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Animal Traction in West Africa: Categories, Distribution and Constraints A Nigerian Case Study

Roger Blench

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**ANIMAL TRACTION IN WEST AFRICA:
CATEGORIES, DISTRIBUTION AND CONSTRAINTS**

A NIGERIAN CASE STUDY

Roger Blench

November 1997

Overseas Development Institute
Portland House
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Preface

This working paper combines two major elements: firstly, a co-operation between the Agricultural Research Unit of the World Bank and the former Subhumid Programme of the International Livestock Centre for Africa (ILCA) carried out in Central Nigeria between March and July 1987 and secondly, the findings of the National Livestock Resource Survey, 1989–92. Visits to Nigeria in May 1996 and May 1997 enabled me to update some of the price information.

The first element was funded by the Agricultural Research Unit's Program on Crop–Livestock Interaction and with the logistical support of the ILCA Subhumid Programme, Kaduna. I am grateful to Hans Binswanger (formerly of the Agricultural Research Unit) for commissioning the study and to Ralph von Kaufmann for discussion of the survey design, support during the fieldwork, and data preparation. John McIntire of ILCA, Addis Ababa, assisted in the presentation of the original terms of reference. The argument has benefited greatly from formal and informal discussions with researchers attending the ILCA Animal Traction Thrust Planning conference, which took place in Addis Ababa, 7–11 September, 1987. I would like to thank all those who took the time to read and comment on the report in its draft phase, in particular, Ralph von Kaufmann, John McIntire, Mike Goe and Paul Starkey. It was then presented to the World Bank and approved in October 1987.

The second element, the Nigerian National Livestock Resource Survey (RIM, 1992) for which the author was Ground Survey Co-ordinator, was submitted to the Nigerian Government as part of the preparation for a Third Phase of Livestock Development.

In view of the fact that neither of these reports were published or widely distributed and in the light of the expanded experience of animal traction in the 1990s it seemed worthwhile to re-analyse and update the information for wider circulation. This Working Paper is the first step in that process. Johan Hesse of Göttingen provided helpful comments on the present document.

Roger Blench
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Acronyms

ADP	Agricultural Development Project
EMCOT	'Empire Cotton', trade name of the locally manufactured plough
IBRD	International Bank for Reconstruction and Development
ILCA	International Livestock Centre for Africa

Geographical Terms

- Adamawa** A pre-colonial political unit consisting of the region directly south of Lake Chad, comprising modern-day Adamawa and southern Borno States in Nigeria and adjacent parts of Cameroun Republic.
- Middle Belt** A commonly used term for the northern part of the Nigerian subhumid zone; generally referring to the area north of the Niger-Benue.

Administrative Divisions

Subsequent to the fieldwork analysed in this report, Nigeria created more States. Gongola State was split into Adamawa and Taraba States, Borno into Borno and Yobe. As of September 1996, the Federal Government had embarked on another round of State and Local Government creation, although no published map of these new States is yet available. In the face of this administrative instability, the States and Local Governments referred to in the text are those that existed at the time of the surveys reported here.

Currency

The currency of Nigeria is 1 naira (₦) = 100 kobo.

Until October 1986, the value of the naira was approximately one naira to US\$1. However, subsequent to devaluation the naira was allowed to float. Its approximate value in March–July 1987 was four naira to US\$1. In October 1997 the exchange rate was ₦135 to US\$1.

1. Introduction

Although animal traction in Africa is a subject of considerable interest in terms of sustainable development, most literature concentrates on its technological aspects rather than on contexts of use. Surveys carried out from 1986 to 1991 across a broad region of northern Nigeria have mapped the distribution of different types of traction, with a view to establishing some parameters leading to its adoption and analysing the constraints on its further spread.

This study is divided into two major sections (see Foreword). The first part (chapters 1–3) gives the general background to animal traction in Nigeria, enumerating the principal species used and the different types of use to which they are put. The second part (chapters 4–6) describes a major study of the constraints on adoption of animal traction and concludes with general recommendations as to further research and policy reorientation.

1.1 Background to draught animal power in Africa

Although the literature on draught animal power in Africa is extensive, only a small proportion concerns the ethnography of its adoption and use (see the bibliography by Goe and Hailu, 1983). The contrasts between plough-using and non-plough-using societies have long been of theoretical interest to sociologists. Boserup (1970) argued that plough-using societies were distinguished by greater emphasis on private landholding, more participation by men in agricultural work and (often) more elaborate social stratification. Goody (1976) refined these hypotheses by showing that the opposition of hoe and plough also has consequences for inheritance, marital strategies and kinship systems.

In the pre-colonial era, animal power was virtually unknown in most of sub-Saharan Africa, with the exception of the use of camels to draw water. Ethiopia is well-known for the use of the *maresha*, essentially an ard which fractures and disturbs the soil, dating from antiquity. However, all forms of animal traction have an ancient history in North Africa (Bulliet, 1975) and, in theory at least, could have been transmitted across the Sahara with the caravan trade along with food crops and irrigation techniques. Indeed, as Bernus (1981: 286) points out, simple camel-drawn ground-preparation tools (*ashek n egdri*) are used in Saharan oases by the Tamasheq.

Wheeled vehicles were not present in pre-colonial Africa, despite the existence of Saharan rock-paintings illustrating horse-drawn wheeled chariots more than two

millennia old. Bulliet's (1975) account of the dynamic relationship between the camel and wheeled vehicles shows that carts are by no means an inevitable progression from other types of traction.

These examples suggest that animal traction existed on the borders of sub-Saharan Africa and would have spread to it, if some obstruction had not occurred. The most common explanation is the widespread presence of the trypanosomiasis carried by the various species of tsetse fly (*Glossina* spp.). In this century, tsetse has retreated due to both active eradication campaigns and extensive habitat destruction. However, in the pre-colonial era it was found up to the desert margins. The confinement of the plough to the tsetse-free highlands of Ethiopia is then explicable: subjecting cattle in the lowlands to the additional stress of traction was enough to eliminate them rapidly. Although it is possible to maintain work-oxen in the lowlands under strict prophylaxis (Bourn and Scott, 1978), migrants from the highlands saw their animals die rapidly after such a move.

The development of effective prophylaxis against the trypanosomiasis together with the destruction of habitats for the vectors following extensive agricultural colonisation (Bourn, 1983) have made animal traction practical in a much broader range of environments. The desire of the colonial authorities in Africa to encourage intensified farming systems and cash-crop production led to attempts to introduce tractors and ox-ploughs throughout the continent, particularly in the semi-arid and subhumid zones.

The first phase of this has been reviewed by De Wilde (1967). SEDES (1975) provides some quantitative documentation on the dissemination and spread of ploughs in various African countries up to 1974. Pingali et al. (1987) review the entire question of the relationship between manual labour, animal traction and tractorisation. The conventional wisdom on the economic benefits of ploughs and tractors can be questioned in many circumstances.

There are also specific country studies illustrating the social and economic contexts of the adoption of animal traction. Panin (1986) has compared the socio-economic aspects of hoe and animal traction using households in Northern Ghana. Holy (1986) has analysed the effects of adopting ox-ploughing on inheritance and kinship patterns among the Toka people of Zambia. Peltre-Wurzt and Steck (1979) chronicle the spread of animal traction in relation to cotton cash-cropping in northern Côte d'Ivoire. Munzinger (1982) has reviewed the entire subject of animal traction in Africa, while Blench (forthcoming, b) has considered its impact on the African environment.

1.2 Nigeria: country background

This research is intended to be comparative. The conclusions drawn should have a broad relevance to the problems of innovation adoption and development strategy. However, some features of the administrative structure and economy of Nigeria are unique within the West African context. Since these affect the diffusion and adoption of animal traction, a brief description of the survey area is given here.

Nigeria is one of the larger countries in Africa and has the largest population, estimated at 88.5 million in 1992. Central Nigeria is the most ethnically diverse region within the country where there are between one and two hundred distinct ethnic groups speaking different languages (Crozier and Blench, 1992). The zone was raided for slaves from further north for several centuries, and this may account for the isolation of many peoples in hill-refuges (Ballard, 1971). At the beginning of the colonial era, many of the hill-peoples descended to the plain. At the same time, southward migration from regions of exhausted soil in the semi-arid zone began, thus creating a diversity of both populations and farming systems.

Although formerly there were small, dispersed populations of dwarf West African shorthorn cattle throughout the zone, the appearance of occupationally specialised pastoralists herding zebu breeds dates only from the late nineteenth century. These pastoralists were Fulbe (Fulani), as elsewhere in West Africa, and they were able to expand into this area, following the conquest of Hausaland by their settled 'cousins' during the last century. The factor limiting their southward expansion was almost certainly the tsetse fly; grassy uplands such as the Jos and Mambila Plateaux were settled long before the subhumid lowlands.

Unlike the Sahelian regions, most of the populations among whom the pastoralists settled kept only small ruminants and were unfamiliar with cattle. The process of investing in cattle by arable farmers, which has been under way for millennia in East Africa, has really only become important in subhumid regions during the last half-century. Since milk is not widely drunk by the indigenous arable farmers, the purpose of investing in cattle was to sell them for meat.¹

Nigeria is distinguished from its neighbours by its high degree of urbanisation: estimates put the figure as high as 40% of the total population. In addition, the absolute population of the country is very large, with a high urban demand for foodstuffs of all kinds. As a result, a conventional division between 'cash' and 'subsistence' crops is not useful in Nigeria. Usual West African cash crops, such as cotton and groundnuts, are insignificant in comparison to the internal demand for maize, rice, tomatoes and peppers. More peripheral crops, such as ginger and

¹ This is often attributed to lactase-intolerance, although this remains debatable.

soya-beans, can prove extremely profitable to specialised producers in particular locations.

Nigeria has always had a relatively well-developed marketing infrastructure. The influx of cash into the economy in the oil boom period (c. 1975–90) expanded the informal sector, with the result that the marketing system is remarkably efficient. A plethora of lorries and pick-ups, purchased by traders during the period of cheap imports, still reaches the remotest areas, and villagers will often unite to make or repair a motor road, even when collective work on farms has been abandoned. Farmers rarely complain about problems of marketing surplus staples, because any significant quantities are picked up directly from their farms by traders for shipment to the cities.

In explaining the decision-making process of individual farmers it is relevant to emphasise the extreme variability of access to inputs and resources such as tractors and fertilisers. Both tractors and fertiliser can be widely in use in remote areas and yet entirely absent in villages on a tarmac road only a short distance from a Local Government Headquarters. The economics and indeed feasibility of animal traction thus have a mosaic distribution rather than spreading gradually at a uniform rate.

1.3 Historical background to animal traction

Both livestock and arable farming extension services have a history stretching back to the First World War. Walker (1979) provides an abbreviated history of the livestock services and Tiffen (1976) describes the operation of arable farming extension in the post-colonial era. The encouragement of animal traction has a long tradition, described for the pre-Second World War period in King (1939) and Corby (1941). The motivation for this type of extension was essentially the encouragement of smallholder cash-cropping, particularly cotton, as the trade name of the locally manufactured plough, EMCOT ('Empire Cotton') indicates. A comparable process was to occur in northern Côte d'Ivoire in the 1960s (Peltre-Wurzt and Steck, 1979).

Credit for ox-ploughing was established as early as the 1930s. Loans were generally for the plough itself, for trained oxen and sometimes for a cart. These loans were made by the 'Native Authority', roughly equivalent to the present Local Government system established in the post-colonial era. This practice was continued into the late 1970s in certain places, notably Adamawa. However, the smallholder economy of Nigeria, based on cotton and groundnuts in the North, and oil-palm, cocoa and other tree-crops in the South, was transformed by the massive influx of money subsequent to the development of oil resources at the end

of the 1960s. The Federal Government embarked on ambitious programmes in education, health and agriculture. Universal Primary Education was introduced in the mid-1970s, while clinic-building, water supplies and rural electrification projects were all expanded at this period. At the same time, most taxes on peasant farmers and livestock producers were dropped. The agricultural extension services of the States were built up and a number of large-scale Federal Government farms and ranches were established, often in partnership with development agencies.

The relevance of this for animal traction was the image of 'progressive' agriculture presented to the farmer. Tractor Hiring Units were established in all northern States and tractor-ploughing made available to farmers at highly subsidised rates. Some of the ADPs made soft credit available to farmers to hire tractors, while promoting 'improved' maize and fertiliser which were also made more attractive by subsidies. The pattern of tractor use reflects this situation. The tractor is associated with modernity and thought to be progressive. Even where farmers have observed damage to the environment they remain impressed by its working capacity. In contrast, some ADPs continued the pattern of more traditional extension and sold ox-ploughs through Farm Service Centres as well as giving loans to buy oxen.

