WETLANDS IN DRYLANDS: THE AGROECOLOGY OF SAVANNA SYSTEMS IN AFRICA

PART 3a: Economics and management of fadama in northern Nigeria

by Are Kolawole

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Edited by Ian Scoones, Drylands Programme, IIED, London.
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This review project was supported by the Swedish Agency for Research Cooperation with Developing countries (SAREC) and was coordinated by IIED, London. The review is a collaborative effort, drawing on the wide experience of researchers based in Europe and Africa.

The review is in three parts and is aimed at providing a broad overview of the role of 'valley bottomland' wetlands in savanna agroecosystems in Africa. The role of spatial heterogeneity and farmers' and pastoralists' responses to patchiness is often ignored by researchers, planners and extensionists. The review aims to map out the key issues and suggests a new way of interpreting savanna agroecosystems with important implications for future directions in agricultural and pastoral development in drylands areas.

Part 1 by Ian Scoones: Overview - ecological, economic and social issues.

The overview provides an introduction to the case studies (part 3) and the detailed assessment of biophysical aspects (part 2). It attempts to highlight key issues that run through all analyses of patch use within dryland agroecosystems. Bottomland agriculture and pastoral systems are investigated with a series of case studies. Questions of environmental degradation, land tenure and appropriate economic analysis are also explored. Part 1 concludes with a discussion of the implications for agricultural and pastoral development.

Part 2 by Julie Ingram: Soil and water processes

The review of soil and water processes examines the literature on soil processes by looking at interactions between topland and bottomland in soil formation and movement. Bottomland wetland areas are placed in a landscape context by reviewing catchment level processes. In situ soil and hydrological factors are also examined. Part 2 concludes with an assessment of the potential impact of land use change on patchy wetland areas.

Part 3: Case studies

Part 3a by Are Kolawole: Economics and management of fadama in Nigeria.

Part 3b by Folkert Hottinga, Henk Peters and Sjoerd Zanen: Potentials of bas-fonds in agropastoral development in Sanmatenga, Burkina Faso.

Part 3c by Mohammed Osman El Samanni: Wadis of North Kordofan - present roles and prospects for development.

Part 3d by Zeremariam Fre: Khor Baraka - a key resource in Eastern Sudan and Eritrea.

Part 3e by Misael Kokwe: The role of dambos in agricultural development in Zambia.

Part 3f by Ian Scoones and Ben Cousins: Key resources for agriculture and grazing: the struggle for control over dambo resources in Zimbabwe.

Contributors

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PART 3a: ECONOMICS AND MANAGEMENT OF THE FADAMA IN NORTHERN NIGERIA

Are Kolawole

Contents

ECONOMICS AND MANAGEMENT OF THE FADAMA IN NORTHERN NIGERIA

by Are Kolawole

1 Introduction

This study examines the role of wetland farming in general and particularly that of the fadama in the environmental resource management of the drylands of Northern Nigeria. Fadama cultivation forms a very strong component in livelihood strategies. This paper reviews literature on the socio-economic and agronomic context in which fadama crops are produced. The overall aim is to characterise the research area in relation to the role of the fadama in the agroecosystem; the practices involved in the management of the fadama, both past and present; the direction and impact of the state intervention on the utilization of fadama land and the economics of the fadama cultivation.

The study area lies within latitudes 10°50′ - 13°N and longitudes 4°00′ - 14°E (Figure 1). The zone has a number of climatic features which make it the most vulnerable zone of the country. First, the zone is characterised by a long dry season (October to May), and a relatively short wet-season (June to September). The length of both the dry and wet season varies from 7 months in the Southern part to 2½ months in the extreme Northern most part of the zone. Second, the rainfall is not only scanty, but also erratic in distribution. Third, the rainfall pattern is characterised by spatial and temporal variations in distribution, which often means a drastic reduction in the growing season, low yields and malnutrition or even famine. The zone is consequently fraught with risk and uncertainty.

In response to risks and uncertainties farmers have evolved a range of coping mechanisms. Vulnerable as it is, the zone seems to have a high carrying capacity as it was home for over 25 million people in 1973; well over a third of the country's population. The zone in addition supports much of the country's livestock economy, hosting about 90% of the cattle population, about two-thirds of the goats and sheep, and almost all the donkeys, camels and horses (Mortimore, 1978). Furthermore, additional pressure is put on this zone due to disasters in the neighbouring countries, notably the Republics of Chad, Niger, Mali, Burkina Faso and Cameroon. One of the crucial survival mechanisms in this environment is the use of wetlands in general and, in particular, the fadama.

The case study is drawn from the Galma Fadama (the Galma River), Hantsu Fadama (Hadeija River Valley), Kano State; and both the <u>Masakwa/Firki</u> cultivation and the lake floor farming in Borno State, Northeast Nigeria (see Figure 2). These areas demonstrate the role of the fadama within traditional management practices, as well as the latest state intervention in fadama land. Thus, both Yankunama and Hantsu represent the

