terroirs,* which had been managed under one of four major regimes (1, fallow >50 years; 2, pasture; 3, cultivated without fertilisation; and 4, cultivated with organic or mineral fertilisers), there is an expected decline in nutrient status from long fallow (> 50 years uncultivated) through grazing land, to cultivation without fertilisation (as on

most *daji* fields). But there is a sharp improvement in nutrient status under cultivation with fertilisation (*karkara* fields). This increase, in some samples, brought nitrogen, phosphorus and potassium up to the levels of uncultivated land.

This finding provides evidence that farmers know how to manage fertility sustainably, and answers in part the question, 'have the productive achievements of Maradi farmers been achieved by mining soil nutrients, or by sustainable recycling?' (Harris, 2000; Issaka, 2001).

Their constraint is an inability to fertilise a larger proportion of their land, owing to supply, labour or transport factors. The supply of manure is constrained by the size of the animal population, grazing management (which determines whether manure can be concentrated where it is needed), composting technique (if any) and availability of low-cost transport. Where an individual can overcome these constraints through the market, it is only by creating a greater deficit among those with the least means; such a redistribution is at the heart of rural inequality. Mineral fertilisers, which could break this cycle, are themselves constrained by low cost-benefit ratios and high risk in the event of drought, and the effect of cash scarcity at a time of year when household incomes are critically low.

Baseline data for comparing soil nutrient status over time are extremely scarce. But three soil profiles on long-cultivated land in Sharken Hausa, which were first analysed in 1977 (Feau, 1977), were re-sampled and analysed in 1999, and showed no evidence of fertility degradation. Finally, it should be noted that soil nutrient status is not necessarily the best indicator of the efficiency of farmers' nutrient management. In a system which is characterised by a short, hot and intense rainy season and a long, chemically inert dry season, the ways in which farmers manage manure, nitrogen fixation, weeding and crop interactions is as important as the level of the soil fertility indicators themselves.

Tree management on farms

In spite of the misunderstanding created by authoritarian forestry policies (referred to above), observations across Maradi Department show that although natural woodland is becoming increasingly scarce (Table 2), tree densities are now rising on farms (Moussa, 2000). The practice of *défrichement amelioré* (Joet *et al.*, 1996) is widespread across the department, especially in its northern parts (Awaiss, 2000). This practice, which consists of protecting valuable species when clearing land for cultivation, is an indigenous form of management that was promoted by the PDRM and forestry services during the 1980s. In fact, farmers actively manage the selective preservation of tree shoots and trees, and the harvest of bushes, on their fields. The trend now is to preserve more shoots until they grow to their full tree height (Moussa, 2000).

Meanwhile, over the past decade, naturally regenerating woody species have begun to receive a greater level of protection through national legislation. However, in the four *terroirs* that were targeted by this study, the smallest trees (4–14 cm stem diameter) generally fall outside the protective legislation (Awaiss, 2000). Significantly, in these *terroirs* there is now a tendency for households to protect trees that are not covered by legislation.

Biodiversity among tree species is apparently greatest in the northern parts of the department, where *défrichement amelioré* is most widespread (Awaiss, 2000).

Most wood used by households for fuel is harvested from cultivated lands or other land managed by the household (such as fallows). Branch and dead wood, and unwanted seedlings, are important sources of wood. Where wood shortages occur (mainly in the north, and near towns), a market for fuelwood has developed. In the study villages, it is reported that the income gained from selling wood is used for both household consumption and investment in small ruminants (Awaiss, 2000). The most important observation on wood consumption in the area generally is that notwithstanding an increasing demand for fuelwood (as a result of a growing rural population), *stable or increasing densities of trees* are being maintained on farmland, that is, on more than 80 percent of the surface (Table 2). Urban, not rural, demand for fuelwood is the greater danger to tree populations, especially in remaining areas of natural woodland where effective community management systems are a priority. The same conclusion was reached in a major study of woodfuel in the Kano region of Nigeria (Cline-Cole *et al.,* 1990).