The colonial literature on animal traction in Nigeria is mostly concerned with the economic benefits of the introduction of the plough (e.g. Faulkner and Mackie, 1936; King, 1939; Turner, 1940; Corby, 1941; Laurent, 1968). In most of this literature, plough users are referred to as 'mixed farmers'. Only later did this term come to have the more general meaning of farmers practising a variety of integrated livestock/cropping enterprises. Tiffen (1976) and Mirchalaum (1976) describe the introduction and spread of ploughing in Gombe Emirate of Bauchi State and Longuda District of Gongola State respectively. Blench (1987a) analysed the constraints on animal traction along its southern limit, based on interviews with former plough users. Starkey and Ndiamé (1988), Starkey and Faye (1990) and Lawrence et al. (1993) have edited useful summaries of experiences with animal traction in West Africa, with sections focusing on Nigeria. Maharazu (1996) and Chiroma (1996) give recent accounts of the history and economics of animal traction in villages near Kano and Damaturu, respectively.

A bibliography of draught animal power in Nigeria has been published by the National Animal Production Research Institute (Gefu et al., 1989). This confirms the continuing lack of serious research on the social and economic background of animal traction. The bulk of the material tends to concern potential traction equipment, much of which is remote from the actual situation of farmers.

2. Types of traction and their distribution

2.1 Animals used for traction

The main types of traction in Nigeria are ploughing, carting and drawing water. The species used are cattle, camels, donkeys and horses. Of these, cattle, camels and donkeys are used for ploughing; cattle are used for carting; cattle, camels and donkeys for drawing water; and horses are used for turning sugar-mills (Table 1). Horses are of virtually no economic significance.

<i>Use</i>	<i>Camels</i>	<i>Cattle</i>	<i>Donkeys</i>	<i>Horses</i>
Ploughing	+	+	v. rare	v. rare
Carting	+	-	v. rare	-
Water-drawing	+	rare	+	-
Sugar milling	-	-	-	+
Pack animals	+	+	+	-
Personal transport	+	+	+	+

2.2 Types of animal traction and their distribution

Ploughing

Ploughs were first introduced on an experimental basis in the 1920s, and were regularly imported from the 1930s onwards. Although the original motivation was to increase smallholder cotton production, ploughs were rapidly adapted by farmers to the needs of subsistence tillage. In the 1990s, the farming systems of central-north Nigeria can be characterised by the use of animal traction. Even smallholders who do not own traction implements can usually afford to hire them from neighbours. Ploughs were formerly provided by the Government at a subsidised rate, but by the 1990s they were all bought at local markets with prices ranging from ₦1,000 (for locally-made frames) to ₦3,500 for a new factory-made implement (1997 prices).

In the semi-arid zones, the expansion of cultivation and the shortening of fallow cycles has led to soil exhaustion in many areas, and ploughing enables the tillage of larger areas of farmland in an attempt to compensate for declining yields. At the same time, the growth of markets for both cash crops and surplus staples to feed the cities has acted as a stimulus to ploughing because of the greater cropping area being used. In cases where the rains are likely to arrive late, thereby compressing the critical time of peak labour input, a plough-using farmer is far better able to cope than a hand farmer.

Camels. Camel-ploughing has been established in the Sahel for more than forty years, but in north-western Nigeria it is a relatively recent phenomenon. In Sokoto State, this form of ploughing was unknown before 1975, and generally has only been adopted in the second half of the 1980s. It is said to have spread from the Republic of Niger. The Jetko and Manga people in north-western Borno (Yunusari Local Government Authority) claim to have been using camels for ploughing since 1960, but this innovation has yet to spread elsewhere in Borno.

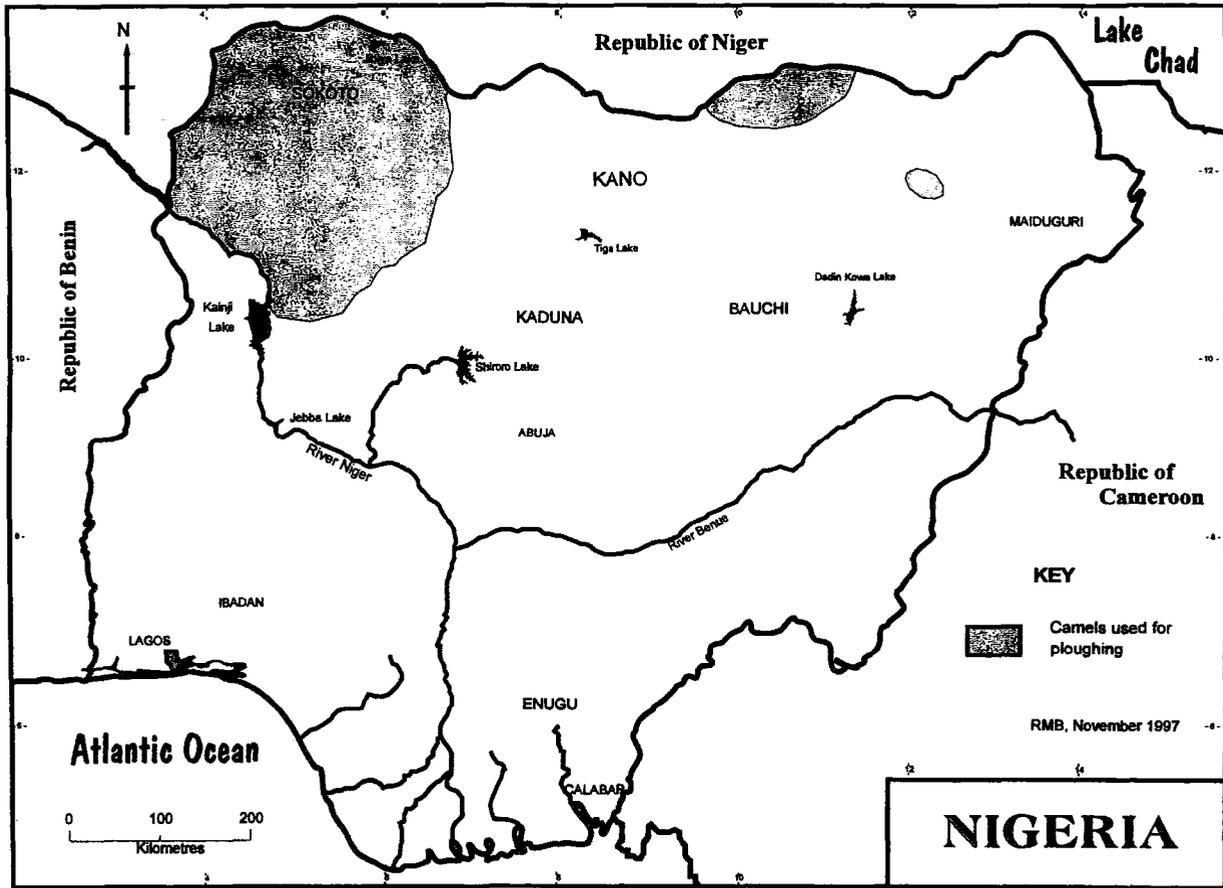
The harness used for attaching the plough is usually a simple rope frame attached by heavy cords to a conventional ox-drawn ridger. One man guides the plough and another leads the camel from the front with a rope attached to its nose. Very exceptionally, a second person rides on the camel to direct it. The advantages of camels, according to their owners, are that they plough faster, live longer and need less feeding and veterinary attention than other traction animals. Another virtue of camels is that it is far simpler to turn them at the end of a row, as turning paired oxen is an altogether more complex and skilled operation.

The most striking feature of the use of camels for ploughing is their southward location in Nigeria. As shown in Map 1, camel-ploughs were seen in 1991 as far south as the shores of Lake Kainji – a surprisingly humid region. Given the high capital cost of camels, owners must be fairly certain they will survive under conditions of high moisture. This suggests that camels can thrive in areas of higher rainfall than previously supposed.

Cattle. Cattle are always used in pairs for ploughing in Nigeria. Zebu cattle are the principal breed used throughout northern Nigeria. Most breeds of zebu are used for traction, although there is little consensus about the superior qualities of individual breeds. Sokoto Gudali are rarely used, as Azawak and Rahaji are generally preferred. Kuri cattle are used in the region of Lake Chad and the valley of the Komadugu Yobe, and some are even transported to Kano State for traction. In the south-west of Nigeria, in Borgu, along the Benin Republic border, keteku (a zebu x muturu cross) are preferred for traction because of their size and disease-resistance. Muturu (humpless shorthorns) are not used for traction at all, even in

Map 1

Distribution of camel-ploughing in Nigeria, 1991



the north where they exist alongside zebu. Map 2 shows the approximate distribution of ox-ploughing in Nigeria as it was in 1991.

Although the literature conventionally refers to 'oxen', the evidence is that only a small proportion of work-cattle are actually castrates. Most farmers keep their bulls entire, perhaps because they can withstand better the dry season grazing, or simply through lack of knowledge. Cows are very rarely used for traction, although the practice is not unknown.

Farmers usually buy cattle from Fulbe traders when the animals are between three and four years old. They may be bought when even younger and kept with the Fulbe for grazing until they are of sufficient size. Training takes one to three months, with the cattle being taught first how to pull a heavy weight, then how to pull a plough and later, in some regions, a cart. The cattle, usually bulls, are worked for about five years before they become too fat and are sold.

Few farmers can afford to operate a plough without hiring it out, as the cattle have to be provided with *dusa* (bran) and *harawa* (dried fodder) during the farming season.¹ Plough animals also have to be fed well prior to the farming season, because if they are left out to graze for the whole dry season with the other cattle they may not be strong enough to work effectively once the rains commence. Some animals may be kept at home all year and used to pull carts.

Plough owners may be willing to postpone payment for hiring their plough until after the harvest, which is preferable for a farmer who would otherwise have to hire and pay labourers by the day. The cost of hiring a plough is measured either by the actual area to be covered or, in an area with variable soils, by the type of soil to be ploughed. Hiring a plough has the disadvantage that the land is not worked immediately after the first rainfall, but this is often weighed up against the loading of management risks onto another farmer.

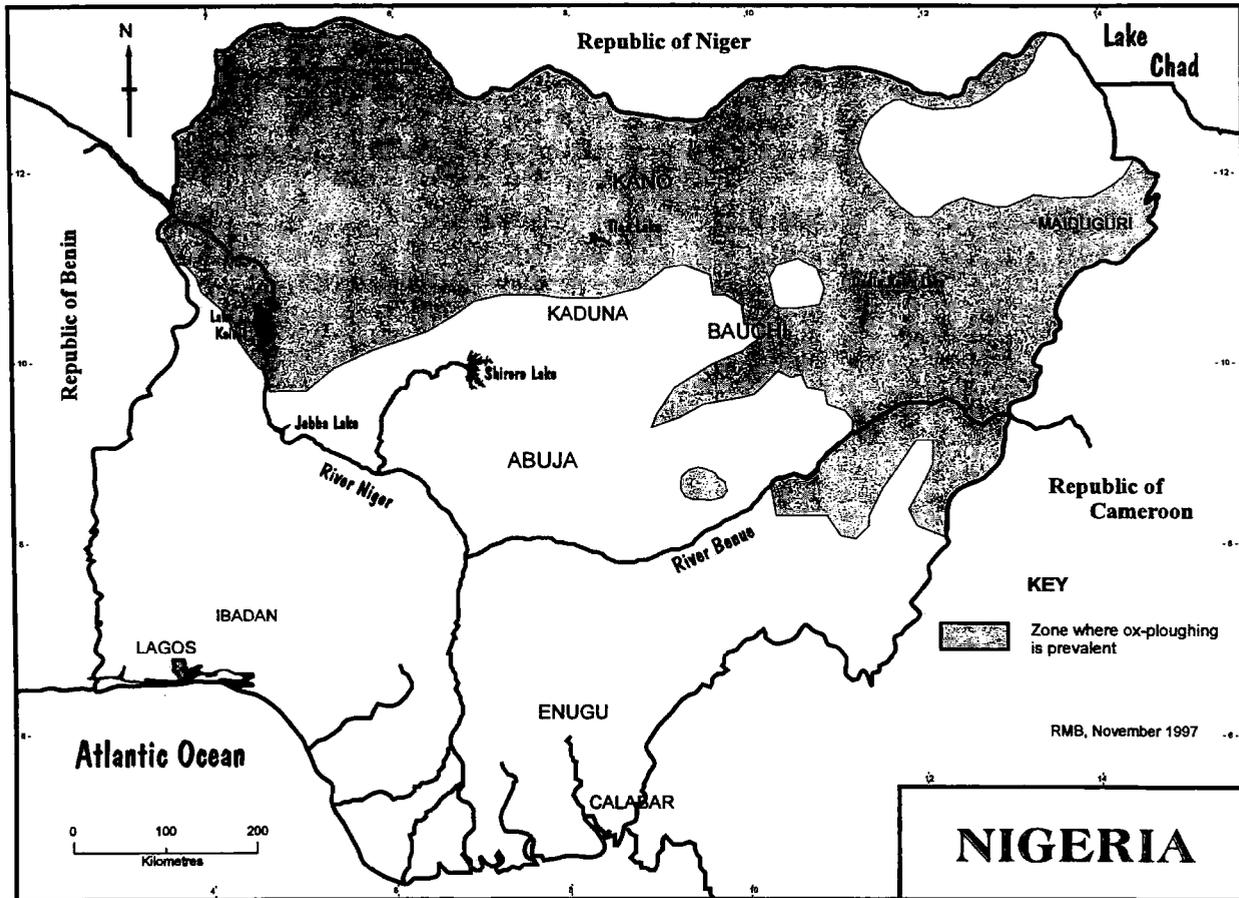
Carting

Carts were introduced into Nigeria later than ploughs, and they seem to have never enjoyed quite the same degree of success. Haynes (1965) describes some of the early models of ox-carts. As Map 3 shows, the use of carts is much less widespread than ploughs even in northern Nigeria. In part this is because ploughs were introduced and their use extended for a specific economic motive, the

¹ Maharazu (1996) found that in a sample village in Kano State, ploughs were owned by only one family in 25, but that virtually all families could manage to hire a plough for basic ridging.