Figure 1: Bioclimatic zones of West Africa

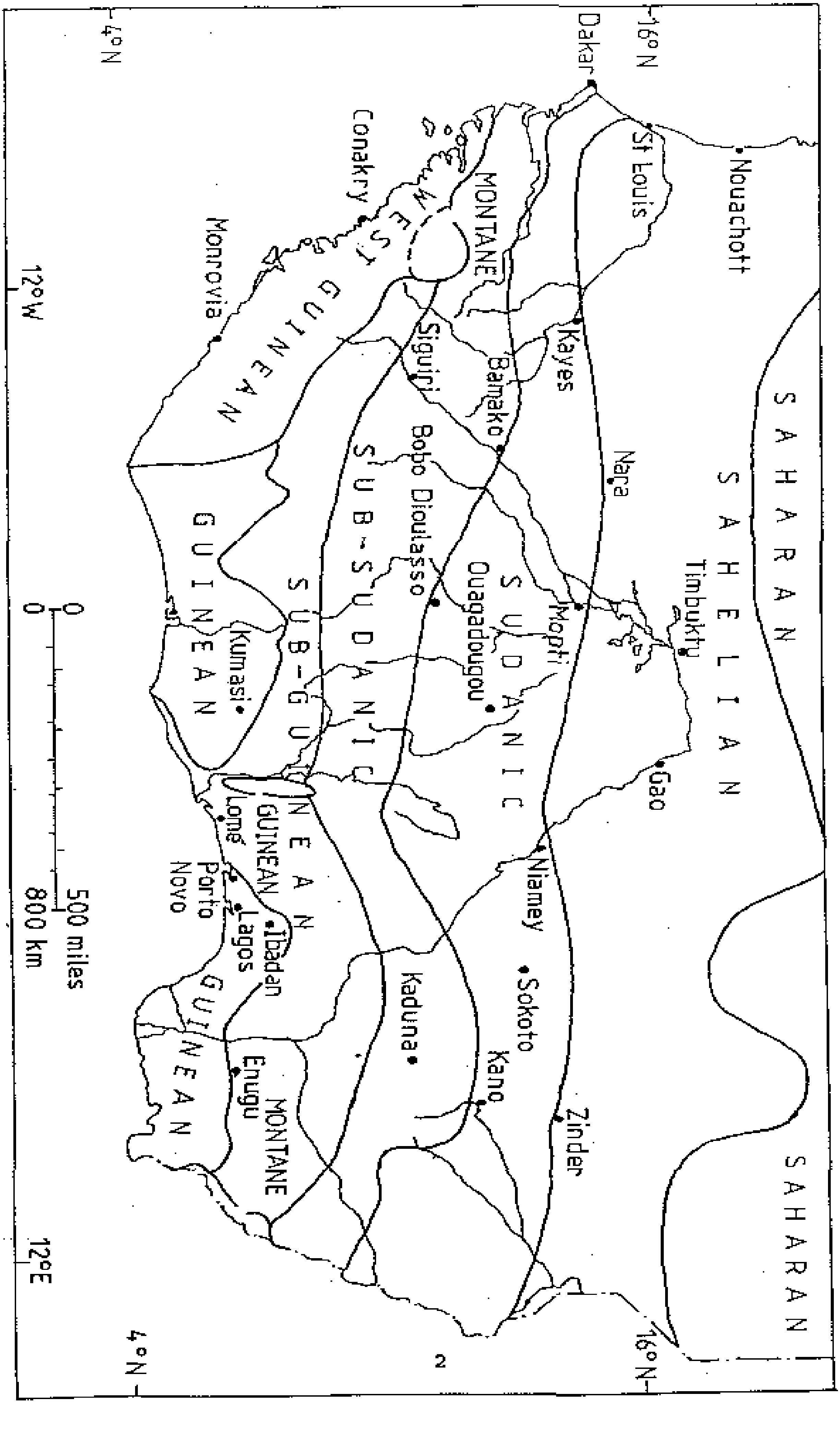
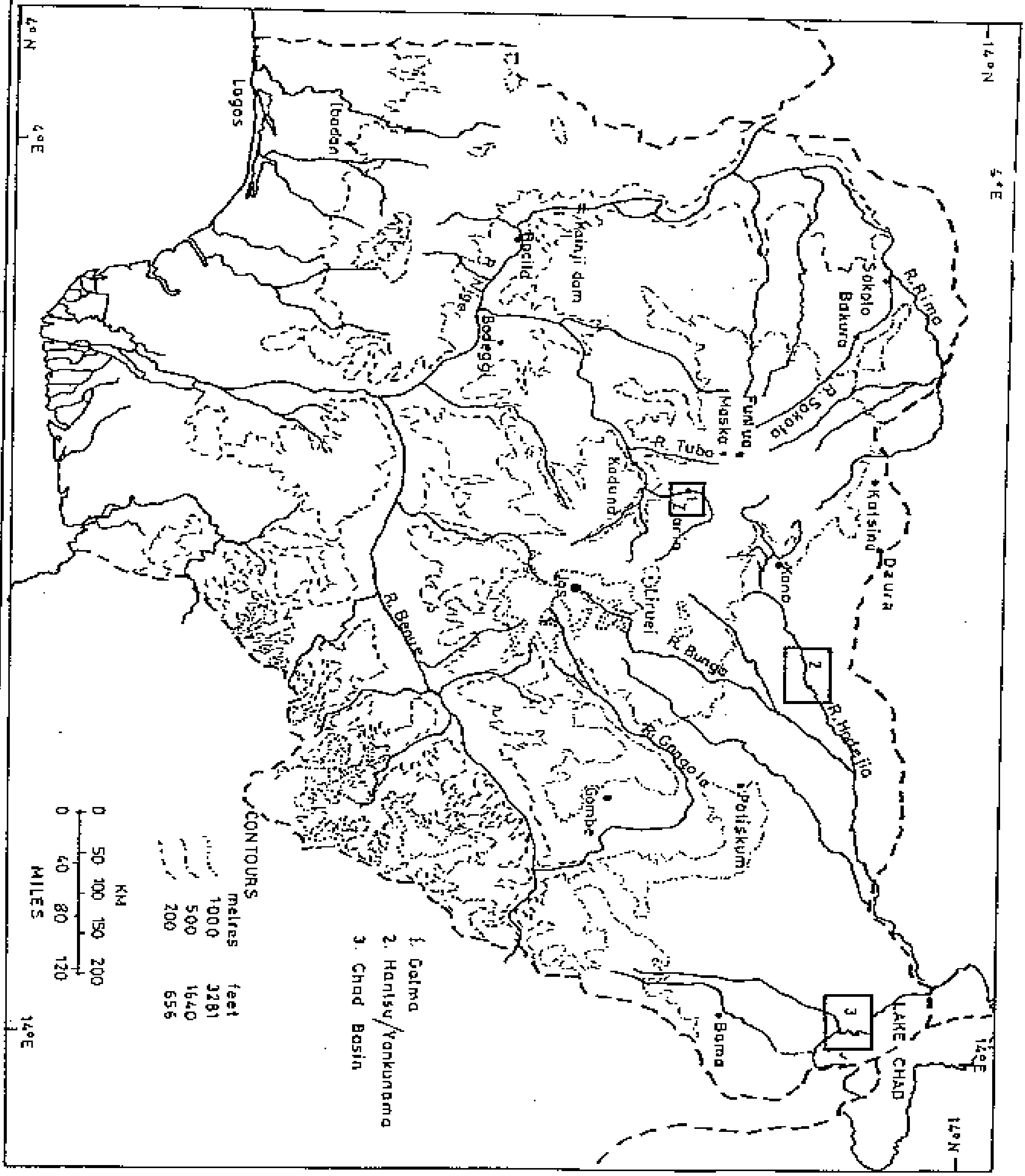


Figure 2: Location map of three study areas



farmers' fadama management, where ownership is synonymous with control and management, while Yakofoji and Galma fadamas present stories of state intervention in fadama land use. There are also marked variations in the decision making process in the fadama. While those under indigenous farmer management are more flexible, a characteristic feature of environmental resource management of the semi-arid zone, those under state control are less so.

A two-staged sample survey was conducted in the study area to generate empirical data. The target group of the survey was the fadama farmers. The 1988 survey of the lake floor farmers in the Chad Basin Area covered 332 farmers (Kolawole, 1989), while that of Yankunama was 34; Hantsu, 50; Galma, 54 (Kolawole; Alamu and Ambi, 1990).

The questionnaire contained questions relating to the socio-economic characteristics of the fadama farmers, sources of labour, costs of production, access to extension services, farm inputs, farm operations performed and transportation. The other component of the survey was the physical measurement of plot size of 10 per cent of randomly selected farmers. In addition to the physical measurement of the plots, some information was collected on the costs of farming operations, notably land acquisition, land preparation, ploughing, harrowing, weeding, planting, fertiliser procurement, cost of fertiliser application, irrigation, harvesting, threshing and crop yield to determine the economics of the fadama farming in Nigeria.

2 Definition and typology of wetlands in Nigeria

Wetlands are defined as lands having hydromorphic soils, (WURP/IITA, 1981). The major concern of this paper is valley-bottom cultivation, otherwise known as fadama; but cultivation of the floor of Lake Chad, which is based on the flood-retreat and flood-advance is also discussed. Fadama is a Hausa word which means "land which is flooded in the wet season". Turner (1977:34), however, defined fadama as "land which is seasonally water-logged or flooded". But this would seem to be a broader definition embracing some areas which not all farmers agree to be a fadama, since they tend to dry up after the rainy season. Read et al (1967) however, defined fadama as "the actual water surfaces of the ponds and swamps left behind as the floodwaters retreat from the floodplains of the largest river".

It is probably in order to draw a distinction between floodplains and fadama. Floodplains are one type of fadama flooded by over bank flow from a river (Chang, 1968). On the other hand fadamas may be flooded by sheet-wash from the surrounding upland or may be waterlogged but not flooded. The impression one can gather from these definitions is that the fadamas are low-lying, relatively flat areas, sometimes streamless depressions and sometimes areas adjacent to streams (Turner, 1977). They are usually waterlogged or flooded during the wet season.