Livestock feeding and integration

With the disappearance of natural woodland and pastures (Table 2) from many parts of the department, the livestock sector can no longer depend on these feed sources throughout the year. Either transhumance (to grazing areas further south, including those in Nigeria), or increased use of crop residues after harvest, have filled this need. In central Mayahi Arrondissement, transhumance is not confined to Fulani and Tuareg herds, but now includes others. As former nomads take up farming, farmers use transhumance in the rainy season. In Hausa villages, the sheep and cattle may be sent with a herder, accompanied by the owners' older children, to look for pasture in northern Mayahi, returning after harvest. Hausa villagers may even cultivate a portion of such pastures, returning home after the harvest. Fulani herds are also taken away after the second weeding, and returned after the harvest (Joet *et al.,* 1996).

There is now a market for crop residues. Cattle are the most exposed to the loss of natural grazing as their needs are greater per animal than those of small ruminants, they make less efficient use of residues, and feeding them by 'cut-and-carry' methods calls for much labour time during the busy farming season. Crop residues provide 4–5 times as much feed as natural pastures during the nine months outside the farming year (Banoin, 2000: 4), though in a wet year, natural pastures yield better. It is clear, therefore, that to intensify livestock husbandry, within a context of spatially expanding crop production, calls for optimising the use-efficiency of these resources. The growing practice of fattening (*embouche*) – the result of a stable, buoyant meat market – is driving an increase in commercial relations in livestock feeding and a severing of the age-old link between herds and open-access grazing in natural woodland or on fallows. This trend has also been observed in Senegal's northern *Basin Arachidier* (Faye and Fall, 2000). Fallowed land used for pasture is now being privatised by its owners (Boubacar, 2000). Hamadou (2000a) found that only 25% of owners practised the old extensive system of livestock management, 53% were semi-intensive and 14% intensive.

Livestock statistics are unreliable and incomplete[14]. However, on the basis of the data available to us, and reviewed earlier, there is little evidence to support either gross fluctuations as suggested by carrying capacity models based on rainfall (Peyre de Fabrègues, 2000) or a long-term downward trend proving chronic overstocking. What is clear is that there are:

- strong upward tendencies after every downturn in the numbers of livestock units, starting with goats and sheep[15];
- a continuing preference for cattle both in their numbers and as a proportion of total livestock units; and
- a growing popularity of goats among the poor, especially women. The sale of animals is an important resort of families when crops fail (CARE, 1997: Table 9.10).

If the livestock production system is in crisis, evidence is needed. On the contrary, the evidence available is consistent with two things: a buoyant economic environment for livestock keeping (a local manifestation of the global 'livestock revolution'), putting at an advantage those having reserves and the least need to make emergency sales; and a transition from dependence on natural grazings to an integrated crop-livestock system making more efficient use of residues.

Resource tenure

Within the general framework of Hausa customary tenure, there is much variation in arrangements across the department, which is related principally to the degree of pressure on land resources. Land tenure has been changing to cope with the fact that there are no longer empty lands that can be allocated, either to immigrants or to village members.

The growing influence of the State has reduced the power of local leaders in the land tenure system. This has led to more power over land being exercised by family lines through the household head (*Maigida*), and to more individualised control of land by smaller family units and individual members of the family line (Boubacar, 2000). This trend was first observed more than 20 years ago (Grégoire, 1980; Grégoire and Raynaut, 1980; Raynaut *et al*, 1988). In practice, the landholding based on the extended family (*gandu*) no longer exists in some areas, especially in the south, where the pressure on land is greatest. Other factors (e.g., high taxes, Islamic rules) have exacerbated the trend toward individualised control of land rights as production groups (e.g. households) become smaller. The trend towards individual incomes since the 1960s has also had its effect. The *Code Rurale* process, intended to secure title for existing cultivators, created uncertainty which farmers resolved by appropriating remaining open land and putting fallows under cultivation; meanwhile, customary grazing rights withered away. Rights to *land* are giving way to rights to land *parcels*, and rights to *resources on land* (e.g., trees, crop residues, pasture) have also tended towards privatisation (Boubacar, 2000).

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[14] Firm figures are available only when there are vaccination campaigns.

[15] Grégoire and Raynaut (1980: 51) illustrate a fall in the livestock population after drought. Since 1988 the Département de l'Elevage, Maradi, appears to have believed that there has been an increasing trend, 46 percent in 1988-94 (Report to the Director of Regional Planning, cited in CARE, 1997).