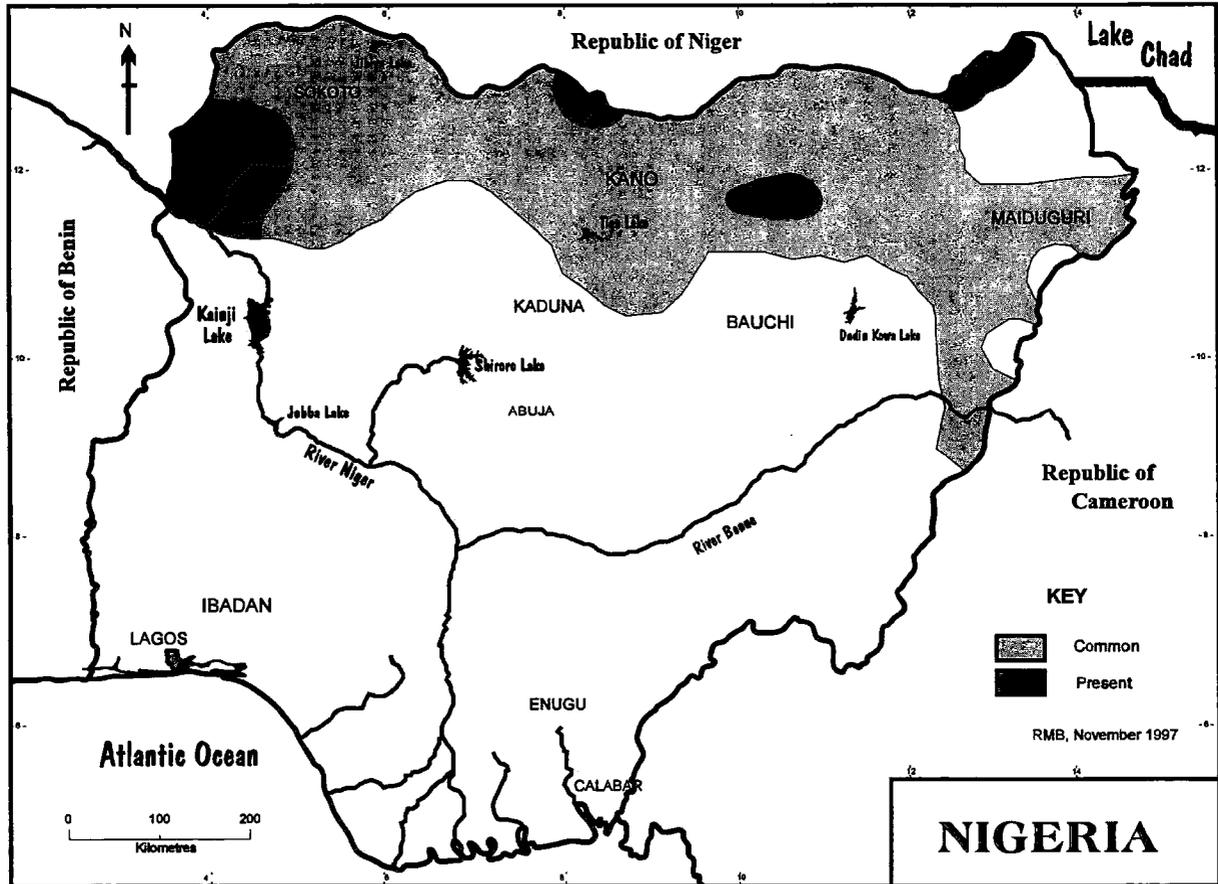
Map 2

Distribution of ox-ploughing in Nigeria, 1991



Map 3

Distribution of ox-carts in Nigeria, 1991



cultivation of cotton. Carts were introduced for more disinterested reasons, and only in certain areas. The diffusion of carting came to a virtual halt at the end of the 1970s with the development of cheap transport networks based on motor vehicles for both people and produce. However, there has been a considerable expansion of cart manufacture following structural adjustment, as the costs of maintaining pick-ups have risen and transporters have preferred to keep their vehicles on tar roads.

Drawing water

Cattle, camels and donkeys are used in the arid regions of northern Nigeria for drawing water from deep wells. The species of animal used is partly a function of the depth of the water-table and partly of the wealth of the individual family.

Sugar milling

Horses are not used as work-animals in Nigeria, with the exception of powering one device, the sugar-mill (*masankwela*). This crushes the sugar-cane and the liquid is then boiled to produce heavy cakes of brown sugar. Goodban (1944) describes the operation and economics of sugar-crushers near Zaria during the Second World War. At that time, the production of brown sugar was very profitable because of the disappearance of imported sugar. The virtual collapse of sugar-crushing followed the widespread availability of modern 'white' sugar in the 1980s.

The horse-mills that survive are dependent on the market for cakes of brown sugar which are still popular in traditional Hausa areas. In 1991 there were some five mills still operating on a seasonal basis in Bauchi, Sokoto and Katsina States. There are also sugar-mills close to Kano town. The millers have a number of operating sites and they move from one to another on a seasonal schedule. They buy up stocks of cane in each region, crush it, make cakes and transport them away for sale and then continue to the next site.

3. Implements, technologies and supply

3.1 Ploughs

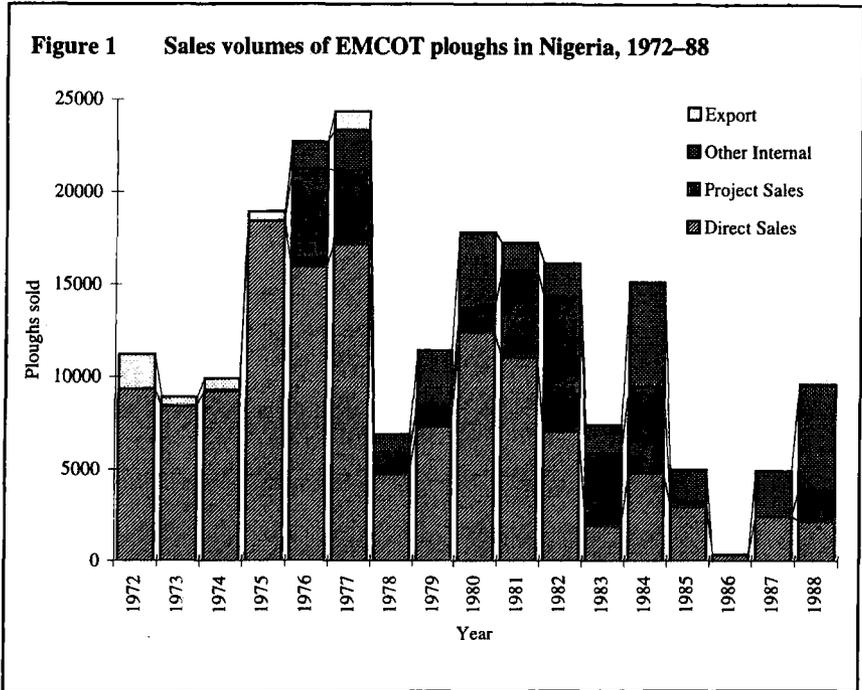
The 'plough' in general use in Nigeria is actually a ridger with two wings and originally designed for cotton cultivation (Ransome, Sims and Jefferies, 1965). The rare examples of donkey-ploughs are smaller, but of the same type. There are no examples of mixed teams of animals used for ploughing, as has been reported in Morocco. The usual function of ridgers is to throw up ridges in the farms, although some farmers also use the implement for weeding. Turning the soil in swamplands, *fadama*, is not common, because of the danger of oxen breaking a leg in the sticky soils, but it is reported from the region of Lake Kainji.

Sources of supply

There are two in-country manufacturers of ploughs in Nigeria, John Holt Agric Limited in Zaria and the Muhamadiya Implement Workshop at Gusau. The EMCOT plough was designed in the 1920s and exported to Nigeria by Ransome, Sims and Jeffries until the 1960s. In 1966, John Holt Agric opened their factory at Zaria and since that date have been selling several thousand ploughs a year. The factory at Gusau was opened in 1989 and has manufactured several thousand implements, though actual sales volumes are not available.

Figure 1 shows the annual volumes of EMCOT ploughs sold by Holtag since 1972. The most obvious feature of the sales is the decline since the peak period in the 1970s, corresponding to the import of ploughs from India for the ADPs and the increasing cost of steel brought in from outside. There is a small but significant flow of Nigerian-made ridgers across the international frontiers to the Republics of Benin and Cameroon. In addition, there is some manufacture by local blacksmiths in the far north, where ploughing is well established. The framework of the plough is welded together from salvaged iron and fitted with a purchased share. The price quoted for these was ₦500–800, although it was recognised that they were less robust than factory-made ploughs.

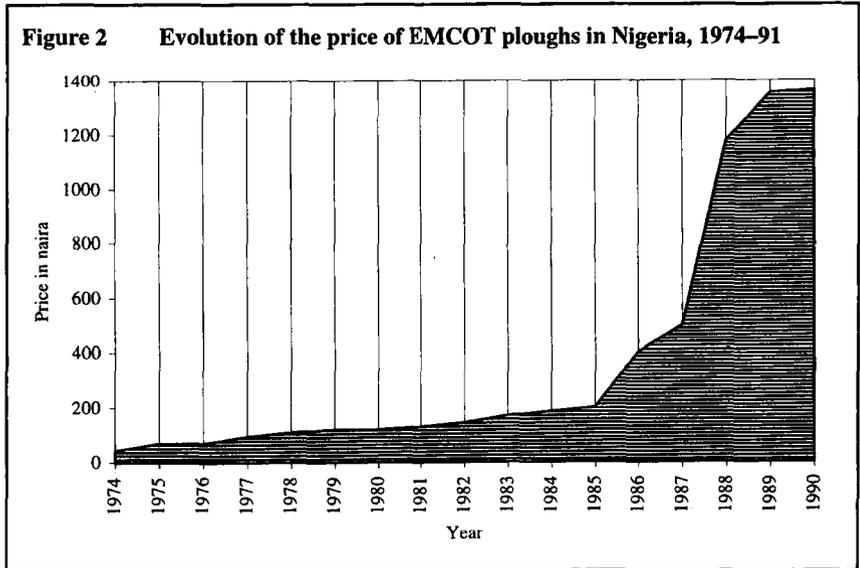
In the early period, all ploughs were supplied to farmers on credit schemes; some Hausa farmers still retain their repayment books from the colonial era. With the opening of the factory in Zaria, and the widespread acceptance of traction technology, ploughs began to be sold on the open market. The earliest price quoted for a plough in the literature is 30/–, but prices for ploughs in 1987 were based on estimates by farmers and discussions with traders in markets. The



devaluation of the naira in October 1986 caused substantial price increases (see Figure 2). At that time, a heavy ridger made in Nigeria cost about ₦250 at the factory gate, and ₦300–400 (or even as high as ₦600) if purchased from a trader in the market. A number of Chinese and Indian ploughs of lighter construction can be bought for just over ₦200. Bauchi State Agriculture Corporation, the commercial arm of Bauchi State Agricultural Development Project, was selling a less durable type of plough for ₦175 in mid-1987. Ploughshares, now costing ₦300–450 (1997 prices), can be bought in many markets, even where the ploughs themselves are not available.