The fadama soils are hydromorphic soils which have a high water retention capacity; a unique characteristic which makes them suited for dry season farming. The soils are deep, usually over 150 cm (60"), and they are usually poorly drained. The soils are usually grey or pale brown, and the texture of the upper horizons varying from clay to loamy sand, but is usually loam or sandy loam. As Turner (1977) pointed out, there is usually an increase in clay content with depth and there is usually clay or clay loam below 100 cm (40") although these vary remarkably. Based on the geomorphological and hydrological features, Turner (1977) classified fadamas into three broad categories notably: fadama without stream channels; stream side fadamas; and flood plain fadamas.

The fadamas discussed in this paper are the floodplain fadamas. They consist largely of the alluvial deposits, and materials, washed down from the valley sides (Turner, 1977). Fadamas are vegetated with diverse species which are valuable for grazing, and other domestic uses.

The other type of wetland which is central to this case study is the flood-retreat and flood-advance cultivation found in the Chad Basin Area, Northeast Nigeria. This is dependent on the topography and the seasonal variations in the level of Lake Chad. The topography of the Lake Chad Basin is generally so low that small changes in lake levels can cause significant variations in the land areas flooded.

There are four agricultural systems found in the area; each is related to different soil types and differentiated under the present lake regime by local farmers into the flooded (Zuru) and the non-flooded (Kudu) zones (MRT Consulting Engineers; Figure 3). Each area is further classified by local farmers into sandy soils (Kati Kassa) and soils containing mainly silt and clay (Kati Kulum). The four systems are consequently identified as:

i sandy soil (Kati Kassa) cultivation in flooded (Zuru) or non-flooded (Kudu) zone.

ii silt and clay (Kati Kulum) cultivation in the flooded (Kudu) zone.

iii silt and clay (Kati Kulum) cultivation in the flooded (Zuru) zone, and

iv the Firki clay cultivation.

'Lake floor' cultivation is another form of management, which although ancient has enjoyed very little publicity. The term 'lake floor' refers to that area between the high lake level of 1962-63 and low lake level of 1986 (Kolawole, 1988). The soils of the lake floor are hydromorphic, and these have been classified into four broad categories, depending on their form, colour, degree of coherence, texture and organic content (Figure 4).

Figure 3: Land system units in the Chad basin

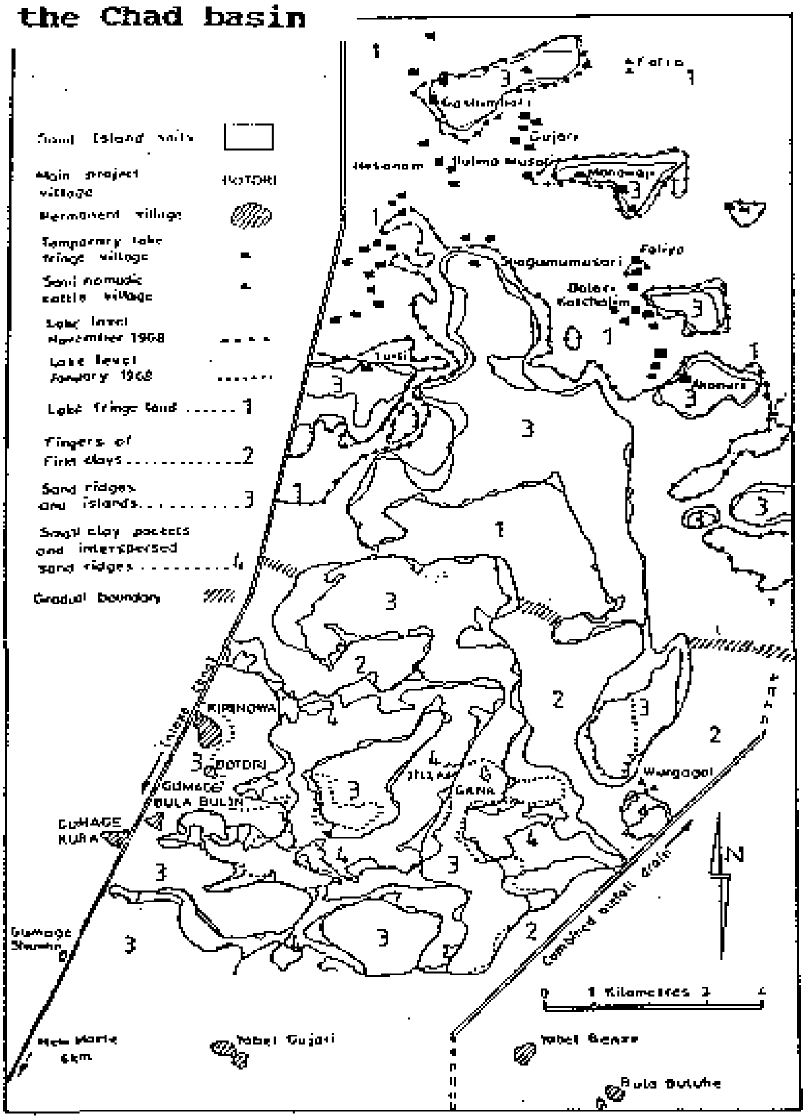
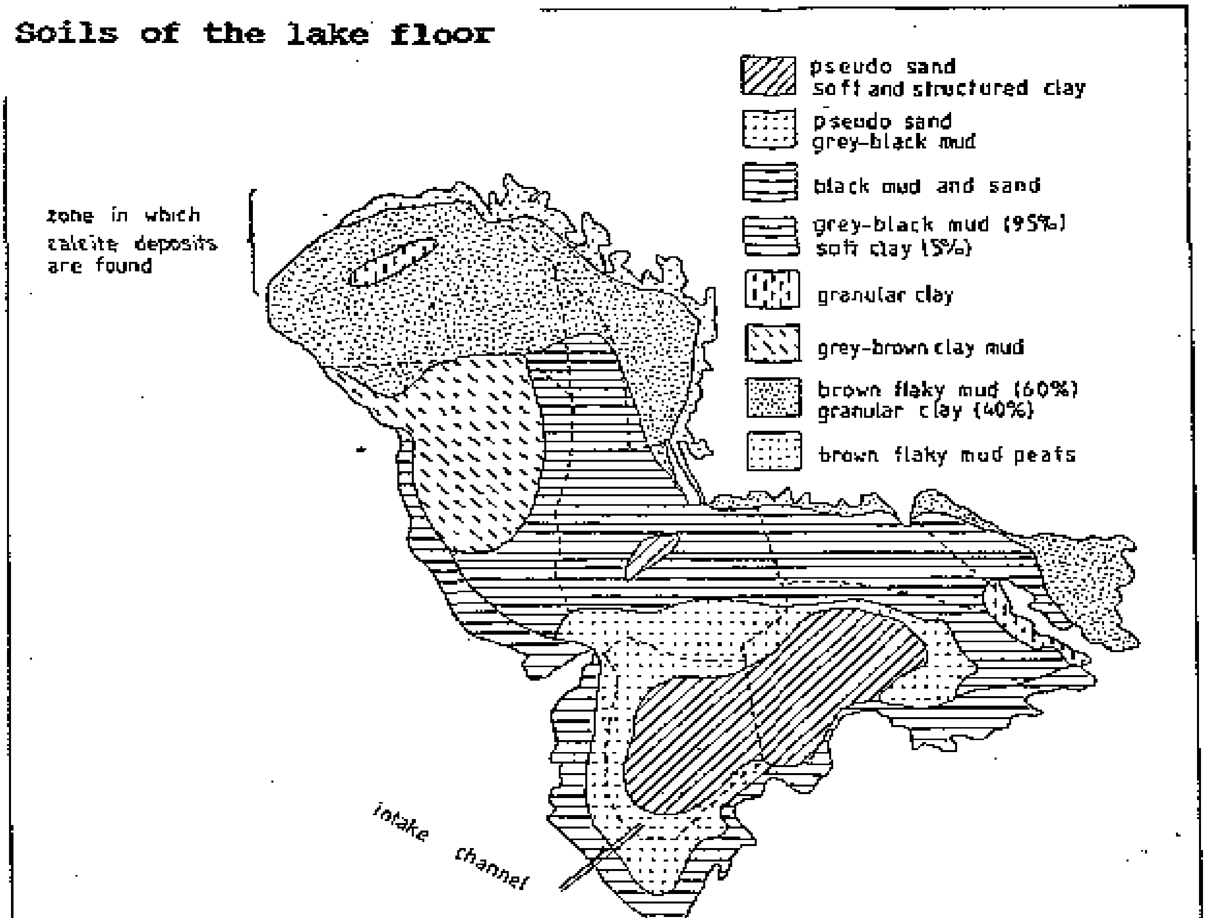