An increasing privatisation of tree resources may be associated with the natural regeneration of trees on privately owned farmland.

In addition to the trend towards privatisation, many family lands are now controlled by women, especially when men are away trading or selling labour, and women have been able to purchase lands for themselves as they earn money through their own ventures and enter the developing land market (Boubacar, 2000).

It is clear that stability of control is a requirement for investments in land. In Maradi Department this stability has generally been assured through the customary system. Since the 1960s the means by which individuals and families can acquire land have diversified. There are six main ways by which the control of land is transmitted: inheritance, gift, loan, pledge, sale and rental. The commercial transactions (pledges, sales, rental), however, are more common now than before (Boubacar, 2000). In spite of the changes to the system which have been imposed by the State, in much of the department, the customary system is still a powerful force. There is little evidence that the persistence of the customary system has impeded investment in land (Boubacar, 2000).

We may conclude that the system of resource tenure, under which the department was originally settled and brought into cultivation by new farming communities, adapted effectively (from the farmers' point of view), first to the conditions of 'saturation', then to accommodating the State's interventions, and finally to an increasing level of commercialisation in economic relations, in which no impediments to investment have been identified. It has not been successful, however, in safeguarding grazing or woodland areas for those whose customary rights were more opaque.

4.5 Institutional change

Individualisation within the family

Since the 1960s, family structures in rural areas have become more nuclear. The balance between the extended family unit (*gida*) and the nuclear sub-unit (*iyali*) was described in the 1960s (Mainet and Nicolas, 1972), and a trend in favour of greater autonomy of the *iyali* was reported by Raynaut (1975) and Grégoire (1980). This phenomenon is now more widespread. Extended family structures still exist in some villages, while they are disappearing in others. In the drought of 1984, many men left to seek additional incomes, exacerbating the trend. But variations between villages suggest that its strength is not explained by a single factor (Doka, 2001). In the absence of men, women in their households become the main managers of the family farm. The trend towards more nuclear and female-headed households is most evident amongst the most vulnerable.

Even where men have stayed at home, women are having an increasing role in joint decision making (Doka, 2001). In general, decision making within households has become more individualised. Family heads have lost some power and control. The trend also applies to household incomes, both non-agricultural and agricultural (Doka, 2001).

Education

Parents value *ilimi* (wisdom) and see it as essential to worldly success and ability to deal with the wider world. However, it is distinguished from *sanni* (knowledge of a practical skill) which can be acquired, amongst other ways, through the formal education system if this leads to future employment as a civil servant. However, this latter channel is becoming less accessible to parents, through the incessant strikes in the public system. Parents also try to inculcate *hankali,* or the knowledge of good manners and social norms to enable the child to grow up as a socially respected person. Basic Quranic education is seen as contributing to *hankali,* its more advanced forms (for which travel outside the village is necessary) contribute to *ilimi* and perhaps to becoming a *marabout* (Doka, 2001).

Three of the sample villages chosen for this study have schools, founded in 1958–62, while in one the school was established in 1980. Most schools have remained small, with many more boys than girls attending, though attendance has increased. Parents remain discouraged by the poor rate of success in obtaining paid employment (Table 9).

Table 9: Four schools in Maradi Department

Village	Founded	Past size	Current size	Successes recollected
Dan Kullu	1962	106 in 1982	183	18 civil servants
Sharken Hausa	1961	140 in 1982	290	25 since 1961
Magami	1980	42 in 1980	40	None
Jiratawa	1958	?	253	Important number of civil servants

Source: Doka, 2001.

Compared with the past, there is some improvement in education. Table 10 gives the educational characteristics of adults sampled by CARE in 1996 which shows many more had received Quranic than primary education. In 1999–2000 sample, within 48 somewhat better-off households sampled in the four villages, 31 percent of the relevant age groups were attending government schools, 20 percent attended Quranic schools (concentrated in Jiratawa, where there is easy access to higher Quranic studies in Maradi) and 49 percent attended neither. In the bigger CARE 1996 sample, 20.4% of the appropriate age group were in primary, and 2.5% in secondary (no information on Quranic). Official estimates are that attendance at school in the department has increased from 15 percent in 1988 to 28 percent in 1999 but this includes the urban population (CARE, 1997). Rural children do often appear to have more education than their parents. There have been various adult literacy campaigns, but these do not reach all villages. Relatively few of the families in our sample villages appear to have benefited, except in Sharken Hausa. Early literacy campaigns taught French; the later ones have used Hausa. This gives men travelling to Nigeria access to written information in Hausa; but there is less literature for women staying at home, who consequently do not find it of much use, despite efforts to favour them.