In August 1991 the factory-gate price of ploughs made in Nigeria was ₦1,395 as opposed to around ₦1,100 for the lightweight ploughs imported from India. This price differential can at least in part be explained by an import tax anomaly favouring the importation of prefabricated implements and charging a higher rate on components for local assembly. The continued sale of the more expensive ploughs is testimony to farmers' appreciation of their appropriateness for West African conditions. By 1997, the factory-gate price of ploughs had risen to ₦3,000.

Donkey-ploughs are common in a number of other West African Sahelian countries, but have never been manufactured commercially in Nigeria. Such ploughs have been brought in in very small numbers from the Republic of Niger. Other tools, such as harrows and weeders, have been designed and distributed in small numbers. However, these do not appear to have ever come into common use.



3.2 Carts

In most of the Francophone Sahelian countries, carts were introduced with purpose-built chassis. In the Republic of Mali, for example, early carts had all-iron wheels. However, in the 1960s a factory was established in Abidjan to produce purpose-built axles fitted with pneumatic tyres. These axles are exported to most of the Francophone countries of West Africa and form the backbone of rural transport in many regions of the Sahel.

In Nigeria, by contrast, carts were originally brought in from outside on an experimental basis in the 1950s and 1960s. The intention was gradually to establish local manufacture of some components. However, the oil economy brought a very large number of cars and trucks into the country, many of which were wrecked extremely rapidly. Local blacksmiths in some areas quickly became adept in making carts from the chassis of wrecked cars. Such carts are relatively cheap, although of varying effectiveness. The future of this strategy depends on

the economy of the country as a whole but the general recession has made those already owning vehicles less profligate with them and chassis correspondingly harder to find. This suggests that in future there will be a need to import or manufacture purpose-built axles, especially for donkey carts, since motor-vehicle chassis are generally too heavy to be pulled in comfort.

3.3 Other implements

Apart from ploughs and carts a wide range of other agricultural implements intended for draught animal power have been designed and tested in Nigeria. Gwani (1990) gives an overview of these implements, which include multi-purpose toolbars, straddle row and rotary weeders and harrows. Despite attempts to extend these to farmers from the 1960s to the 1980s, it is fair to say that none have found sustained use in arable production.

An unusual implement that is used in eastern Kano State is a weeder, *kalkaveta* or 'cultivator'. Designed and built by blacksmiths, it consists of five hoe-like blades arranged in pyramidal fashion on a frame, which is dragged between the lines of plants to turn over the soil, thus uprooting weeds. The blacksmiths were able to sell these to farmers for ₦220 in 1990 (Starkey, 1990: 14).

3.4 Water-lifting

There are no records of any mechanically complex water-lifting gear. Even the elaborately carved wooden axles, commonplace in Sahelian countries, are absent in Nigeria. The rope simply passes over a wooden or steel bar fixed across the mouth of the well. Wooden pulleys, commonplace in the true Sahel, seem to be a recent introduction in Nigeria and are often absent or broken. The harnesses used are usually made from simple rope loops without further attachments to prevent rubbing.

3.5 Sugar-mills

The crusher is built around a pair of vertical and ridged cylinders, powered by simple gears and driven by a horse. The horse is attached by a leather harness to a heavy wooden pole and driven in a circle about the crusher. The major problem with such an operation seems to be that none of the harnesses are well designed and often cause sores on the horse. Former owners of crushers claimed to have given up because of their animals' high death rate. Horses still in use are worked for some five to six hours a day, with breaks.

4. Adoption and maintenance of animal traction

4.1 The origin of the study

Map 2 showed clearly that cattle traction is confined to the semi-arid northern regions, covering only a small part of the area in which cattle are found. The absence of cattle through most of the subhumid zone has never been satisfactorily explained. The former International Livestock Centre for Africa (ILCA) operated a Subhumid Programme studying livestock production within the zone from 1979 to 1993. At the same time, a long-term study of the causes and consequences of the adoption of mechanisation in Africa and elsewhere was undertaken by the Agricultural Research Unit of the IBRD in the early 1980s (Pingali et al., 1987). In conjunction with the Agricultural Research Unit, a separate study was commissioned to explore the reasons for the anomalous distribution of animal traction in Nigeria.

The importance of ox-ploughing in the semi-arid zone of Nigeria and its absence further south seemed paradoxical for a number of reasons:

- A longer growing season makes possible the even distribution of animal labour across a greater proportion of the year, making the investment in a traction team more economic and easing labour bottlenecks.
- An abundance of land and an almost unparalleled demand for staple foods from the cities suggests that farmers would have considerable potential to increase their income. A network of North–South highways and interconnected feeder roads crossing the zone provide adequate access for the effective marketing of agricultural surpluses.
- Zebu cattle can survive throughout the year within the zone, even along the edges of the forest, and their populations are expanding almost everywhere.

This suggested that the barrier to the spread of animal traction was probably environmental rather than economic or the result of inadequate extension. If this was the case, then the factors influencing farmers to adopt or reject animal traction could be elucidated by a journey along the ‘plough line’, that is, the southern boundary of ploughing. Three classes of farmers were interviewed:

- Farmers successfully using ploughs.
- Farmers who formerly used ploughs, but for some reason stopped.

- Farmers who have chosen not to use a plough.

Despite an extensive network of agricultural extension and a number of Agricultural Development Projects (ADPs) in the relevant areas, there appear to be no primary sources on either the distribution of animal traction or the reasons determining its adoption or rejection.

4.2 Primary and subsidiary hypotheses

The initial assumptions of the study were that:

- The southern limits of animal traction broadly coincided with the northern boundary of the subhumid zone.
- Where the plough had not spread, it was not as a result of lack of knowledge or absence of extension services, since the plough had been well established throughout the north of Nigeria since the 1930s.
- The absence of the plough was not connected with lack of access to the equipment or to the funds to purchase it, since further north where household incomes are similar to or lower than those in the subhumid zone, ploughs are plentiful.

The reasons for the limited distribution of ploughs were therefore assumed to be technical. Seven hypotheses were initially proposed to account for the situation, with the following two considered the most likely:

- i. **Soils.** The soils of the subhumid zone were believed to be either too hard to till, or to have such a high density of stumps and stones as to make animal traction uneconomic.
- ii. **Disease.** Greater humidity creates more habitats for the vectors of the trypanosomiases and a more suitable environment for other chronic ailments such as streptothricosis. Although zebu cattle survive in the zone, traction stress might decrease their tolerance to disease and make their use as plough-animals impractical.

A number of other subsidiary hypotheses were put forward:

- iii. **Poor market access.** The relatively sparse population of the subhumid zone and its underdeveloped infrastructure could discourage farmers from

purchasing ploughs to produce cash crops, especially as the oil economy has created alternative investments particularly in commerce and transportation.

- iv. **Marginal returns to labour.** In the bush-fallow systems of the subhumid zone, the returns to labour may be much lower than in the light sandy soils of the semi-arid north.
- v. **Ethnic/religious differentiation.** The 'plough-line' appears to correspond to the southern limit of Hausa settlement, which is also the southern limit of Islam in many places. It was thought that the techniques of traction might not cross this ethnic/religious frontier.
- vi. **Farming system.** Tubers become more important further south and ethnicity often determines the extent of their cultivation. Among certain peoples, such as the Tiv and Mumuye, yams and other tubers are the dominant staples. Since ploughs cannot be easily adapted to building yam-mounds or yam-ridges, this might make the investment in animal traction less economic.
- vii. **Stock-theft.** Other research in the semi-arid zone (Blench, 1987b) made it clear that insecurity and stock theft have discouraged the use of animal traction in some regions.

A further hypothesis, indirectly related to the pattern of animal traction, was that the distribution of ox-drawn carts would prove to be closely correlated with ox-ploughs.

4.3 Methods

The study began in March 1987 on the border with the Republic of Benin. The final interviews were conducted in July, when the ploughs were working in the fields. The researcher travelled gradually across Nigeria from West to East, moving from village to village to establish the exact location of animal traction. In addition to formal interviews, brief questions about the distribution of animal traction were asked in numerous settlements.

Sometimes individual farmers were interviewed, but in general small groups were gathered, with the assistance of the local chief. These interviews constitute the database underlying the study. Apart from finding farmers willing to be interviewed in detail, more informal interviews were held with local rulers, extension agents and villagers in order to gain an overview of the general situation in each area.

The principles underlying the survey sample were to select farmers representing the three categories of plough user, former plough user and non-plough user, dispersed as evenly as possible along the 'plough-line'. The maximum distance of the interview sites from one another was 70 km although in most regions it averaged about 30 km. In some cases, a separation of sites was determined by Game Reserves or uninhabited land as in western Plateau and Kwara States. In addition to following the 'plough-line', we interviewed farmers where we heard about former plough users well south of its present location, as at Abet and Koro.

Rural populations in Nigeria are not accustomed to answering questions about their domestic arrangements and are not generally familiar with the goals of statistical data collection. Almost inevitably, the researchers were thought to be associated with the credit schemes that are part of agricultural and livestock development. Responses may thus have been coloured in many instances by the belief that loans would result from the researchers' visit. This almost certainly resulted in optimistic assessments of ploughing by those who had stopped for any reason. Nevertheless, the researchers were satisfied that responses to the key questions concerning the causes that induce farmers to stop ploughing were largely truthful, in part because there was no strong motivation to lie.

4.4 Results

Technical aspects of animal traction

Types of equipment. Only one tool is used for ploughing: a ridger with an arrow-shaped share and a pair of 'wings'. All the farmers interviewed considered the primary function of the implement to be throwing up ridges. Harrows and true mouldboard ploughs, such as are common in Mali, have been designed for local manufacture in Nigeria and a certain number were allocated to extension agencies in Kaduna State in the early 1980s. However, not one farmer interviewed used anything but the ridger, and few had even heard of other tools.

The heavy ridgers sold in Nigeria are robust and rarely break. Only 32 (15.7%) plough owners had had to replace them. In most places, minor repairs can be carried out by village blacksmiths. Mending implements was a problem only in remote settlements where ploughing is uncommon. The shares have to be sharpened regularly and must be replaced every one to two years depending on local conditions.

Although ploughs were originally supplied by the colonial government, most plough users these days obtain their implements from the market. Table 2 shows the sources of ploughs as reported by current and former plough users.

n = 220		
<i>Source</i>	<i>Number</i>	<i>Percent</i>
Market	117	53.2
Government extension	59	26.8
Neighbours (i.e. hired ploughs)	20	9.1
Inherited within the family	9	4.1
Mission extension	8	3.6
Bought within village	4	1.8
Market/government extension	2	0.9
Government/mission extension	1	0.5

In three cases individuals had had a succession of ploughs from diverse sources.

An attempt was made to record the costs of ploughs, but in many cases the plough had been bought long before and the farmers were vague about the actual price paid. In addition, the costs of arranging to buy the plough and transportation to the village are variable. One farmer in Sokoto State observed that although he had paid ₦100 less than his neighbour by getting it from the Local Government, the wasted time and journeys trying to arrange the purchase meant that it would have been cheaper to buy it from a trader in the market. For a farmer to travel from a village in Gongola State to the market at Jambe and carry back a plough would cost nearly ₦200 in transport, in other words 70% of the cost of the plough.

Although donkey carts can sometimes be seen in the far north, oxen are generally used to pull carts. This contrasts with other Sahelian countries in West Africa, for example Mali, where donkeys and horses are used for carts and ploughing. In Nigeria, only 1% of the farmers in the sample owned horses and 10% donkeys. Carts in Nigeria are constructed differently from those in the Francophone countries. In Mali and Côte d'Ivoire, for example, the axles and wheels are specially manufactured and can be easily fitted to a wooden superstructure by local craftsmen. Older carts had large, spoked iron wheels, but these have been replaced by pneumatic tyres, usually with a single axle. In Nigeria, blacksmiths

dismantle wrecked cars and convert the chassis into carts, which most commonly have four wheels.

Although ox-carts are sporadically present throughout the survey zone, their importance is minimal. Only 10.3% of former and current plough owners had carts. This should not be taken to represent Nigeria as a whole; in some places, for example around Azare north of Bauchi, ox-carts often block the roads on market day, and they are highly visible in the Kamba area (many apparently purchased from Niger Republic, just 3 km from the town). Their faint impact on the zone should thus not be taken as an indicator of their value. Unlike Mali, where all types of cart are common (RIM, 1987), in Nigeria they must compete economically with cheap motorised transport. Many farmers complained about the rising cost of moving goods in pick-ups, and carts became visibly more common between 1987 and 1996.