Figure 4: Soils of the lake floor



The lake floor is vegetated by plants with diverse economic significance. Table 1 summarises the ecological features of the lake floor. Wild plants such as the dum and date palms are useful famine food. The aquatic and semi-aquatic plants of the lake such as Cyperus papyrus are used for mat-making, fences, baskets and boats; Typha australis, Aeschynomene elephroylon and Phragmites australis are also used as building materials. Of the five wetland types identified in the Chad Basin Area, only two, notably the Firki/Masakwa cultivation and the Lake floor cultivation, are referred to in this case study.

Table 1: Ecological Features of the Lake Floor 1984-1988

Settlement/ Distance from N Marte (km)	Remarks	Features
Kirinowa 22	High lake level in 1962-3 when about 1,700 people were driven from 10 villages by flooding	Wooded Cordia rathii or Acacia raddiana tree shrub and shrub savanna with Leptiada spp and Cenchrus spp grasses, mixed Ballanites tree shrub savanna and Sporobolus helvous
Faria 1-7 26	There was lake water here in 1982 hence maize was cultivated. Faria now grows crops with lower water requirement, for example, water melon	
Baranga 29	The lake flood of 1982-83 allowed maize cultivation and the inhabitants also fished, and hippopotami were seen up until August 1983. By July 1985 the village relied on pump irrigation to grow cowpeas, maize and vegetables	This area is almost denuded of vegetation but for fragments of Ipomoea almost covered by blown sand dunes
Abuja 43	There was lake water in 1982-3	Same as above
Tumbuma 43	The lake flood in 1984 was sufficient for rice and maize cultivation but now water melon and cassava are cultivated	Same as above

Metele 50	Maize was planted here in 1984 and it is now a pastoral settlement. More than 50% of the village had migrated to the lake edge with their herds	Same as above
Bukare 55	Maize was cultivated here in 1984 but now a substantial proportion of the population has moved to Doro Buhari to grow cowpea. The village is littered with stranded boats	This is covered by debris of dead semi-aquatic and aquatic plant of Cyperus papyrus mixed with dead Aeschynomene elephroxylon (ambatch trees) and patches of isolated green Typha australis
Doro Buhari 80	Doro in Kanuri means lake settlement. Doro Buhari was founded in November 1984 when the lake level was 280 masl. The popular crops as of July 1985 were cowpea, maize, water melon and vegetables	Same as above but green vegetation became pronounced
Doro Kereta 91	This village is probably in the Republic of Cameroon judging from its composition	Green patches of Cyperus papyrus punctuated by Typha australis, Aeschynomene elephroxylon and other aquatic grasses became more pronounced
Doro Kpata 96	An agro-fishing settlement and the inhabitants saw lake water until April 1985. The area was being heavily cropped with maize as of June/July	Same as above but the features were pronounced
Doro Kifi 101	This is a fishing settlement and the nearest village to the lake. Maize cultivation was in progress in June/July 1985.	The area from here is covered with green papyrus, Echinochloa swamp grassland, Aeschynomene elephroxylon and marshland

Notes: 1. The date of seeing lake water coincides with the date of settlement; 2. Cultivation of maize indicates that the lake has just receded.
Source: reconstructed from field observation, notes and interviews.

3 Case Studies

3.1 The Masakwa (Firki) Cultivation in Borno, Northeast Nigeria

Masakwa, otherwise known as Firki sorghum (Sorghum cannum), is a drought resistant and cool tolerant sorghum grown during the dry and cool harmattan period on the residual soil moisture on heavy, deep vertisol black cotton soils (Ogunlela and Obilana, 1984). Since masakwa cultivation is heavily dependent on total rainfall rather, than on seasonal distribution, water conservation practices are crucial for its success. The most significant aspect of masakwa cultivation is bunding which takes place in the dry season, and before the onset of the rainfall.

The primary objective of bunding is to allow water to collect and penetrate the soil before transplanting (Ogunlela and Obilana, 1984). This is made possible by the hydromorphic nature of the soil, with high water retention capacity. The burning of grasses which precedes bunding serves as the major source of fertilizer, providing much needed soil fertility. Bunding commences in July and the bunded area is sub-divided into plots, with water-courses and channels (James, 1977).

With the bunded area divided into plots, farmers can phase their planting sequences, depending on the labour availability and the total rainfall, so stagger planting reduces the risk of failure.

Masakwa cultivation complements the upland sandy soil, rainfed cultivation which is characterised by low output and high risk (MRT Consulting Engineers, 1973; James, 1973). Unlike the upland sandy soil which depends largely on distribution of rainfall, masakwa cultivation relies heavily on the inherent fertility of the Firki clay soil and its residual moisture content which minimises variability output potentials. As James (1977:52) argued:

> "In drier years, some of the farmer's plots may not receive water in which case he does not plant them. In this sense, the risks involved in masakwa cultivation are fewer than in sandy cultivation. Decline in production in a poor year is largely the result of a reduction in the area planted and not a fall in the yield per acre."

There is therefore a complementarity between upland sandy soil rainfed agriculture and bottomland, clay soil masakwa cultivation, with the latter forming the main source of income. In addition to increasing farm income, its contribution to self-sufficiency in food production was long recognised by the colonial administration. The colonial report on Mare District in 1938 noted that:

> "The crops in the district were phenomenal except gero (millet) crop, which was destroyed by birds, but this was complemented by good red and white guinea-corn, which resulted from the extensive flooding of the firki soil

areas. These areas have been planted out with dry season guinea-corn, and the farms stretching often as far as the eye can reach over the level plain are an impressive sight ... the industry of the farmers is remarkable, though admittedly the soil requires little tillage" (NAK/MAI PROF ACC/21, 1938).

The failure of masakwa would seem to be synonymous with food shortage, widespread hunger and malnutrition in Eastern Borno. Hence the principal cause of food shortage in Eastern Borno in 1954 was attributed to the poor performance of masakwa. To quote the colonial report again:

> "... Masakwa crop is being harvested and yields are under average due to adverse harmattan conditions and damage by birds ... food though fair in supply, shows an upward tendency in price" (NAK File No 1297/20, 1955).

The colonial administration was so impressed by the performance of the masakwa cultivation that attempts were made, though unsuccessful, to transfer its technology to other parts of Northern Nigeria (NAK 3/1, 1938). This is because the success of masakwa cultivation lies in the inherent fertility of the firki as hydromorphic soil; the low risk and uncertainty involved; the drought resistant and cold tolerant nature of the crop variety; and the relatively high water table.

Masakwa cultivation has, in recent years, witnessed a dramatic decline, as only 11.7% of the 332 sampled households had masakwa farm in 1988 (Kolawole, 1989). The dramatic decline in masakwa cultivation is a function of two important factors. Firstly, the areas of firki clay soil on which masakwa is traditionally cultivated west of Lake Chad has been expropriated from the farmers for the development of the South Chad Irrigation Project, whose performance has not been satisfactory (Kolawole, 1989a). Second, the Sudano-Sahelian droughts of the early 1970s and that of the 1980s have meant less than average rainfall, and less flooding of firki clay soil.

