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AGRICULTURAL DEVELOPMENT IN DARFUR REGION, SUDAN With Special Reference To Innovation, Technical Change And Open Access Resources

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ABSTRACT

Darfur is the westernmost region of the Sudan. Rainfall is low but there remains scope for the expansion of traditional agriculture. The early twentieth century saw development based on expansion, on the introduction of simple techniques and on exports.

More recently Darfur has suffered a series of droughts leading to relief and development efforts. Famine and desertification have resulted in an emphasis on conservation as well as development. The Tragedy of the Commons thesis has been influential.

This doctorate thesis examines the processes of agrarian change in the Darfur context using extensive farm surveys as well as a range of secondary data compiled from local sources.

Three main models are considered: Schultz's "Transforming Traditional Agriculture", Myint's "Vent for Surplus" and Boserup's "Autonomous Transformation". A distinction is drawn between those models, (Schultz and Myint), which suggest that traditional agriculture shows special characteristics, and models which see change as a function of a shifting resource endowment (Boserup). Much aid-funded development work attempts to overcome the 'special characteristics'. They have had little success in Darfur. Attempts to tackle the Tragedy of the Commons have also failed.

Darfur has many traditional characteristics. Nevertheless, they are flexible and no obstacle to agrarian change, which occurred for much of the twentieth century. When that process did come to a halt, it was the result of a failure of political and economic management at the macro-level. Political development had been influenced by both pre-colonial and colonial history, but the failure was also a reflection of what can be described as the current political resource endowment; that is to say the balance between the governor and the governed. Because aid resources are so substantial they have a very important impact on that balance.

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1. INTRODUCTION

Darfur Region of the Sudan Republic lies on the watershed between the Nile, the Congo and the Lake Chad basins. There is a small strip of Africa that is more than 1600 kilometres from the sea in any direction. It runs through the west of Darfur, which may justly be called the heart of Africa. The people of the region are typical of the many communities of small farmers and pastoralists throughout the continent. The name Darfur means homeland of the Fur tribe. It now includes more than that, although it was all more or less subject to the Fur sultanate at one time or another. There is great ethnic diversity with peoples of Hamitic, Arabic and Sudanic stock. There are some 14 distinct languages although only a few, apart from Arabic, are still widely spoken. Almost all, however, are Muslim.

In 1985, as the scale and severity of the drought affecting Western Sudan became apparent, there was a heightening of interest in this little-known area. That interest has now slackened, just as the excitement generated by the Sahel drought of the late 1960's and early 1970's faded away. More recently, Darfur has been the scene of tribal fighting complicated by the spillover of more serious conflicts from neighbouring Chad and there was another poor harvest in 1990/91. In the first half of the twentieth century, by contrast, Darfur saw relatively rapid economic growth and even limited political development.

In response to the successive droughts, a number of new development programmes were instigated and there now exists a substantial body of experience from those programmes. This thesis uses the information gathered on some of those programmes to analyse the processes of development in Darfur. Using the Darfur experience, a variety of theories of rural development and agrarian change are considered: Schultz's 'Transformation of Traditional Agriculture', both Boserup and Hayami and Kikuchi's analyses of development through population pressure and Myint's version of Vent-for-Surplus. Land tenure is loose in Darfur, both for arable and grazing land, and particular attention is paid to the range of issues wrapped up in the phrase 'The Tragedy of the Commons'.

Recent events in Darfur have been dominated by the processes of international development support summed up as Aid. Those processes and their economic justification, often more implicit than explicit, are also examined through through their impact on development in a typical underdeveloped region.

The writer served for nearly seven years in Darfur, between 1982 and 1992. During that time he worked on the two largest aid projects in the region - the Western Savannah Development Project (WSDC) and the Jebel Marra Rural Development Project (JMRDP). As chief agro-economist on both projects he was responsible for a total of twelve major farming systems surveys, covering as many as 700 farm households per survey, and for a similar number of monitoring and evaluation exercises. His involvement with the surveys was particularly close by virtue of the fact that he has a degree in Arabic and therefore speaks the language of most of the farmers interviewed. Most of the evidence presented is derived from these surveys. A summary of the scale of the survey work is shown at Annex I and references in the text follow the pattern: 'WSDC, FS83' standing for 'WSDC Farmer Survey 1983'.