Many families make financial investments in both Quranic and state education for their children. For many the main purpose of getting an education is not to get a particular type of work, but more simply, to become better educated, and therefore better able to deal with the wider world. The *ilimi* concept of gaining knowledge underlies some parents' motivation to invest in educating their children (whether Quranic or state). One's knowledge and one's status are strongly linked. Agents of the State are the main sources of agricultural innovations in the study villages, and the youth are important sources of innovations such as style, clothes, cycles, radios, etc. (Doka, 2001).

Table 10: Educational characteristics of adults in 1996

	Men	Women
No education	54.6	87.5
Incomplete primary	6.7	1.8
Complete primary	4.0	0.5
Secondary	3.6	0.8
Quranic	26.4	9.0
Adult literacy	4.7	0.4

Source: CARE, 1997, Table 4.3b.

The findings of this study show that social institutions such as the family itself are capable of adaptation in the face of changing circumstances, and that in the all-important matter of inter-generational transfer of knowledge, educational investments are pragmatic. A majority of rural parents still do not see the utility of French primary education.

4.6 Conclusion

In this chapter, we have summarised findings from the present study which show that rural households in Maradi Department have found ways of adapting their livelihoods and their management of natural resources to changes whose depth and direction gave rise to very negative expectations on the part of an earlier generation of observers. These observers had the symptoms right, but perhaps not the prognosis. An analysis of long-term changes has revealed that the adaptive resources of the people were not only under-estimated, but can be understood in terms of a rationality based on well-known economic principles. This finding is more remarkable in view of the intensity of several drought cycles during the period, the low productive potential of the natural resources in question, and the poverty of the macro-economy in whose ambience their decisions had to be made. It should be remembered that before this period of study (1960–2000), rural households enjoyed (in general) an expansionary period which was characterised by high rainfall, an apparently infinite natural resource base, and access to a protected and profitable export market. This experience of adaptive change, rather than a diagnosis of mismanagement, suggests a principle for prioritising policy options.

However, we have also shown that the transition to a more intensive system of agriculture is very much related to population density and access to markets. We have distinguished between the southern parts of the department, with average densities of

around 68/km^2 in 2000, and the much lower densities characteristic further north. In Dakoro, with densities around 20, an extensive system of agriculture is still viable and profitable. In central areas like Mayahi, with densities probably now around 45–50, people appear to be struggling to make the transition, and to be worst off (Figures 13 and 14). However, these relationships are not as clear as would be desirable, owing to deficiencies in both the CARE sample, which from our point of view might have been clearer if linked to *arrondissements*, and in our own, which was very small.

5 FINDINGS FOR POLICY

In order to answer the question 'Is a transition to a more sustainable production system possible or likely?', attention needs to be given to the hesitant recovery in mean rainfall and diminution in the intensity of droughts after 1984, which are hinted at in Figures 1 and 2. While no statistical significance can be attached to them, they do indicate that fluctuations will continue to be normal and that upward trends are as likely as downward ones. The Sahel has already sustained a greater fall in rainfall than those predicted in earlier climate change models[16].

We now look again at our original hypotheses, in the light of evidence presented, and identify the implications for policy.

1 Population density

> 'an increase in rural *population density* can facilitate agricultural intensification, through increased farm labour per ha, market growth, and lower interaction costs'

We have presented evidence that the farming systems of Maradi Department are not in a state of impending collapse, owing to population growth and land saturation. Rather, they have adapted to land scarcity (and to increasingly frequent droughts) and maintained food grain output on a per capita basis during the period since 1960. On millet yields per hectare, and per mm of rainfall, evidence from the south of the department (though not yet from the north) suggests that a declining trend has been stopped and perhaps reversed. An increase in total crop output amounts to an increase in the value of output per square km in the department as a whole. To this must be added an increase in the value of livestock production from a stable or increasing herd, though to an unknown extent, this increase was partly based on transhumance to grazing resources outside the department. While livestock keeping has been forced to yield up grazing land to ever-expanding cultivation, new synergies are being realised through a closer integration of crops and livestock, a development which is predicted in the model.