Carts generally cost between ₦500–700 in 1987, approximately the same price as a small motorcycle in the period 1980–5. They are available in far fewer places, and they are difficult to move long distances. More than one migrant farmer from the semi-arid zone mentioned that he had been compelled to leave his cart behind with his family because of the difficulty of moving it. They are also difficult to repair, as most village blacksmiths do not have the required skills.¹

Comparing the cost of ploughs with the cost of animals is problematic as very few owners buy adult animals on the market. The majority are bought from pastoralists as calves or are the offspring of existing animals. In particular, the practice of selling a weak calf (i.e. one which a herder estimates will not survive a long trek) to farmers is common. The farmer must then invest time and labour in turning the calf into an acceptable work animal.

Animals used for traction. Only two animals are generally used to pull ploughs, cattle and camels. Oxen predominate – only 2% of the sample used camel ploughs. However, the susceptibility of camels to disease in more humid regions and the difficulty of breeding them does not allow a generalisation of their overall status in Nigeria. In the north-west (around Kamba), camels were only introduced in 1975, according to the farmers, and have made considerable progress displacing oxen in limited areas, despite their cost (see Appendix). In part, this is because they can also be used to draw water in areas where wells are extremely deep (up to 70 metres) and transport crops and baggage without the further investment in a cart.

¹ There is a paradox here, because the repair of cars and motorbikes is quite common, even in remote areas. However, 'mechanics' are trained separately and are rarely blacksmiths.

No special plough has been designed for camels. The harness used consists of a rope and a whipple-tree, unlike the yoke for a pair of oxen.

In the survey area, the principal breed of cattle is a zebu, commonly known as the Bunaji or White Fulani also locally called Daneeji or Yakanaaji. Other breeds include the Red Fulani, known as Rahaji or Bodeeji, and the Sokoto and Adamawa Gudali (RIM, 1992 and Blench, forthcoming, a). Residual populations of trypanotolerant West African shorthorns are present in the area, but no example of their use in ploughing was reported. Female animals are rarely used for traction, but oxen and uncastrated males are commonly paired together or used in mixed teams.

Cattle prices have risen substantially since the devaluation of the naira, making the purchase of draught animals by smallholder farmers more difficult. The most common strategy is to purchase a pair of male calves; in remote areas in 1987 these cost ₦300–400 each, but nearer the towns a more likely price is ₦600–700. A farmer with more money to invest can buy year-old males at ₦900–1,100. When discussing possible credit packages, farmers said they would prefer to buy older animals because they had a better chance of long-term survival. A mature bull cost ₦1,500–1,700 in 1987. The disadvantage of buying such an animal is that it is difficult to train, and there is almost no sale of mature trained oxen in the survey zone. It is quite difficult to replace a traction animal that dies or is stolen. Farmers with connections in the semi-arid zone often travel a considerable distance north to buy single trained animals. The rapid turnover of plough-oxen in the northern parts of the semi-arid zone ensures that these come regularly to market. For example, farmers in the Katsina area keep plough-oxen for between 18 months and two years before selling them and buying replacements.

Tasks performed by animal traction. The central function of animal traction in subhumid Nigeria is ridging. Ridges play a crucial role in traditional farming systems and their labour-intensive nature makes the replacement of hand-hoes with animal power attractive (Kaufmann and Blench, 1987). The same tool can be used for both the first and second weeding of cereal crops planted on ridges, though this requires more skill. The second weeding in particular is considered to be the most difficult, because of the danger to standing crops from ill-directed animals. Most (91.4%) plough users were also able carry out at least primary weeding with traction. This contrasts sharply with the situation in Northern Ghana where the practice of weeding with the plough appears to be unknown (Panin, 1986: 9).

The plough can also be used to prepare land in the *fadamas* (naturally flooding plains close to water sources), although this is less common. The object here is not to throw up ridges but to create seedbeds for rice or other crops. Plough users

complained that oxen tend to get stuck in the mud (and thus risk breaking a leg). This suggests that tillage of *fadamas* is left until the ground is quite soggy. Although some farmers considered tractors more suitable, it seems likely that tractor drivers would encounter the same problems as oxen. Only 43% of plough users also prepare *fadamas* with animal traction. Apart from the *fadamas*, there are also the dry-season irrigated gardens (*lambu*) particularly associated with the Hausa people. These are found in parts of the survey area (25.4% of respondents) and are exclusively worked by hand.

The division of labour. One aspect of ploughing emphasised by almost all farmers is that the plough saves labour. Yet in labour terms ploughs are not generally used in the most cost-effective way. In Nigeria, a farmer guiding a plough will have one and sometimes two helpers to guide the oxen. This contrasts with Ethiopia and most of Asia where a plough is generally worked by one person. The situation in Nigeria is mirrored throughout West Africa (Paul Starkey, pers. comm.) and may reflect either farmers' nervousness with the animals due to less effective training methods or the availability of additional farm labour.

The usage and ownership of ploughs is strictly a male preserve and not a single example of women either owning or using a plough was encountered in the survey. This type of gender dichotomy is explicable in Muslim areas, for example among the Hausa, Fulbe and Zarma, where women had little or no role in farmwork in the era of manual labour. However, it is equally the case where women have substantial farms and rights to individually earned income from their produce. For example, among the Hwana in northern Adamawa, where women have entirely separate households and farms, animal traction is nonetheless confined to men. This phenomenon has been reported elsewhere in West Africa (Goody, 1976). A parallel process has restricted the access of women to transport. In the pre-colonial era, horses were denied to women and now women are restricted to bicycles while men ride motorcycles.

Geographical distribution of animal traction

Map 2 shows the southern limit of ox-traction in 1991 as determined by the survey. There is just one 'island' of ploughing and animal traction generally forms a discrete territorial block. It also illustrates the importance of roads in the spread of traction. The Kontagora–Mokwa and Jalingo–Wukari roads constitute particular foci for the migration of plough-using farmers from the semi-arid zone.

The initial assumption that the southern 'plough-line' correlated with the northern limit of the subhumid zone proved to be unjustified. Although true in the middle of the country (between 7° and 9° of longitude), animal traction extends far south

into the zone elsewhere. East of Kaduna, in Plateau and Gongola States, it comes down as far as the 8° line. A rough calculation suggests that some 25% of the zone has at least some animal traction.

Interviews revealed that a map of this line drawn in the 1970s would have looked rather different. At that time, there were 'islands' of traction, heavily dependent on extension services, below the present-day boundary, for example at Koro, Bida and Abet/Zonkwa. At the same time, ploughing along the Kontagora–Mokwa and Jalingo–Wukari roads would have been much less advanced. In certain areas the plough is spreading of its own accord. Anecdotal observation in 1996 suggested that there was some ploughing south of its 1991 location.

5. Farming systems and the role of livestock

5.1 Systems of cultivation

The Nigerian 'Middle Belt' presents an extreme diversity of farming systems, in part due to its environmental variability. The ancient hill-agriculture of peoples such as the Kofyar, described by Netting (1968) and Netting and Stone (1996), still exists. The initial farming pattern of the farmers who moved down to the plains at the beginning of the colonial era was swidden cultivation (slash and burn). This persists in the more sparsely populated regions. However, as density of settlement has tended to increase in many areas, the cycle of bush fallow has shortened and in some areas continuous cultivation has become the norm.

Throughout the central region of Nigeria, the principal farming system is bush-fallow, and forest-fallow where the population is particularly sparse. The boundary between these two systems is not always easily established. Only in parts of the semi-arid zone is continuous cropping practised. Table 3 shows the distribution of types of farming system at the fifty interview sites.

In addition to fallow cultivation, various types of wetland agriculture are practised throughout north-central Nigeria (Table 4). The percentages reflect the fact that some farmers practice more than one system of wetland cultivation. The most common type is floodland cultivation (*fadama*): the planting of rice, cocoyams and pulses in naturally flooded areas. No water control is practised and the crops produced are generally aimed at subsistence rather than sale.

In the semi-arid zone, particularly the basins of the Sokoto and Hadejia rivers, dry season irrigated gardens, *lambru*, are very widespread. The farmers plant onions, tobacco, tomatoes and vegetables such as peppers, garden eggs and bitterleaf that can be sold year-round in the markets. These gardens are irrigated with the North African *shaduf* or by hand. Small petrol pumps have recently become popular,

Table 3 Farming systems in the survey zone

n = 50

Type	Number	Percent
Bush-fallow	41	82
Forest-fallow	7	14
Continuous cultivation	2	4

although by 1987 the price (₦3,000) was out of the reach of all but the wealthiest smallholder. Dry-season gardens, with or without pump irrigation, are almost invariably cultivated by hand. Although this type of market gardening is gradually spreading further south, virtually all those in the sample were Hausa farmers concentrated along the northern boundary of the subhumid zone.

The staple crops are sorghum, millet, maize, fonio and rice. Tubers such as yams, cassava, sweet and Irish potatoes are only locally important, although they become progressively more dominant further south. Farming systems have a great variety of cultivated plants and complex patterns of intercropping (Kaufmann and Blench, 1987).

<i>Type</i>	<i>Number</i>	<i>Percent</i>
None	32	12.1
Fadama	232	87.9
Dry-season gardens	67	25.4
Pump irrigation	15	5.7

5.2 Livestock production systems

Livestock-keeping by farmers is common and out of the entire sample only 27 (10.2%) kept no livestock at all. Goats are the commonest type of compound stock, followed by cattle and then sheep. Cattle-keeping outside the use of oxen for traction is widespread. Of the farmers interviewed, 166 (63%) kept cattle. The average holding was 5.6 per compound. This figure is skewed by the fact that the sample was not random, but focused on current and former plough users. Donkeys, horses, pigs and camels are kept in only insignificant numbers (Table 5).

Cattle are kept by farmers for a variety of reasons, of which traction is only one (Table 6). Male animals may be kept in the compound and fattened for sale, normally over a period of one to two years. Female animals are kept for milk and calf production. Animals of farmers in all three categories may be contract-herded, that is, given to pastoralists who live in or pass through the area for management.

Table 5 Livestock holdings of farmers in the sample

n = 264

<i>Species</i>	<i>Number with none</i>	<i>%</i>	<i>Mean holding (Total sample)</i>	<i>Mean holding (Owner only)</i>
Cattle	98	37.1	5.6	8.9
Goats	82	31.1	5.5	8.0
Sheep	129	48.9	3.7	7.2
Donkeys	238	90.2	0.2	1.8
Camels	259	98.1	–	1.0
Horses	261	98.9	–	1.0
Pigs	262	99.2	–	1.5

These contracts may be in kind, whereby in the case of female animals the herder has the right to milk and one of the offspring every two years. For male animals, whether they are traction animals herded in the dry season or bulls, payment is usually cash or cereal grains.

There is little or no difference in holdings of contract-herded animals between the three categories. If anything, farmers who no longer or have never used ploughs have more cattle being herded for them. In part this may reflect a choice not to use traction and therefore not to allocate labour to animals for any reason. Holdings of milking animals are substantially lower, and fattening animals higher, among non-plough users than for the other two categories. In essence, this represents the class of non-Muslim cattle owners in the more humid parts of the survey zone. They are

Table 6 Mean cattle holdings for each category of farmer

n = 264

	<i>Number</i>	<i>Milk</i>	<i>Traction</i>	<i>Fattening</i>	<i>Contract herded</i>
Plough users	109	1.70	1.85	0.37	0.80
Former plough users	111	1.29	0.25	0.21	1.01
Non plough users	44	0.98	0.00	0.77	0.98
Total	264	1.41	0.87	0.37	0.92

not milk drinkers and have thus chosen to invest in cattle-fattening within the compound.

The best way of keeping traction animals is a subject of debate among farmers. The most common method is undoubtedly stall-feeding, either by permanent confinement of the animal, or in combination with daytime grazing. Some animals, particularly those owned by Fulbe, are grazed all the time, while others are stall-fed in the work season and sent away with contract-herders for the rest of the year. This is particularly common in areas with a high tsetse challenge, such as along the Kontagora–Mokwa road. Table 7 gives the frequency of different management practices among plough owners.

<i>Category</i>	<i>Number</i>	<i>Percent</i>
Stall-fed	132	64.7
Stall-fed by night; grazed by day	40	19.6
Grazed by kin/servant	25	12.3
Stall-fed ploughing season; otherwise contract-herded	6	2.9
Contract-herded	1	0.5

5.3 Characteristics of current and former plough users

Sociological characteristics

The diversity of ethnic groups in the subhumid zone was reflected in the interview sample. Some 37 different peoples speaking distinct languages were represented. Table 8 shows these amalgamated into the dominant Muslim groups of the north (Hausa/Fulbe/Zarma) and the others, usually non-Muslims from minority ethnic groups. The Hausa represented just under half the entire sample, despite the fact that most of the interviews were conducted outside the conventional borders of Hausaland. For purposes of analysis, the Hausa, Fulbe and Zarma were combined, all of whom are strongly Muslim groups originating from the semi-arid zone who have only migrated into the subhumid zone during the past hundred years. There were 131 farmers who fell into this category, as opposed to 133 farmers from other small ethnic groups.