3.2 Cultivation of the floor of Lake Chad, Northeast Borno

Cultivation of the floor of Lake Chad is based on a flood-advance and flood-retreat farming technique. Lake Chad lies between latitudes 12^{o} - 14^{o}N and longitudes 13^{o} - 15^{o}E in the Chad Basin Area of Nigeria. The lake is bounded by the Republics of Niger, Chad, Nigeria and Cameroon. The lake has a basin area of approximately 2.5 million km^2.

The lake has however, witnessed a reduction in size since the beginning of this century, fluctuating between 25,000 km^2 in 1963 to about 3,000 km^2 in 1988. Correspondingly, the available land in the lake floor expanded from zero in 1963 to 225,000 km^2 (c 2.25 million ha) in 1988. Potential agricultural land made available by the lake recession, varies from year to year, and from one season to the other.

Cultivation of the floor of Lake Chad has a long history. Denham and Clapperton (1826) noted the agricultural potentiality of the lake shore reporting: "cotton plantation covered with water" and noting that: "almost anything might be produced". At Lari, then on the lake edge, the explorers observed that:

> "... the soil near the edges of the lake was firm, dark mud, and, in proof of the great over flowings and receding of waters, even in this advanced dry season the stalks of the millet of the preceding year were standing in the lake, more than forty yards from the shore" (Denham and Clapperton and Oudney, 1826:183).

With the increasing climatic fluctuations since the turn of this century, and most especially following the droughts of the 1970s and 1980s, cultivation of the floor of Lake Chad has become a crucial aspect of semi-arid environmental resource management. For example Gatson et al (1979) reported the movement onto the lake floor of pastoralists and sedentary farmers from the Republics of Chad and Cameroon, with farmers engaging in both fishing and flood-advance and flood-retreat farming. By 1982, the intensification of burning on the lake floor and its possible negative effects on the hydrological character of the lake had been noted. By 1985, Nigerian migrants had established numerous settlements on the lake floor, not only to graze their cattle, but also to cultivate cowpea (Vigna unguiculata) and maize (Zea mays).

Flood-advance and flood-retreat farming is governed by the soil type and the level of water table, as determined by the stage of lake recession. The soil is hydromorphic and appears in two forms: mud and clay. Clay soils, because of their heavy nature, water retention capacity, high C/N ratio and high organic contents, are particularly suited for maize production. Maize production is based on the flood-advance technique, is planted in June just before the onset of the rains and this allows supplemental irrigation provided by rainfall. Maize consequently benefits enormously from the residual moisture content, the advancing lake water, and later, rainfall. The crop is harvested in October when the lake starts to rise in a normal year, thereby minimizing the risk and uncertainty arising from either water stress or excessive flooding. Because of the inherent soil fertility, productivity is relatively high, even without the use of organic fertilizer.

Cowpea (Vigna unguiculata), is produced on the muddy soils, which are made up of materials with granular facies, well-sorted materials, and well-drained with relatively low organic content. This is planted from January to February as the lake starts to retreat, and harvested from May to August. Due to the low water-use requirement of cowpea, the crop relies essentially on the residual soil moisture contents provided by the receding lake.

In 1989, the average plot size per household was 4.4 ha varying from 1.8 ha to over 16 ha. Larger sizes were recorded in the northern part of the lake floor, where there were large-scale commercial farmers, with holding sizes of between 100 - 200 ha or more. However, an average holding size of 4.4 ha is large compared with what obtains in other parts of Northern Nigeria. Land seems to be no major constraint to agricultural development on the lake floor.

Surveys of lake floor farming record that agricultural productivity is relatively high; much higher than both the upland farms and the government irrigation projects. The average maize produced per household was 1.98 metric tons, varying from zero production to about 9.8 metric tons. Some large-scale farmers produced 90 metric tons of maize. The average for cowpea was 2.5 metric tonnes per household, ranging from zero in some households to about 9.0 metric tonnes. Some households, particularly the large-scale farmers, produced 100 metric tonnes. On the whole, about 123,120 metric tonnes of cowpea are being produced on the lake floor annually. This level of production thus made a paradox of the 1983-88 Sudano-Sahelian drought; a situation of massive crop failure on the topland on the one hand, and that of massive food export from the lake floor to all parts of the country on the other (Kolawole, 1987:162).

The massive crop production has also led to increases in rural income. The average household income derived from the production of maize and cowpea in 1988 was N9,366.00, and this varied from less than N1,000.00 to over N41,000.00.[1] A further breakdown shows that large-scale farmers made fantastic incomes ranging from N20,000 to N100,000.00. The prosperity of lake floor farming has resulted in the accumulation of wealth, notably livestock, grain stock, household equipment and farm equipment, among the lake floor farmers. Upland farmers have fared less well over this period.

The state, through a parastatal, the Chad Basin Development Authority (CBDA) the parent body of the South Chad Irrigation Project (SCIP), has attempted intervention in lake floor farming. By 1985 the CBDA had extended its activities onto the lake floor, describing lake floor farming as "an ancient indigenous agricultural system which has passed the test of time" (FGN/CBDA/SCIP, 1984). In 1984, the UN and the Chadian Authorities had resettled some drought victims in Kraal Village, on the lake floor, provided them with agricultural tools and farm inputs in order to grow their own food (Diallo, 1984). The CBDA cultivated about 4,000 ha of land in Doro Buhari in 1985. The CBDA's intervention involved mechanization, the use of tractor-drawn equipment for land preparation and levelling, the use of fertilizer, herbicides and improved seed varieties.

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1 The FEM Exchange Rate = US $1 = N7.92.

The CBDA's experiment was, however, a failure because of the inappropriate technology involved. For example, mechanization disturbed the moisture - soil relationship and the water table which inevitably affected the crops. Secondly, CBDA planted improved varieties of cowpea, which are not only susceptible to diseases, but also require the application of chemical fertilizers, which is inappropriate without additional supply of water.

3.3 The Hantsu and Yankunama fadama, Hadejia river valley, Kano State

Both the Hantsu and Yankunama fadamas are situated in the Jahun Local Government Area of Kano State, about 150 km north-east of Kano. They are located south of Hadejia town, along the Hadejia River Valley. The two fadama represent the site of the latest technological innovations by indigenous farmers in fadama farming, with limited support from the state.

The Hantsu and Yankunama fadama farms are cultivated year round, depending on the level of the water table, the residual moisture content of the soil, and irrigation facilities available. Fadama crops are high value, labour intensive and need careful attention in the seeding stage and transplanting (Turner, 1977). Crops which are irrigated tend to require more labour than those which are dependent on ground-water supplies, but usually give greater returns. Irrigation types can be categorised as: shadouf irrigation, found along the streams; bucket irrigation from shallow wells; and small-scale irrigation schemes. Both the Hantsu and Yankunama fadamas are examples of small-scale irrigation areas based on simple irrigation pumps.

Until the impoundment of the Hadejia river for the Tiga Dam, the Hadejia valley fadama has been very popular for the production of fadama crops. Turner (1977) classified these into two: the fadama crops and crops which can be grown on either fadama or upland sites. In the first category are crops like: rice (Oryza sativa and Oryza glabemina) sugar-cane (Sacchtam afficinarum), carrots (Dacus cerota), lettuce, cabbage and cauliflower, and wheat (Triticum ssp). The second category of crops includes: tobacco (Nicotiana fobacum), tomatoes (Lycopersiarum esculantum), onions (Allium caps), peppers (Capsicum annum and C frutescens) and vegetables (purubcains, spinach etc). These crops are contained in Table 2 below.