In producing more value from the same resources, the farmers of Maradi Department have achieved a measure of agricultural intensification. However, the departmental average performance hides differences at the local level between fertilised and unfertilised fields and between degraded and better managed grazing land. As for the

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[16] At the time of writing, the IPCC Report of 2001 was not yet available.

agency of the three factors proposed in the hypothesis: (1) it may be said that an increase in the average rural population density (since 1977) for the department as a whole from 24 to about 44 per km^2 , and in three southern *arrondissements* to about 68 per km^2, has provided an increase in *potential* farm labour per hectare, though we lack farm level data series to demonstrate this; (2) output is linked to market growth, as shown in the next section; and (3) the role of reduced (real) interaction costs can be plausibly deduced from growing towns and markets, better roads, more transport and communication.

Therefore the fundamental question for policy is not how to rescue and transform a failing system, but how best to support an adaptive one in increasing its productivity per hectare and, if possible, per capita. This calls for a reconfiguration of the policy challenge. Farmers' knowledge and experience should be given equal status with that obtained from research and extension; extension systems must serve the farmer rather than attempt to correct or redirect practice on the basis only of expert assessments; technological change goals must be controlled by the resource constraints and investment capabilities of poor farmers, not by productive potentials proved under station conditions. The supply constraint affecting crop production is that of fertilisation (whether organic or inorganic) and that affecting livestock production is traditionally assumed to be fodder availability, though farmers tend to cite animal health and a shortage of capital. The constraint affecting non-farm incomes, which are an important component, is the lack of access to any occupation demanding literacy. Relaxing such constraints so that practices developed on more intensively managed land can be extended to other areas should be a goal of policy.

2 Markets

> 'improved access to profitable urban or export *markets* can provide both incentives and funds for rural households to invest in enhanced productivity and conservation of natural resources'

As we have found in our parallel studies in Kenya, Senegal and Nigeria, better access to product markets is crucial in providing profitable opportunities in crop or livestock production that can also offer incentives to invest in technologies to enhance productivity. At the beginning of our period (1960), groundnut production was energetically promoted by government agencies and taken up by farmers. Since the decline of groundnut production took place after the early 1970s, price incentives have driven the choice of market crops with or without such promotion (cowpea, tiger nut, and now millet are the most important). The unique aspect of the alliance between farmers and markets in Maradi is the role of the cross-border trade with Nigeria. The ebb and flow of groundnut, millet and cowpea movements between Niger and the north of Nigeria has responded to price movements and exchange rates between the FCFA and the Naira. These movements, which are aggregates of decisions by small producers as well as traders, show the flexibility that exists in the system, notwithstanding the constraints imposed by a marginal environment, and some national policies. The dangers of allowing a currency to become overvalued is shown by the boom in investment that seems to have followed the devaluation of the FCFA (section 4.3).

The picture just described for crop production and marketing is mirrored in livestock, with the added dimension that animals may be the only marketable output from northern

areas in dry years. The enormous and constantly expanding meat market in Nigeria has attracted cattle, sheep and goat exports since long before our period started. Without a buoyant market for livestock products, it is very doubtful whether the increasing interest in livestock which has been found in this study could have been sustained. Market considerations influence almost all decisions of farmers about animals (buying and selling, breeding, fattening, use for traction, hire, production of manure, milk), and increasingly, those of specialist livestock-keepers also.

There has been a reluctance to trust markets to drive agricultural development except under conditions of price control and centralised policy making, especially in Francophone West Africa. Yet under widely unpopular programmes of structural adjustment, the State has withdrawn control, and notwithstanding some reports of widening economic disparities, today's farmers are showing flexibility and adaptability. This is, indeed, a condition for surviving and flourishing in this environment. Average per capita incomes in Niger make it appear one of the poorest countries in the world, with high child mortality and low life expectancy, low literacy and health access rates. Nevertheless the rural households in Maradi Department have not been helpless, surviving several major droughts, the fading of the groundnut boom, and the removal of state subsidies.