Table 8 Categories of farmer with ethnic group aggregated

n = 264

<i>Category</i>	<i>Sample</i>	<i>Hausa/Fulbe/Zarma</i>	<i>Others</i>
Plough users	109	65	44
Former plough users	111	58	53
Non plough users	44	8	36
Total	264	131	133
$\chi^2 = 22.07$	(DF = 2)	P > 0.01	

Population pressure in the semi-arid zone and consequent soil degradation has given considerable impetus to pioneer colonisation. An effect of migration from Hausaland has been that farmers from communities where animal traction is well established have migrated further south, bringing ploughs and oxen with them. Table 9 shows the percentages of farmers interviewed who were not indigenous to the sites where they are now settled.

Table 9 Categories of farmer by origin

n = 264

<i>Category</i>	<i>Sample</i>	<i>Indigenous</i>	<i>Percent</i>	<i>Migrant</i>	<i>Percent</i>
Plough users	109	78	71.6	31	28.4
Former plough users	111	68	61.3	43	38.7
Non-plough users	44	41	93.2	3	6.8
Total	264	187	70.8	77	29.2
$\chi^2 = 15.59$	(DF = 2)	P > 0.01			

The striking difference between plough users and non-plough users reflects the importance of migration in the distribution of ploughs. Although the subhumid zone is by no means a Muslim area, enquiries about current and former plough users underscored the strong relationship between Islam and draught animals. Table 10 shows the predominance of Islam among all categories of farmers.

Animal traction, Islam and ethnicity have a triangular relationship and nowhere is this more clearly seen than in regions where the plough is expanding. A typical

<i>Category</i>	<i>Sample</i>	<i>Islam</i>		<i>Christian</i>		<i>Traditional</i>	
		<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>	<i>%</i>
Plough users	109	84	77.1	21	19.3	4	3.7
Former users	111	103	92.8	8	7.2	0	0.0
Non users	44	37	84.1	1	2.3	6	13.6
Total	264	224	84.8	30	11.4	10	3.8
$\chi^2 = 19.29$		(DF = 4)		P > 0.1			

example is the road from Kontagora to Mokwa, a relatively well-maintained tarmac surface that is part of the main route from Lagos to Kaduna and Sokoto. Until the mid-1970s, the road passed through virtually uninhabited bush. There were only scattered villages of Asu and Nupe people in the nearby forest. However, with the development of the oil economy, firewood cutters' hamlets grew up, and then ribbon settlements intended to service the growing number of heavy trucks using the road. This in turn attracted arable farmer settlement from both the Zarma and Hausa areas of Sokoto. Virtually all the villages on the section of the road north of Mokwa were established by migrants from the semi-arid zone after 1980, and all those villages use animal traction. The migrants face quite serious problems both with disease and stumping. Most plough-team owners send their animals north with the pastoralists outside the work season. However, the persistence of traction illustrates the potential for building bridgeheads of ploughing far south of its 'normal' distribution, if farmers are determined.

Plough users tend to be older than the mean age of the population, reflecting the period required to accumulate the capital necessary to invest in draught animals. However, the age of non-plough users (i.e. heads of households with the option to purchase ploughs) is not significantly different from plough users. The absence of a significant percentage of young people at schools or wage labour in the towns also contributes to the age of those in the sample (Table 11).

The mean age of farmers was probably at least five years older than the figures given here in all categories, as many informants were unsure of their precise age, and individuals born within any decade were allocated to the lower age. For example, a farmer apparently between 40 and 50 years old was written down as 40. The average age of respondents may have been increased by the process of calling informants to the ruler's compound. It was necessary for the survey to work this way as entering a community without consultation would be considered

Table 11 **Mean ages of farmers in the sample**

n = 264

<i>Category</i>	<i>Number</i>	<i>Mean age</i>
Plough users	109	41.2
Former plough users	111	46.9
Non plough users	44	40.6

a major breach of etiquette. However, there was inevitably a tendency for chiefs to call men from their own age group.

Somewhat less than half the farmers practised a profession in addition to farming. No profession showed any striking predominance, although traders (25), tradesmen (27) and religious professionals (12) were the most common. The remainder, 155 (58.7%), said that they had no profession other than farming. There is no correlation between the exercise of a profession and success or lack of it in animal traction.

Transmission of animal traction skills

The use of traction in a village does not by itself create the networks of support and information transfer necessary to sustain it. By and large, just as ploughs are bought in the informal sector, so the techniques of ploughing are learnt from relatives and friends. It is more common to buy the implement from a government institution, such as an ADP, or Local or State Government, and learn to plough within the village, than to buy a plough in the market and yet learn from an extension agency. Table 12 and Figure 3 illustrate the sources of technique reported by current and former owners.

These figures underemphasise the importance of mission extension in spreading ploughing in non-Muslim areas. A number of plough users who learnt from relatives and friends mentioned that the relative had learnt from a mission. Protestant missions in Plateau and Gongola States had a commitment to agricultural extension until the 1960s, but since then have placed more emphasis on evangelism.

To assess the role of government extension in the diffusion of ox-ploughing, all the non-governmental sources of training can be combined. Of 204 plough owners only 34 (16.7%) learnt from government extension. The remainder learnt in the

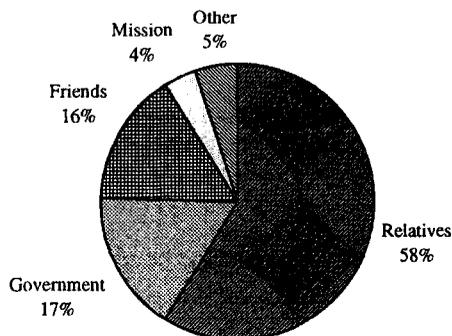
Table 12 Sources of ploughing skills cited by plough owners

<i>Source</i>	<i>Number</i>	<i>Percent</i>
Relatives	120	58.8
Government extension	34	16.7
Friends	32	15.7
Mission extension	8	3.9
Paid a neighbour for training	5	2.5
Hired a servant to plough	4	2.0
Employ my neighbour to use my plough	1	0.5

(Excludes farmers who hire ploughs)

informal sector either within the circle of the domestic group, or from friends or servants.

It might be argued that the plough users who failed were inexperienced, and thus unable to maintain their oxen or plough effectively. There were no substantive differences in the length of experience of current and former plough users. Of the former users, the mean number of years using the plough was 9.7, while the figure for current users was 9.5 years. The mean period of years since former users had

Figure 3 Sources of ploughing skills

given up was 7.0, which puts it slightly before the widespread availability of tractors and the rinderpest epidemic of 1983–4. This suggests that there is a constant attrition of plough users for a variety of reasons.

Reasons for the abandonment of animal traction

The stated causes for ceasing to plough. An underlying assumption in the original research outline was that some of the farmers who had adopted animal traction and then abandoned it would cite reasons that were environment-specific. In other words, to account for the demarcation of ploughing and non-ploughing zones there would be some ecological, enzootic or geographic feature discouraging farmers. However, as the study progressed it became clear that this was only true in particular locations. The distribution of animal traction was better accounted for by the former presence or absence of extension services.

Farmers ceasing to plough covers both farmers who were compelled to stop through the death or sale of oxen and those who deliberately chose to cease ploughing. The majority of farmers falling into this latter category attributed their decision to two main factors: epizootic disease and cash-flow problems in the household, particularly in relation to marriage (Table 13). Subsidiary causes were other diseases, theft or the fear of theft, labour constraints because of a sudden extension of primary and secondary education and the overwhelming attractions of highly subsidised tractor hire. The reasons for ceasing to plough are tabulated in order of importance, and linked to the numbered hypotheses set out in section 4.2.

Discussion of the categories. The database includes the farmers' statements in full so that they can reanalysed as necessary. The categories here have been abstracted from these statements, and only record the primary reason given by the farmer.

a) Disease

Hypothesis 2 (p.24) was that the increased frequency of disease in more humid regions would discourage animal traction. Although the broad category 'disease' is the major cause of 'plough cessation' (59%) it would be a mistake to conclude that this is always a consequence of conditions in the zone. Epizootic disease, in particular rinderpest, other diseases and trauma are not zone-specific but reflect the inadequate veterinary infrastructure, which is a national problem. Liver-fluke and trypanosomiasis are more likely to be a direct consequence of humid conditions but they only accounted for 13 farmers who stopped, 11% of the total. Individual categories were as follows.

Table 13 **Reasons given by farmers for ceasing to plough**

		n = 116	
<i>Major category</i>	<i>Sub-category</i>	<i>Number</i>	<i>Percent</i>
a) Disease	Epizootic	37	31.9
	Sickness	14	12.1
	Trypanosomiasis	8	6.9
	Liver-fluke	5	4.3
	Trauma	4	3.4
Subtotal a)		68	58.6
b) Economic	Cash needs	19	16.4
	Labour shortage	10	8.6
	Theft	7	6.0
	Tractor	7	6.0
	Fraud	1	0.9
	Credit	1	0.9
Subtotal b)		45	38.8
c) Other	Overage oxen	1	0.9
	Breakage of plough	1	0.9
	Soil hardness	1	0.9
Subtotal c)		3	2.6
TOTAL		116	100.0

Note: The total 116 is greater than the figure 111 used in other tables of former plough users. This is because it includes five farmers who 'failed' but have recently begun to hire ploughs.

- **Epizootic.** This includes all deaths ascribed to an epizootic, but also sales of healthy animals premised on the fear that they will die. In most cases, the deaths relate to the rinderpest epidemic of 1983-4 but also include a case of anthrax and one of contagious bovine pleuro-pneumonia. There are also several cases of sale of oxen in anticipation of rinderpest - a widespread strategy of livestock owners in 1983-4.

- **'Sickness'**. This category includes all the deaths of oxen ascribed to an unidentified disease. It is worth noting in passing that many farmers are very uncertain about the causes, symptoms and treatment of cattle diseases. Their statements were often contradictory. A common response to an animal falling sick is to call a Fulbe pastoralist to diagnose the illness, and then buy the drugs recommended in the local market.
- **Trypanosomiasis**. All deaths of traction animals ascribed to '*jola*' and '*samoore*'. These cannot be assigned infallibly to trypanosomiasis, as some may also be equivalent to tick-borne diseases such as babesiosis (RIM, 1984). However, there is little doubt that only in the humid and subhumid zones are there remaining reservoirs of tsetse flies.
- **Liver-fluke**. This disease, usually called '*hanta*' is treated as a separate category, firstly because it can usually be reliably identified by livestock owners and secondly because its incidence is generally thought to be higher in more humid zones.
- **Trauma**. This category covers all types of physical injury to cattle, the most common being breaking a leg or a neck in a fall.

b) Economic

- **Cash needs**. Outside disease, the need to obtain cash urgently is a commonly cited cause of the abandonment of ploughing. Within this category, paying for children's marriages and repairing the house are the principal components, although three interviewees sold their oxen to get cash to start a business. It is probably not irrelevant to observe that the period 1979–83 saw a spectacular rise in the importation of consumer goods. A number of farmers mentioned in passing that they were able to buy radios, motorbikes and zinc roofs with money 'left over' from the sale of traction animals. Despite its numerical importance, this is not zone-specific and was therefore not considered in the primary hypotheses.
- **Labour shortage**. Where farmers have no children or dependants to work the plough and take care of the oxen, they may sell their team, especially when they themselves grow old. In general, farmers cited the absence of all their children at secondary school as a reason for ceasing to plough. The period 1975–80 saw the establishment of numerous primary schools, and children who passed through them went to board at secondary schools in the early 1980s. The degree of school attendance is very variable in different parts of Nigeria. Schools are prestigious throughout the centre of the country, especially in Christian areas. However, in the extreme east and west, labour shortages were rarely highlighted

Overall, slightly fewer than half of the farmers had used tractors. In many cases, hiring tractors was not an option and the researchers were frequently asked to use their influence to bring tractors to a village. Table 15 shows the frequency of use among the different categories of farmer.

The strikingly higher percentage of former plough users with experience of tractors illustrates neatly the strong disincentive to animal traction that they represent.