Table 2: Crop Groups

Group A	Requires flooding	Swamp rice*
Group B	Shallow rooting, tolerant of water logging	Bananas, beans (some), 'spinach' (some)
Group C	Shallow rooting, intolerant of water logging	Onions, potatoes*, carrots*, cabbage*, lettuce, 'spinach'** (some), (groundnuts)*, pineapple, beetroot
Group D	Deep rooting, tolerant of water logging	Sugar**, cassava (some), guava, mango, pumpkin, melon*, okra, sweet potatoes, beans, wheat*, aubergine?, cocoyam
Group E	Deep rooting, intolerant of water logging	Tomatoes, peas, citrus, beans* (some), avocado, (cotton)*, cassava (some), maize**, yam

( ) never grown in fadamas.
* high photosynthetic capacity, ** low photosynthetic capacity - after Black (see Note 10).
Source: Turner (1977:487).

Two significant factors are responsible for the diffusion of small-scale irrigation pumps in this area. The first factor was the construction of Tiga Dam and the subsequent impact or the decline of the Hadejia river loods (Stocks, 1977).

The second factor, was the inception of the Accelerated Wheat Production Programme (AWPP), a clarion call to small-scale farmers to cultivate wheat in order to make the country self-sufficient in wheat production. However, the logic of wheat production requires an adequate supply of water and other farm inputs; wheat cannot be cultivated on a massive scale without the promotion of small irrigation pumps. The impoundment of the Hadejia River for the Tiga Dam and the introduction of AWPP, have drastically altered the land-use pattern of the fadamas along the Hadejia River Valley.

The non-flooding of the Hadejia river has led to widespread investment in small irrigation pumps to abstract water from the Hadejia River to produce crops. The AWPP has also led to the abandonment of most of the conventional fadama crops, thereby altering radically the cropping pattern in this area. The attractive price incentive given to wheat producers in recent years is quite unprecedented. Coupled with the remoteness of the Hantsu and Yankunama from urban centres, this has meant that crops like tomatoes, onions, peppers and other vegetables would only be produced in limited quantities. The only crop competing with wheat, and capable of dislodging it for socio-economic reasons, is rice.

First, rice is a staple food which farmers prefer, whereas wheat is a 'cash' crop. Second, the farm gate price of rice appears to be more attractive than that of wheat. Third, rice is relatively easier to produce and process than wheat. Finally, rice is planted in May and harvested in November at about the same time when wheat is being planted. Thus, any delay in rice harvesting will definitely jeopardise the chance of wheat planting.

Remoteness of both Hantsu and Yankunama has proved to be advantageous. Farm sizes are relatively larger than those fadamas closer to the urban centres, notably Dambatta, and Tomas (Kano state) and Galma (Zaria, Kaduna state). The average holding size of a fadama farm in Kano and Kaduna states was 0.84 ha, but this varied from 0.6 ha in Kano state to 1.0 ha in Kaduna (Table 2). About 20% of the sampled farmers have farms bigger than 1.0 ha. The survey also showed an inter-village variation in Kano where the farm size ranged from 0.31 ha in Dambatta to 3.1 ha in Yankunama, while that of Kaduna state varied from 0.25 ha to 2 ha in Galma, Zaria. Hantsu and Yankunama fadamas' remoteness means that the fadamas are owned and operated by the indigenous farmers, unlike the Dambatta, Tomas and Galma fadamas, where the plots are controlled by urban dwellers.

Table 3: Average farm size (Ha) and average yield (T/Ha) in selected fadama villages

Village	Average Farm Size (Ha)	Average Yield (T/Ha)
Dambatta	0.3	0.69
Tomas	0.5	0.44
Yankunama	3.1	1.42
Hantsu	1.5	0.97
Zaria, Galma	1.0	0.38
Overall Average	0.84	0.76
Average for Kano	0.60	1.14
Average for Zaria	1.0	0.38

Source: Kolawole, Alamu and Ambi (1990:32).

Of the two principal fadama crops, wheat and rice, data is available only on wheat. Table 3 summarises the average yield (T/Ha) in the study area. The overall average was 0.76 metric tonnes per ha, but this varied from 0.38 metric tonnes per ha in the Galma fadama to 1.14 metric tonnes for all the selected fadamas in Kano state. That of Kano state varied from 0.44 metric tonnes in Tomas to 1.42 metric tonnes per ha in Yankunama.

This analysis suggests that fadama management by indigenous farmers, with minimum state intervention, as in Hantsu and Yankunama, is more productive than where development interventions are more evident, as in the state irrigation projects.

However, the building of upstream dams has resulted in major changes in the fadama flooding pattern and water levels. Small-scale irrigation, using motorised pumps, is available to some, but increasing inequalities in access to fadama agricultural resources results. The re-establishment of a natural flooding pattern and the reopening of natural water courses to carry water to suitable areas for farming is seen as a priority (Adams & Hollis, 1989). The success of small scale fadama agriculture is under threat. State intervention in upstream dams is affecting fadama production. Also, successful expansion of fadama cropping, especially following incentives supplied by the wheat production programme, results in increasing conflict with other fadama users.

The nature of state intervention in the Hadejia valley fadama has been managed through the Kano State Agricultural and Rural Development Authority (KNARDA) and is directed at raising the carrying capacity of the fadama land in Kano. This involves promotion of new technological innovations, notably the use of small irrigation pumps, new and improved seed varieties, fertilizer, pesticides, improved water supplies and feeder roads. By mid-1987, KNARDA had dug 2,017 jetted boreholes, 896 shallow tubewells and supplied 32,000 motorised pumps (Adams and Hollis, 1989).

These interventions have resulted in a number of conflicts:

- Conflicts among settled farmers - opportunities for investment in irrigation technology is available to only the relatively wealthy. Such individuals have been able to expand their area under cultivation often excluding other, resource poor farmers from fadama production.

- Conflicts between agriculturalists and pastoralists - the expansion of fadama agriculture has resulted in the ploughing up of dry season grazing grounds used previously by Fulani pastoralists. This has resulted in major conflicts between these groups during the dry season when the transhumance brings the animals south to the fadama lands. In recent years, this has resulted in bloodshed.

- Conflicts between agriculture and fisheries - the alteration of water flows, both due to upstream daming and due to local water extraction by irrigation pumps, has resulted in the reduction of high quality fishing areas (eg at Maza fadama). The exact nature of impact on fish populations and yields remains unknown.

Technical intervention, such as encouragement of small scale irrigation in the fadama, must be combined with policies to offset the conflict between different user groups (eg farmers and pastoralists) and inequalities arising within the fadama farmers. A focus on land rights and tenure patterns is a clear priority.

Fadama rehabilitation exacerbates existing and growing conflicts about access to fadama resources between farmers and pastoralists. Externally imposed development, even if superficially 'low tech', simply does not avoid such conflict.

3.4 The Galma valley fadama (Zaria)

The state has also intervened in this fadama through flood control and water diversion measures, as well as the introduction of large-scale engine powered mechanisation for water control. Dams and canal networks have replaced the traditional water management practices, fadama land-use and shadouf and bucket irrigation. This also involves the use of new and improved seed variations, chemical fertilizers and pesticides. The water control measures have therefore neutralized the difference between annual and perennial fadama, as year round farming is made possible.

The degree of utilization of the Galma fadama seems to be higher than that of the Hantsu and Yankunama fadama (Section 3.3) for a number of reasons. The first factor relates to the extent of state intervention in this area. The second factor is the availability of labour to work on the fadama farms. The settlement density is the first measure of accessibility, and has an important influence on the amount of fadama which is cultivated (Turner, 1977). The third factor is the demand for fadama crops which increases with the population density. Fadamas located around the city are closer to the market and therefore have marketing costs drastically reduced.