Those who are able to play the markets need to be supported with market information, marketing institutions, infrastructure, and above all, a stable macro-economic environment that makes sustained productivity attractive. Those who are less able to do so should also be supported. It is clear that inter-household economic differentiation exists, especially in relation to access to land, and inequality *may* be increasing as larger, better endowed households are also better able to bring in off-farm incomes and even to buy in land. Policies to support poor families should therefore be concerned with markets and off-farm opportunities, as well as with agriculture. Increasing monetisation represents, not a failure of household self-sufficiency (which is a difficult goal to achieve under variable rainfall), but an adaptive strategy for a modern world.

3 Technological change

> '*technological change* and a diversity of appropriate technical options are promoted by increasing population density, urbanisation, interaction and information flows'

In farming systems that are in a process of continuous evolution, a diagnostic-prescriptive mode is inappropriate as a basis for development policy. Our data show that this evolution can be positive in respect of the key indicators, output per capita and per hectare. Therefore the search for technical improvements must be set in the context of a full understanding of this evolution, rather than in models of transformed ('modernised') peasant practice. This technical and productive evolution at the level of the system represents cumulative, popular investment decisions that are made in response to farmers' own assessments of their needs. These needs are also concerned with managing other productivity constraints, especially rainfall variability.

The most diverse cropping systems are found in the most densely populated *arrondissements* that enjoy the best access to towns, markets and information, and crop production has benefited from technological change as these factors have improved over time. Technological change has been promoted by development programmes (such as

the PDRM) through extension and credit, but the sustainability of technical change depends on farmers' ability to maintain their investments. To provide a conducive policy environment, market opportunities are more necessary than credit. Credit has less relevance to investments that are created by labour, investments too small to be credit-worthy, and investments at the mercy of risk (mostly but not all from drought).

4 Integration of crop with livestock and tree production

> 'under conditions of increasing land scarcity, the drive for agricultural productivity promotes crop-livestock *integration* and tree conservation on rainfed farmland'

Two technological changes that have special significance in a context of agricultural intensification are the integration of livestock production with that of crops and the planting and protection of trees on farms. A closer integration of crops and livestock can be inferred from the stable or rising livestock populations in conjunction with declining areas of pasture, except perhaps for cattle (some of which are taken on transhumance for part of the year). This indicates a greater dependence on crop residues for fodder. More manure, more use of animal energy on the farm, and added value per hectare (of crops plus livestock products) are inevitable. Similarly, *défrichement amélioré,* if not the planting of economically productive trees, at densities of up to 15/ha, add value without detracting from crop performance. Policy should recognise farmers' rights to manage and benefit from trees on their land.

The use of inorganic fertilisers has long been promoted as the solution to declining soil fertility, in recent years as part of a package with organic materials in 'integrated fertiliser management' (IFM). Inorganic fertilisers are expensive in relation to the value of crop output, and structural adjustment has removed or reduced subsidies both in Maradi Department and in neighbouring Nigeria. We know that the essential logic of intensification without access to massive mineral fertiliser inputs is recognised by farmers, and implemented within the constraints set by manure or compost production, which means, in practice, on less than a half of cultivated fields.

The configuration of integrated farming systems must continue to be decided by the farmers in relation to their livestock holdings or access to manure produced by others. Changes in pricing can bring about inorganic fertilisation on the scale necessary to arrest fertility decline on fields not presently fertilised. But dependence on mineral fertilisers alone will not provide fertility on a sustained basis. There is a need for research on the constraints affecting crop-livestock integration as a route to intensification, as well as the desirability of mineral fertilisers in IFM practices. How far can the known technologies take the system and where are the bottlenecks justifying intervention?

5 Income diversification

> '*income diversification*, associated with access to education and temporary or permanent migration, can provide investment funds for agriculture'

In Kenya, income diversification has been closely associated with the acquisition of education, migration and employment; and some of the income earned has been invested in agriculture, including soil and water conservation. In Maradi, migration in

search of alternative incomes is a necessary adaptation to risk, which was underlined by increasingly frequent droughts during the last 40 years. However, opportunism also plays a part as young men have responded to the employment opportunities offered in the towns (including those in Nigeria), the short-lived uranium boom and now Libya. Our results show that this must be recognised in policy as a legitimate, long-term and rational strategy both for facing risk and for taking up opportunities for income growth at the household level. Although it can provide investment funds for the natural resource sector as well as supporting consumption and other household needs such as health and marriage costs we have no strong evidence for this in Maradi.