<i>Category</i>	<i>Sample Size</i>	<i>Yes</i>	<i>%</i>	<i>No</i>	<i>%</i>
Plough users	109	33	30.3	76	69.7
Former plough users	111	69	62.2	42	37.8
Non-plough users	44	21	47.7	23	52.3
All farmers	264	123	6.6	141	53.4
$\chi^2 = 22.5$	DF = 2	P > 0.01			

- **Fraud.** One farmer found that he was being defrauded by his children when they took out his plough for hire.
- **Credit.** A single farmer returned his plough and oxen because of problems with the administration of the loan.
- **Over-age oxen.** One farmer allowed his oxen to grow so decrepit that their sale value did not allow him to replace them.
- **Breakage of plough.** In one case, it proved impossible to mend a plough in a remote area and so the farmer sold the oxen.
- **Soil hardness.** The first primary hypothesis (p.24) was that soil hardness or the increasing frequency of stumps and stones would be sufficient to discourage farmers. In fact, this turned out to be of minor significance. In Kopal, south-east of the Jos Plateau, one farmer said that the hard soil had discouraged him from continuing to plough. Plough owners were therefore asked to list the obstacles they encountered in tillage (Table 16). To act as a cross-check on the tendency to magnify problems, they were also asked if they had ever actually broken a plough so badly as to have to replace it.

Stumps are a widespread problem in all but the most densely settled areas. It was estimated that it took two years to rid a piece of land of them. Unlike stumps, stones can be avoided, though many farmers pointed out that cultivating a stony area was foolish, especially when there is an abundance of land. Only 16% of farmers had actually had to replace their plough which suggests that problems of tillage, while an irritant, are not a major cause of the abandonment of animal traction.

Table 16

Farmers reporting obstacles to tillage

Category	Number	Stumps		Stones		Soil Hardness		Ever replace plough?	
		no.	%	no.	%	no.	%	no.	%
		n = 204							
Plough users	99	83	83.8	42.0	42.4	12	12.1	16	16.2
Former plough users	105	72	68.6	48.0	45.7	10	9.5	16	15.2
Total	204	155	76.0	90.0	44.1	22	10.8	32	15.7

The reasons given by farmers for ceasing to plough may not always be a reliable indicator of the underlying causes. The case of Koro in Kwara State illustrates this. In Koro, there were six plough users, some with carts, who formed an 'island' in an area dominated by manual labour. They had begun to plough in the early 1970s as a result of the enthusiastic encouragement of a missionary in a nearby settlement. Loans were given for the ploughs, carts and oxen. During the following decade the farmers were using animal traction successfully, and had replaced their oxen at least once from their own resources. The missionary left in 1981, and the following year all except one of the farmers sold their oxen. The remaining farmer sold his oxen a year later and there is now no traction in the area. The reasons given by the farmers were diverse: theft, fear of theft, sickness, fear of sickness, etc. Yet the underlying cause seemed to be a lack of confidence, a feeling that animal traction was regarded as eccentric in their community.² This statement may sound surprising, but it should be remembered that ploughs are only used for a short period of the year, when all categories of farmer are extremely busy on the fields.

² The same feeling was expressed by experienced Fulbe plough users settling in Southern Zaria.

The explanation of why farmers who fail for some reason do not buy more cattle and begin again is not always predictable given the reasons for cessation. Almost inevitably, the farmers cited lack of money as their reason for not reinvesting in new traction animals, even when they had previously admitted to owning other cattle. This more closely reflects beliefs about Government credit policies rather than a real desire to restart with animal traction. A more valuable criterion would be the sale of the plough subsequent to the death of one or both animals from disease. This information was not specifically collected, although many farmers mentioned that the cost of buying another plough was a disincentive to beginning again. In addition, the practice of buying ploughs from neighbours (Table 2) suggests a circulation of implements in the informal sector.

Validity of the subsidiary hypotheses. The primary hypotheses, soil hardness and disease, were discussed above. Hypothesis iii (p.24) was that poor market access was discouraging farmers from purchasing ploughs to cultivate cash crops. Questions about market access were generally met with incomprehension, as the urban demand for staples is such that traders seek out farmers at their homes if there is any hint of substantial surpluses. Lorries from urban centres reach rural markets in the remotest areas to buy produce. By the same token, the distinction between 'cash' crops and staples has disappeared. In many interviews it was said 'we sell all types of crop'.

The fourth hypothesis, that returns to labour were too low, appears to be largely undermined by the extensive migration into the zone from further north. Indeed, since ridging is the one function of animal traction carried out by all current and former animal traction users, and since the ridges in the subhumid zone are generally larger than those further north, it is likely that the reverse is true.

The fifth hypothesis (p.25) that ethnic/religious differentiation was responsible for the plough not spreading would not be apparent from Table 13. However, the comparison between the Hausa/Fulbe/Zarma and an aggregation of the other groups (Table 8) showed that the Hausa group dominated the former and current plough users while a mere eight fell into the category of non-plough users. The strong bias against traction among the other ethnic groups and the corresponding majority of current users among the Hausa/Fulbe/Zarma indicate a problem with the transfer of animal traction technology across ethnic lines. This was strongly supported by informal remarks in interviews suggesting that migrants from the semi-arid zone were often unwilling to pass on their skills to their indigenous neighbours. By the same token, the existence of numerous plough users in the 'other' category shows that it is perfectly possible to bypass this transmission problem with sympathetic extension.

Hypothesis vi (p.25) was that the dominant culture of yam-growing might discourage the adoption of animal traction. However, the southern limit of ploughing does not in general abut regions where yam-based farming systems predominate. The single exception to this is the area south of Jalingo in Adamawa, where the Mumuye people live. Guinea yams are their dominant staple and the ox-plough has made no progress among them, despite their relatively large cattle-holdings and the presence of mission-based agricultural extension at Zing. This situation is exceptional and yams do not at present constitute a major obstruction to the diffusion of the plough. However, if animal traction is to spread further south, then it will increasingly come up against the problem of yam-based farming systems.

The seventh and final hypothesis (p.25) was that the risk of theft of traction animals was a major discouragement to potential adopters. An argument against this is that there is no reason for which animal theft should be ecologically constrained and if it were a discouragement to adoption then it would apply across all regions. Theft of livestock has become a major problem throughout most of Nigeria and the continuing recession in the 1990s has exacerbated its incidence. Table 14 shows that theft is far from negligible but that stock is quite often recovered. Nonetheless, given the scale of investment involved in obtaining work animals, it is not surprising that potential owners are fearful of their loss. Draught animals must be given supplementary feeding and anyway tend to be strong animals and thus more attractive to thieves.

6. Conclusions and practical implications

6.1 Constraints on the diffusion of draught animal power southward

The original hypotheses were formulated on the basis of three assumptions. None proved to be wholly correct:

- The 'plough-line' does not in general correlate with the northern boundary of the subhumid zone. Although this is true in the Southern Zaria area, ploughing is practised considerably further south in the zone to the east.
- Lack of knowledge is a major reason for which animal traction has not spread further south. Although many farmers south of the 'plough-line' are aware of the existence of ox-ploughs, the majority have never seen one in operation and are not familiar with them.
- The spread of carts is constrained by their restricted availability. Although ploughs are sold by traders in most large market towns in the semi-arid zone, potential plough users in remote areas often find access to equipment a constraint because of the problems and costs of transportation.

No overall determinant of animal traction distribution emerged from the analysis of the questionnaires, although almost all the features listed in the original hypotheses are relevant in some places. For example, the presence of tsetse is not a major constraint on cattle-keeping, except in the forested areas south-west of Kaduna. A predominance of tubers in the cultigen repertoire only acts as a barrier to the spread of the plough in the western parts of Gongola State. Soil hardness was cited only once, at Kopal in the region south-east of the Jos Plateau.

The broad explanatory model offered by Pingali et al. (1987) is that farmers in Africa have been relatively slow to adopt both animal traction and other forms of mechanisation because in many areas they are either uneconomic or only marginally profitable. Relating this back to the farmers' responses, in some parts of Central Nigeria animal traction has failed to diffuse for sound environmental reasons, notably high levels of stock mortality, or woody vegetation causing damage to ploughs. In other places, difficulty of access has raised the price of ploughs to the farmer to unprofitable levels. Tractors have been more successful in these areas because they were supplied at highly subsidised rates, however this type of advanced mechanisation has proved unsustainable.

These situations can be broadly grouped under the rubric of 'uneconomic'. However, at least as important is the slow transmission of skills and information. The southern frontier of ox-ploughing is one of the most ethnically diverse yet sparsely populated regions of Nigeria. Although major roads now traverse it from South to North, many communities are still remote from them. Because carting is hardly practised, ploughing is all but invisible except at the height of the farming season when the potential audience is fully occupied on their farms. For this reason, the areas where ploughing is currently spreading southwards are almost without exception those settled by migrants from the semi-arid zone who are already familiar with it.

The principal implication is that animal traction can succeed in a wider geographical area. The limitations on its spread are neither economic nor ecological except in a few specific places. There is no doubt that in more southern latitudes farmers do face problems of stumps and greater pressure from disease. However, there is a compensatory benefit of bigger yields from pioneer colonisation of the bush, compared with the intensively farmed soils of the semi-arid zone. To adapt to the marginally greater problems of animal traction in the subhumid zone, as well as the need to adopt new cultigens and tillage methods, farmers need either a supportive community or a sympathetic extension service. At present, the striking predominance of Hausa among those ploughing along the traction limit, despite its remoteness from 'traditional' Hausa terrain, reflects the prestigious role that ox-ploughs have in their society. Ironically, the very newness of these communities and their consequent inability to build links with the local administration has tended to deny them access to tractors, thereby encouraging investment in ox-ploughs.

Without community support, extension services are important in maintaining animal traction. This was formerly the province of government, but the emphasis on mechanisation left many farmers feeling that ox-ploughing was a thing of the past, and that the often elusive tractors should replace them. Missions have not taken a similarly mandarin attitude, but their distribution is patchy. The example of Koro (section 4.4) shows how an enthusiastic individual can maintain an 'island' of traction in a region of hand-cultivation; but that the disappearance of that individual leads to a loss of confidence by the farmers and a rapid reversion to traditional methods.

6.2 Other constraints on increased animal traction

The major constraints on the spread of animal traction are animal health, theft and the cost of equipment.

Animal health and nutrition

Work-animals need to be fed more substantially than free-range stock, otherwise they become susceptible to a wide range of diseases brought on by work-stress. Mortality from disease was the single most important factor discouraging uptake of traction in the Middle Belt. Deaths were attributed to a wide variety of diseases, whose identification is open to doubt. As farmers will freely admit, they are less skilled in cattle management than the pastoralists. Nonetheless, the two most common complaints were *samoore*, trypanosomiasis, and *kirshi*, skin diseases.

Agridaura (1941) describes a series of experiments in stall-feeding traction animals, outside working periods, and makes a preliminary analysis of the costs and benefits of confinement versus herding on the open range. Most farmers cannot afford the labour to stall-feed traction animals all year round, and compromise by supplementing them before and during the working period, and sending them away with pastoralists during the dry season. This strategy is probably more successful in the arid region than in the subhumid zone. The available vegetation in the far north is likely to be a poor substitute for riverine grasses. In the subhumid zone, traction animals are at greater risk from disease and need more attentive feeding for a greater part of the year.

Costs and transport of ploughs

In 1987, few farmers mentioned cost of implements as a major constraint. EMCOT ploughs could be bought for just over ₦200 at the factory gate in Zaria. Even when transported to the furthest extent of the country, west of Sokoto and Adamawa, the additional margin raised the price to ₦400–500, which was still a practical sum for subsistence farmers to raise.

Although local plough manufacturers have a certain number of distributors, the movement of ploughs to the small rural markets where they can be bought by farmers is essentially in the hands of indigenous entrepreneurs. Even those that are notionally supplied by the ADPs are usually bought by traders and redistributed to local markets. Although this is effective when transport is cheap, since farmers can absorb traders' margins, once transport becomes expensive, price becomes a major deterrent.

In early 1987 the effects of the structural adjustment programme introduced in late 1986 were barely apparent. One of the main elements of the programme was to free the naira on the foreign exchange markets and in the following two years it fell to approximately 10% of its former value. Since the late 1980s it has continued

to fall, although more slowly (see preliminary note on currency). Prices of imported steel for ploughs have risen correspondingly and, together with the rising cost of transporting ploughs, has almost doubled the end-user price in remote markets. The consequence is that farmers currently regard the cost of ploughs as a disincentive and fewer are seen for sale in rural markets.

Two ungrounded beliefs

Paradoxically, there is little or no evidence that potential animal traction users are deterred by the two most commonly-cited constraints: the availability of credit and the training of work-bulls. Although farmers are now finding the cost of ploughs problematic, they continue to buy them. Similarly, although oxen have risen in price, farmers are reducing the initial capital outlay by buying calves and hand-rearing them. Farmers are extremely efficient in training work-oxen, especially in Katsina State where they take young males and train them within a month, making it worthwhile to turn over their livestock capital every year. Training is more of a problem where traction is less common, but it is unlikely that institutions could be more effective than other farmers in transmitting skills. As the number of traction users in a given area increases, so does the expertise in training stock, and the complexity of credit and training schemes can be dispensed with.