The flood regulation measures, high population density and the proximity to the growing urban centres have had implications for the land use pattern on the Galma fadama. First, farms here are fragmented and small in size. For example, the average farm size in Galma was 1.0 ha, but this varied between 0.25 and 3.0 ha. Second, crop production is geared towards the immediate requirements of the urban areas; notably peppers, tomatoes, vegetables and okra. But cereals such as wheat, and maize are also produced, mostly for urban consumption and domestic needs. A survey of 94 fadama farmers on the Galma River Valley indicates that they cultivate other crops in addition to wheat.

Table 4: Number and percentage of wheat farmers who planted other crops in Galma fadama

Crops	Frequency*	Percentage
Tomatoes	81	86.2
Peppers	57	60.6
Onion	41	43.6
Rice	62	66.0
Carrot	20	21.3
Cabbage	18	19.1
Lettuce	17	18.1
Garden Egg	12	12.8
Others	6	5.3

* Multiple responses
Source: Kolawole, Alamu and Ambi (1990:41)

Crops are inter-cropped with other vegetables, yams, sweet potatoes and cocoyams. The following crop combinations are noticeable: wheat and maize; maize and tomatoes; maize and rice; tomatoes, peppers, okra and vegetables; and maize, peppers, okra and vegetables.

There is an intense competition between wheat and other profitable vegetable crops like tomatoes, peppers, rice and onions. Such commodities are in great demand in the urban centres. Unlike in other parts of northern Nigeria, where as a result of attractive price incentives, wheat is in the process of dislodging other traditional fadama crops, wheat faces intense competition.

However, in Galma River Valley inter-cropping is gradually being replaced by sole-cropping, due largely to the imposed regulated flows of water to the fadama. Presently, in the Galma River Valley, the major crops are wheat, maize and rice. It is, however, possible to still find a mixture of maize and tomatoes, maize and rice, tomatoes, peppers, okra and other vegetables.

Wheat production on the Galma valley fadama has not been entirely profitable. Research on costs and returns for wheat farmers on the Galma river indicates a negative net return per ha of N1,487.03 during the 1989/90 cropping season. All the wheat farmers here operated at a loss with the highest being N8,079.50. Apart from non-profitability of wheat production, there is the issue of insecurity which manifests itself in crop failure or low yield.

First there is lack of access to farm inputs, notably fertilizers, which has prevented farmers from following the appropriate management practices, and the resultant effect is extremely low yield, which has made wheat farming unprofitable. Second, there is no reliable source of water. Although large-scale engine powered mechanization for water control exists on the Galma River, farmers have to contribute money to buy fuel and engine oil to keep the pumps going. Farmers who cannot afford money for this have to give up the fadama farm allocated to them to wealthier farmers. Third, the production technology has not changed from the traditional hand methods of cultivation - land preparation and weeding being performed using different types of hoe, and knives/sickles for harvesting. Yet efficient and effective wheat production involves heavy mechanisation for land preparation, and the use of combine harvesters. The use of combine harvesters does not only save time and cost, but also reduces other wastage. Land fragmentation means that large scale mechanisation is impossible. Almost all harvesting and threshing were being done manually, thereby resulting in wastage, low output and high cost of production. Incidence of pests, notably stemborers, grasshoppers, rodents and birds poses an almost intractable problem, as prices of pesticides are exorbitant and seem to be out of reach of the poor farmers.

4 Socio-economic decisions involved in fadama management

The production decisions involved in the various case studies already discussed in Section 3 of this case-study have to be made within certain socio-agronomic and economic contexts.

The first principle is occupational diversification. Diversification is a response to ecoclimatic uncertainty, which makes agricultural pursuits extremely risky, and for survival, agricultural activities must be complemented by other occupations. This complementarity allows the risk and uncertainty to be more evenly spread, acts as a buffer against environmental fluctuations, thereby allowing proceeds from one occupation to be used in improving the productivity of the other. The complementary non-farming occupations pursued in this environment are fishing, trading, shoe making, leather works, arabic teaching, bricklaying, carpentry, tailoring, decorating, well digging, livestock rearing, entertaining and butchering, just to mention a few. These non-farming activities provide farmers with some insurance against the unreliability of the climate.

Bigger family size in this environment becomes meaningful only when understood in relation to household diversification. This perhaps explains why the household size in this environment is unusually large. Empirical studies in the Sudan savanna have demonstrated that average household sizes range from 4.4 members per household in Magumeri in Borno, Northeastern Nigeria to 13.0 members in Galma River Valley, Zaria. Large households tend to allow demographic risks to be spread through occupational diversification, specialization and migration, all of which allow large households greater flexibility and capability to survive.

The 'portfolio management', which characterizes the agricultural production system in this environment is an effective and efficient response to environmental risk and uncertainty. The strongest component of the 'portfolio management' strategy is agricultural spatial diversification; a situation where farmers farm different plots concurrently, thereby ensuring complementarity between them.

For example, in Borno, northeastern Nigeria (Section 3.1 and 3.2), farmers combine masakwa/firki cultivation, lake floor cultivation, and rainfed upland farming with irrigated farming, whenever irrigation facilities are available.

Table 5 indicates the incidence of farm types in Borno, northeast Nigeria. Farmers thus combine upland and wetland farming in order to offset risk.

Table 5: Ownership and farm types in Borno, Northeast Nigeria

Farm Type	No of Sample*	Percentage of Total
House Farm	24	3.7
Masakwa Farm	76	11.7
Sandy Soil/Rainfed Farm	257	39.6
Lake Floor Farm	291	44.9
Total	648	99.9

* Multiple responses
Source: Kolawole (1989:62)

Seasonal Patterns

These farming systems form a closely interlinked agricultural calendar. From February to June each year, for example, farmers are engaged in market gardening; June to September, upland rainfed farming; October to January, masakwa/firki cultivation; and lake floor farming from February to December. For some farmers, lake floor farming is becoming a full-time, year round activity as multiple cropping is made possible in a normal year, depending on the rise and fall of Lake Chad each year.

In the Galma Area, Zaria (Section 3.4), there is a complementary relationship between fadama farming and rainfed upland farming. This again relates to a distinct agricultural calendar. Fadama farming takes place mostly during the dry season, but the provision of irrigation facilities has made possible year round fadama farming.

This intensive fadama farming operation commences with tomatoes and other vegetables from immediately after the rainy season in September; wheat cultivation (November to March); rice production (May to September) each year. The cropping pattern and sequence for the Hantsu and Yankunama (Section 3.2) is virtually the same as that of the Galma River Valley, except that few tomatoes, peppers and vegetables are produced due to its remoteness from urban centres.

Stagger, sequential and relay planting result in differing gestation and harvesting periods. This ensures food supplies throughout the year, and especially during the hungry periods, when the harvest of the rainfed upland farms is being awaited. Such regular food supplies, especially from the lake floor, have contributed significantly to the amelioration of the impact of the Sudano-Sahelian drought of 1983-4 in Borno, Northeast Nigeria (Kolawole, 1987).

Labour Demands

The agricultural calendar keeps the farmers fully engaged throughout the year, changing from one form of farming activity to another. It also creates employment for labourers, particularly during the peak periods. In Borno, the lake floor farming promotes labour demand throughout the year; while on the Galma, the greatest labour demands are for planting (April/May), for irrigating (January to April) and for the sugar cane harvest (September to early March). The same pattern is common for Hantsu, and Yankunama fadamas

High Value Crop Production

Production of highly valued crops, notably rice, wheat, tomatoes and vegetables, makes fadama farming a profitable venture. Under poor rainfall it is a more reliable source of income than the upland farming. Most of the fadama crops, particularly maize, are harvested and marketed during the hungry period when the market value is high.