Rural people cannot be restricted to crop or livestock production, they have both the right and the capability of turning diversification to their own advantage. Since it necessarily involves spatial mobility, transport infrastructure and access are vital. However, there are two other elements: education and infrastructure for workshops. In Maradi Department formal education has not played a significant role in furthering income diversification, except for a very small (and usually urban) elite, not including the rural "coping" families described by CARE (1997). Informal channels of information and sources of technical or other knowledge are highly valued in Hausa society but policy needs to adapt the primary curriculum more to village needs, and to consider how to make use of Hausa literature available from neighbouring Nigeria. Without literacy in any language, people are restricted to poorly remunerated, informal occupations that provide for survival needs rather than investment. With a curriculum that is less well adapted to needs than in Kenya, off-farm incomes are less well remunerated, though in villages with access to electricity and water, new occupations are coming into being.

6 *Adaptive resource tenure and institutions*

'*resource tenure and social institutions* can adapt at the local level to the demands made by the new economic conditions'

Land tenure in Maradi is evolving. Tension results from the interaction of the *Code Rurale* with customary tenure, but smallholders have managed the evolution in such a way as to provide the necessary security of title for economic development. There are probably some losers, for whom increased non-farm work opportunities will be important. Policy should be sensitive to the risk of upsetting the dynamic balance in the institutional framework. While there is no possibility of returning to the customary system unmodified, great caution is needed before moving towards titling, as the arguments for it are weak under the circumstances faced by rural households.

Key social institutions (the family, Quranic education) are also subject to pragmatic evaluation and ongoing adaptation by households. Understanding this evolution should be a condition for any intervention. The key is to identify needs for institutional change which lie beyond resolution at the level of individual households, rather than those which are changing autonomously. Of these the most important are finding ways to offer an education that rural people see to be valuable. The expansion of such education is known to be also the best way to improve the position of workers and of women, rather than any direct, top down measure to modify entrenched customs.

This finding is remarkable in that the period in question (the past 20 years) spanned the lifetime of a major internationally-funded rural development programme (the PDRM) and credit provider. In the previous ten years the sampled farmers had made few if any such investments. A similar level of reliance on private funds has been found in Machakos District, Kenya (Tiffen *et al.*, 1994) where there was also a major public-sector development programme in the early 1980s. A diminished priority is now given to credit provision in the thinking of major international agencies (e.g. World Bank, 2001; IFAD, 2001). It is important for us to emphasise that *some* farmers can finance investments, even in dry and risky environments. Perhaps the effect of the development programmes has been in popularising new technologies rather than in financing them.

Conclusion

The study provides some evidence that five of the six hypotheses are confirmed in Maradi Department. The fifth hypothesis (use of off-farm incomes for agricultural investment) remains unproven. In regard to Jouve's question as to whether a transition such as has been observed in Nigeria is possible or has been evidenced in other parts of the Sahel, we say that it is occurring in Maradi, though within the constraints imposed by a drier rainfall regime and greater risk. The transition is being achieved through the same agency as drives the Nigerian one – that is the growing urban demand in Nigeria, focussed in Kano. Demographic growth, technologies, skills and education are all conducive factors to transition, and affect its speed and nature. While densities remain low, as in northern Maradi, fallowing remains profitable, but there can nevertheless be investment in appropriate new technologies if there is a profitable market. The market, therefore, is an essential condition, providing both incentives and means to invest.

Finally it must be emphasised that the farming and livelihood systems show strong evidence of adaptive evolution in the face of climatic perturbation, which has been felt on a scale unknown elsewhere during the past 100 years, and surpassing in magnitude the changes which have been predicted in global climate change models, *even for the Sahel region.* This adaptive capability, therefore, is the peoples' major resource. It should be a goal to provide an enabling policy environment in which it can flourish, encompassing good management of the macro-economy (including prices and the exchange rate), a widening range of technical and economic options, access to education and information, and freedom of movement and employment.

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