6.3 Additional aspects of traction

Other aspects of adding value to the various forms of animal traction also depend on new extension policies. These can be divided into four areas: using existing ploughs to weed and prepare *fadama* land, the extension of carting, the diffusion of additional ox-drawn implements and further attention to other species for animal traction.

Extending the use of existing ploughs

Not all farmers use ploughs to weed. Since most farmers do weed successfully, this is probably no more than a matter of spreading the idea through the extension services. The use of ploughs in *fadamas* may depend on the crops grown and the speed with which the water rises. There may also be a case for adapting or developing more appropriate implements for *fadama* preparation.

Carts

As the price of motorised transport in rural areas becomes prohibitive, carts are likely to become a more attractive option. The present basis on which they are manufactured, i.e. cannibalising wrecked vehicles, is not sustainable in the longer term. Attention needs to be given to the local manufacture of axles similar to those manufactured in Côte d'Ivoire.

The cost of transporting carts long distances is prohibitive. Several farmers who had moved from the northern semi-arid zone mentioned that they had left carts behind with their family because of the problem of moving them. Thus, unless there is a greater dispersal of manufacturing centres, carts are likely to remain peripheral to animal traction.

Implements

The only implement in use throughout the survey area is the ridger. Harrows and mouldboard ploughs exist, but they are rare. Other tools have been designed elsewhere in West Africa that may be appropriate for parts of Nigeria. Research at an appropriate institution should establish the value and appropriate conditions for the use of other implements and this should then be linked to the manufacturing and extension arms, again through the ADPs.

Camels and equines

Camel-ploughing is spreading along the 'plough-line' in north-western Nigeria (see Appendix). The immediate priority is to ensure that credit for animal traction is not restricted to oxen. Credit for ox-ploughs is presently the basis of traction diffusion, yet loans for camels might be more effective in the regions along the northern frontier of the subhumid zone. In addition, camels pull unadapted ox-ploughs with a simple rope harness. It seems likely that some relatively simple design input could make a harness of greater mechanical efficiency.

In Mali, pairs of donkeys pull specially designed light ploughs. Trials with larger ox-ploughs in Douentza led to rapid work-stress (Mike Winter, pers. comm.) and it seems likely that donkey-ploughing is not an option unless a different type of plough is made available. The heavy ridgers sold at present will probably remain appropriate for the sub-humid zone. However, in areas of light sandy soils, such as north of Bauchi, donkey-ploughing may not only be cheaper, but also more ecologically sound.

6.4 Prospects for increased animal traction

Animal traction is a widespread and economically significant use of livestock in northern Nigeria. The most important uses of animals are for cultivation, carting and drawing water in the semi-arid region. Without draught animal power it is unlikely that some communities could continue to survive in these regions.

The introduction and diffusion of animal traction is one of the few livestock interventions that has been unequivocally successful. Adopted and adapted by farmers, it is now spreading from one region to another without further intervention. It should therefore repay careful attention as a model for intervention in other areas of livestock development.

Ploughing is spreading slowly southwards. At its present rate of transmission it will take decades to become common throughout the region where it is a practical technology. If it is desired to accelerate this diffusion, then extension services will have to be strengthened. Where ox-traction is continuing to spread, the most cost-effective strategy would be to make ploughs and carts available to farmers on a cost-recovery basis. At present the 'market' price of ploughs plus transportation often discourages farmers in remote rural areas who are apparently willing to adopt animal traction. Simultaneously, the Federal Government should establish a comprehensive policy on tractorisation and disseminate it widely. The failure of farmers to discern any pattern in the pricing and availability of tractors is discouraging them from making the decision to invest in ox-ploughing.

The most important factor causing farmers to stop ox-ploughing is animal disease. Admittedly, only a small proportion of the disease reported by farmers is zone-specific. The impact of rinderpest was nationwide, reflecting more the state of the infrastructure than the ecology or rainfall of the subhumid zone. Nevertheless, tick-borne diseases such as anaplasmosis and skin diseases such as dermatophilosis show a higher incidence in this zone. In the areas of pioneer colonisation, the trypanosomiases remain a problem.

With a few exceptions, livestock producers throughout the country have been convinced of the value of pharmaceutical medicines. However, these are not always available and the specialised advice from the veterinary service that should accompany them is even less accessible. Most farmers are obliged to obtain drugs on the market, thereby running the risk of buying expired or inappropriate medicines and giving wrong dosages. In view of the economic importance of animal traction, strengthening veterinary services to livestock producers, either through radical change to the existing government system or through a regulated private sector, is essential.

6.5 Policy implications

Establishing a national policy

When tractors were not really a viable proposition, potential adopters of animal traction had only the choice of draught power or hand labour. Although tractor hire schemes on an experimental basis have a long history in Nigeria, it was only with the beginning of the IBRD-funded ADPs during the 1970s that tractor hire began to reach many rural areas. Tractors were originally hired out at heavily subsidised prices in order to encourage farmers to use them.

Farmers were so successfully encouraged that many gave up using draught animals to the extent of selling their oxen and letting ploughs fall into disrepair. However, since that time, policies on mechanisation and draught power have been inconsistent. In some states, the ADPs have changed policy to encourage animal traction through the importation of light ploughs from South Asia. Tractor hire has been made progressively more expensive and less available. Elsewhere, however, the use of tractors has remained state policy and they continue to be imported and made available. Gongola State, for example, established the independent Gongola Agricultural Mechanisation Authority to promote tractorisation in the late 1980s, whilst simultaneously promoting animal traction through the ADP.

Farmers and others find it difficult to make sense of these policies and their reaction is often one of inaction. Many say that it is not worth investing in oxen if the state will make tractors available at subsidised prices. Tractors are alluring to governments, and popular with farmers, because they bear the seal of modernity. The speed of their operation and the potential for timely cultivation have obvious attractions over hand cultivation and animal traction but, because of the high costs involved in their purchase and maintenance, tractors will remain unavailable to the great majority. Tractorisation should be left entirely to the private sector. Tractors would then become available at unsubsidised but stable prices and individual farmers could make investment decisions on a more rational, long-term basis.

Research

Despite considerable discussion about animal traction, current research does not address issues of concern to actual users, but focuses instead on other topics. The main points of an action plan for research on animal traction should be:

- Promotion of carts where ploughs are already in use, and consideration given to establishing axle manufacture as in Francophone countries.
- Improved harnessing for camel-ploughs.
- Promotion and the sub-industrial manufacture of donkey-ploughs.
- Tests on four-ox ploughs and harrows in the *firki* soils of Borno.
- Exploration of the present use of ridgers for weeding and the testing of dedicated weeders.
- Promotion of harrows in selected regions.
- Dissemination of improved cart-making techniques within traditional manufacturing systems.

Carts. It is unlikely that factory-made carts will be competitive with those made from salvaged vehicle chassis for some time to come, in view of the large stock of car and truck bodies still available in Nigeria. However, as Map 3 showed, carting is still relatively uncommon compared with ploughing and is thus an obvious candidate for extension, especially as the rising cost month by month of motorised transportation makes it increasingly attractive.

Because of the varying raw materials from which they are made, carts are not all of the same design. As a result, some are much more efficient than others. A simple intervention would be to contact all the major cart-making workshops in Nigeria and identify those in need of design advice. Short courses could be developed for workshop leaders, blacksmiths and fabricators to improve the quality of their product.

Water-drawing. Water-drawing in Nigeria is poorly developed compared with countries like the Republic of Mali where deep wells can have elaborate arrays of pulleys. As with traction itself, drawing water using animal power is perceived as low status and compared unfavourably with diesel pumps. Nonetheless, the reality is that for many places in the semi-arid region, such mechanised facilities are unlikely to be available in the near future. If this is accepted, immediate benefits could be gained from promoting locally-made, low-cost lifting gear for wells deep enough to require animal power.

Tubers and ploughing. Some assertions by the farmers ought to be tested. For example, most of the plough users did not use their ploughs for tubers. However, where yams are interplanted with cereals in long ridges there is apparently a

potential for using the ploughs to ridge. It would be valuable to know if there are significant yield differences between yams planted in mounds and those in ridges. The ridges made for yams are too large to be entirely made by conventional animal-drawn implements. However, as several farmers pointed out, it is possible to use ploughs to clear the ground and prepare the ridges by throwing up earth. If ridges are equally productive, then societies such as the Tiv, Mumuye and Gbagyi, who live along the 'plough-frontier' but specialise in yam production, might be persuaded to take a more active interest in animal traction.

Conclusion

Until a national strategy is worked out in relation to farm power in Nigeria, all efforts at extension are likely to be undermined by contradictory directives from different agencies, or visibly different policies in adjacent areas. Animal traction must be considered in relation to policy on fertilisers and tractors, and the ability to deliver veterinary services to remote areas. Subsidisation has been almost uniformly unhelpful as it has lured farmers into making decisions that undermine long-term sustainable agriculture.

At the same time, all types of animal power are dogged by unhelpful stereotypes. Animal traction is often seen as not modern and a sign of backwardness, even in the face of visible evidence that mass tractorisation has been a failure. Even where animal power is promoted it is limited by the fixed notion that only cattle can pull ploughs. Work with camels, donkeys and even horses should be considered feasible. However, for these to be effective, new and more flexible veterinary, credit and implement services would have to be encouraged by government. It is clear from present evidence that farmers will continue to experiment with or without state support.

A similar stereotype limits the tasks for which animals are used. Thus harrows are virtually unknown, despite their success in other parts of West Africa. Little effort goes into testing and diffusing either other implements for animal traction or other uses of animal power, such as water-drawing. Trained animals are thus often used only during the season of peak labour demand yet must be fed and cared for throughout the year.

Elsewhere in West Africa the situation is generally better, since without the oil income that made Nigerian agricultural developers so ambitious, planners usually do not consider tractorisation on a large scale and are thus compelled to work with draught animal power. This has not necessarily affected underlying policies. Mechanical equipment is often considered superior to livestock although its use is

inhibited by its cost. If the Nigerian experience were better known, perhaps a more judicious approach might prevail elsewhere in West Africa.

Appendix: Camel-ploughing

Interviews at Kamba and nearby areas in the north-west of Nigeria confirmed that camel-ploughing began in the 1970s and is becoming increasingly popular. Although the farmers claimed it was independently invented, the idea at least probably came from Niger where this practice is more common, and which supplies the camels. This section considers the comparative benefits of camel and cattle-ploughing.

Camels are not bred in this part of Nigeria, but there is a long tradition of importing them to use as baggage animals and to draw water. The breeders (or at least those who trade them) are the 'Buzu', correctly *iklan*, the ex-slaves of the Tamasheq. The camels are brought down from the pastoral zone of Niger and sold in Kamba market. The 1986 price was about ₦2,000 for a three-year-old animal, which is suitable for work immediately after training. Camels require no special equipment but use the same plough as oxen, attached with a rope.

In the case of cattle, a pair of mature bulls ready for work would cost between ₦2,000 and ₦2,500 in 1986. However, this would be an exceptional strategy. Owners normally purchase calves between six months and one year old and expect to stall-feed them for two to two-and-a-half years before they are ready for work. This is usually only practical if the farmer has children in the compound who can cut grass and collect residues to feed the cattle. The advantage of this strategy is that calves can be bought for between ₦300 and ₦500, depending on age, so the initial capital outlay is much less.

The attraction of camels, as far as the farmers are concerned, is that they are less liable to get sick and they work almost twice as fast as cattle, even though only a single camel is required. As there is a substantial market for plough-hiring, this means the owners of camel-ploughs are free to go and work on other farms more rapidly and can thus make a larger profit during the tillage period. Another advantage of camels is that they can be used directly as pack animals, without purchasing a cart, which was an additional capital outlay of some ₦500 in 1986. Ox-carts are widely used in the Kamba area for transporting manure, crop residues and produce to market. All these functions can be taken over by camels, which can also draw water, something of a bonus in a region where the water-table may be as deep as seventy metres in the dry season.

All these factors suggest that camels are a more attractive option for traction than oxen in many parts of the semi-arid zone. In Kamba, four of the ten farmers interviewed had consciously switched from oxen to camels during the past decade.

A similar process has been occurring in semi-arid Mali, where the Fulbe in the Seno-Mango, famous for their sentimental attachment to cattle, have been replacing them with camels for all types of work (RIM, 1987). The limitation on the adoption of camel-ploughing appears to be economic, in other words the farmer's ability to accumulate the necessary capital sum. Camels must be purchased as full-priced adults as calves cannot be bought on the market and reared in the same way as cattle. Interviews in Mali suggested that camels would face more important limitations in terms of disease pressure than cattle in the subhumid regions, but in Nigeria this has yet to occur.

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