Risk Management

The complementarity between rainfed upland farming and the fadama does not only spread risk and uncertainty, but also allows farmers to have investment in two farming systems, thereby facilitating a periodic movement of resources between the two, as the resources of one farming system are used to improve the productivity of the other.

Fadama farming is the management of risks. There are two main risks involved in fadama farming. The first is the fluctuation of the water table, and the attendant dangers of flooding, especially during the rainy season. The second form of risk is the danger of inadequate water supply at the end of the dry season. Caught within these two extremes, farmers have had to strike a delicate balance between water stress on the one hand, and flooding on the other. The cropping strategy is dictated by the farmers' perception of the environment as regards the behaviour of the flood, the soil condition, and the reaction of crops to water stress or flooding. There are a range of strategies involved.

i The **wet-season cropping strategy:** the cultivation of flood tolerant crops such as rice (Oryza glabemia, Oryza satwa) and wheat (Triticum aestrium) in the Sokoto River Valley (Adams, 1986) as well as in Hantsu, Yankunama and Galma fadama. On the floor of Lake Chad, maize (Zea mays), because of its flood tolerant nature, is grown as a flood advance crop.

ii The **dry-season cropping strategy** consists of cultivating the drought tolerant crops, notably millet (Pennisetum typhoidem), sorghum (Sorghum bicolor, Sorghum carnuum), cassava (Manihiot esculanta) and cowpeas (Vigna uniquiculata).

iii The cultivation of crops with **short gestation periods**, notably sorghum (masakwa/Sorghum carnuum) which requires just 90 days gestation period; maize (Zea mays), which has a gestation period of between 80 to 120 days; and cowpea (Vigna uniquiculata) with a gestation period of between 90 to 120 days. This is more popular in the Chad Basin Area than elsewhere. Farmers have learnt that crops with longer gestation periods, notably rice, millet, sorghum and wheat can be adversely affected by inadequate soil moisture content during the critical seed period or disrupted by excessive flood.

iv **Sowing both flood tolerant and drought tolerant varieties** together occurs especially in the Sokoto River Valley (Adams, 1986). The calculation here is that if there is excessive flood, the flood tolerant crop will survive, and in the event of inadequate soil moisture content, the drought resistant crop will yield something. Another common game the farmers often play is to sow the drought tolerant millet variety early in anticipation of rain. If the rain comes, the farmer wins by recording a huge harvest; if the rain does not come, he stands to lose his seeds, which he must replant (Scott, 1979).

v **Inter-cropping** is an important risk aversion strategy in fadama farming (Mortimore and Ologe, 1975). Mixed cropping techniques have the following crucial advantages:

- they allow different rooting systems to exploit different levels in the soil profile for moisture nutrients;
- one crop may provide a favourable micro-climate for another;
- nitrogen fixing plants fertilize the non-nitrogen fixing plants;

- crops which are scattered among others are less vulnerable to pest attacks than single stands;

- labour requirements are less, especially in reducing weeds;

- more moisture is retained in the soil;

- returns are higher per unit of land;

- successive sowing of crop mixtures, supplies a mixed diet over an extended period;

- where labour is a constraint, the returns to labour are increased at the time of the year when labour is limited (Norman, 1974).

Because of these advantages, the prevalence of mixed-cropping in Africa has been put at 80% of all farm lands (Richards, 1985). Norman (1974) found about 147 distinct inter-crop combinations in his study of three villages in Zaria Province, on both fadama and upland fields. The fadama is particularly suited to mixed cropping. Hence Adams (1986) noted that before the construction of the Bakolori Dam, there were over 154 inter-crop combinations in the Sokoto River Valley. The construction of the Bakolori Dam has however, regulated the fadama, thereby reducing the range of crop combinations. The state intervention has altered the traditional agricultural system, transferring the system to one of rice and wheat crops.

vi **Sequential cropping** and **relay cropping** are other significant features of fadama farming. For example, in the Sokoto River Valley, rice is planted in January and harvested in May, another rice crop is planted in June and harvested in November, and this is immediately followed by wheat in November. In the Galma River Valley, wheat is cropped from November to March, followed by maize and rice, and tomatoes, peppers and vegetables. In the cultivation of the lake floor, sequential planting is only practised in abnormal years.

The term 'relay cropping' is often used where these sequences overlap, as for example, in the Sokoto River Valley, where <u>gero</u> millet is harvested in October, by which time the relay crop of sorghum is heading and takes over, and this is harvested in November or December, allowing a third element in the relay to mature in its turn (Adams, 1986).

vii Fadama farmers, except those on the regulated fadamas, where regular water supply is assured, normally prefer **traditional crop varieties** which are not only quick maturing and pest resistant, but are drought tolerant. This is the case on the lake floor, where regular supply of water is not assured. Here farmers' refuse to cultivate the high yielding varieties (HYVs). Farmers' refusal to grow HYV seems to be logical in three significant respects. First, the use of HYVs requires irrigation or a regular supply of rainfall, which is not available on the lake floor. Second, HYVs need heavy doses of fertilizer application and pesticides, which are not available on the floor of Lake Chad. Thirdly, fadama farmers in general, and most especially, lake floor farmers are the most neglected, without access to productive resources, notably farm inputs and extension services.

5 Conclusion

This review has examined the role of wetland farming in environmental resource management in the semi-arid zone of Northern Nigeria. The wetlands identified in this area include the firka/masakwa; the Hantsu and Yankunama fadama; the Galma fadama and lake floor cultivation. In addition to farming, the fadama were found to be an invaluable ground for livestock grazing, as well as a source of famine foods in periods of environmental stress. Conflicts over use of these valuable resources has become a major issue.

Fadama farming was found to be a strong component of portfolio management which involves occupational and agricultural diversification. Diversification allows complementarity not only between one form of occupation and the other, but also between one farming system and another.

Fadama farming is central to the management of risk and farmers have, over the years, evolved risk management techniques such as various labour saving strategies, each with their own crop mix production techniques. Farmers usually strike a delicate balance between risk minimization and profit maximization in their crop choice and crop mix.

The cropping pattern is, however, changing from the conventional fadama crops due to two principal reasons. First, state intervention in fadama management, notably flood control, water diversion and dam construction have reduced river flooding, thereby making it virtually impossible to farm some of the conventional fadama crops. Second, state intervention has also led to the dictation of cropping patterns and the introduction of new crops, particularly wheat. This has tended to promote mono-cropping rather than mixed-cropping. Wheat, the latest addition to fadama crops, is now competing with conventional fadama crops such as tomatoes, peppers, rice and onions.

Fadama farmers are the most neglected in terms of provision of farm inputs and extension services. To enhance the productivity of the fadama there is a need to provide efficient and effective extension services for the fadama farmers; the state intervention should be limited to this area.

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IIED'S DRYLANDS PROGRAMME

The Drylands Programme at IIED was established in 1988 to promote sustainable rural development in Africa's arid and semi-arid regions. The Programme acts as a centre for research, information exchange and support to people and institutions working in dryland Africa.

The main fields of activity are:

- Networking between researchers, local organisations, development agents and policy makers. Networks help exchange ideas, information and techniques for longer term solutions for Africa's arid lands.

- Support to local organisations and researchers to encourage sharing of experience and ideas, capacity building and establishing collaborative links.

- Action-oriented research in the practice and policy of sustainable development in Africa's drylands, focusing on the variability of resources and incomes on which populations depend, development-oriented research methodologies, and natural resource management systems.

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