BACKGROUND

Darfur lies wholly in the tropics, between latitudes 9 degrees and 20 degrees North. It is some 650 kilometres from north to south and 525 from east to west: an area of 488,800 square kilometres. A large part of the north is pure desert and the south is savannah forest, reflecting a range in rainfall from near zero in the north to over 1,000 mm in the south. Most of the population lives between 11 degrees north and 14 degrees north.

At 3.5 million, Darfur has 15 per cent of Sudan's population: 20 per cent of the muslim north. On the broad estimates shown below, Darfur is poor in relation to the Sudanese average and to Sub-Saharan Africa. However, these figures can only be indicative. They depend on an exchange rate that has been distorted and very unstable. The Purchasing Power Parity estimates given are generally considered the more accurate indicator. The figures for Darfur, which are derived from survey estimates of household income, pose especial problems over the valuation of subsistence production and over reaching a valid average estimate in a region where drought and good harvests alternate. In some ways the region may be wealthier than this comparison indicates, most notably in the very large holdings of cattle: nearly a quarter of the national herd in 1977. (VRA/RMR, 1977)

tore 1.1 Dasic Stausues	Darfur	Sudan	SS Africa	
Area - km² '000	488	2,506	22,245	
1987 Population M'n	3.5	23.1	451.2	
GNP Per Capita US\$				
1987	150-300	330	330	
1982	200	440	491	
GNP Per Capita on Purchasing I	Power Parity Basis			
1989	na	1,042	1,187	
	Common Cuidom and C	S A friend West	1 d Damly 1001 8-	1000 TINT

Table 1.1Basic Statistics

Sources - Sudan and SS Africa: World Bank, 1984 & 1989, UNDP, 1992 Darfur: Derived from WSDC, FS83 & NS84 and JMRDP, WS87 & WS88

Production is perhaps the best measure of Darfur's position in the Darfur economy. During the 1970's, before the droughts and economic and civil instability of the 1980's, Darfur produced well over 50% of the cattle sold for urban consumption and export. Of the major export crops, the region produced some 36 % of groundnuts and 20 % of gum arabic. Between them these two crops made up nearly 15 % of the nation's exports.

Darfur forms a vast plain, between 1,500 and 3,000 feet above sea level, dominated by the Jebel Marra range of mountains in the west. These run south to the volcanic crater of Jebel Marra itself which is 10,075 feet (3,071 m) high. This range forms the watershed between the Nile basin and the system draining towards Lake Chad. In the south, the boundary between Darfur and Bahr el Ghazzal is marked by the Bahr al Arab: the most northerly watercourse draining into the White Nile. In the very south-west of the region the mountains containing the headwaters of the Bahr al Arab form the watershed between the Nile and Congo basins. (Figure 1.1)

The rains come in a short season and much of it in heavy storms with dry spells in between. This means that drainage is entirely different from that of more temperate areas. The Arabic word Wadi is used throughout to underline the fact that watercourses only flow for part of the year, in some cases for only a few days or even hours after rain. When they do flow, however, they are violent and the water carries a heavy load of silt. The violence and short duration of the wadi spates and their heavy silt loads, which can fill a dam in two years, mean that water storage for irrigation is rarely practical.

The wadis flow most strongly through the hilly areas. Once they reach the extensive flatlands they lose their force and spread out into ill-defined meanders. On both upland and lowland travel is very difficult during the rains. There are few roads, apart from a single stretch of tarmac between Nyala and Zalingei and a gravel road between Nyala and the capital El Fasher, but most areas can be reached by truck during the dry season. Nyala is the rail terminus of a line running to central Sudan but this line is weak and unreliable, especially during the rains.

Groundwater resources are limited. The region is underlain by Nubian sandstone which does hold water but it is only accessible in the eastern half of the region. Here boreholes can provide drinking water but they are too deep for economic irrigation. To the west, the sandstone is hidden beneath the basement granites and the more rocky terrain means that groundwater is restricted to narrow stretches of alluvium on the line of the larger wadis. These aquifers are normally shallow and not very productive.

There are two major volcanic massifs: Jebel Meidob in the north-east and the larger Jebel Marra range in the middle west. The peak of Jebel Marra is 3,071 metres above sea level. Basement hills extend all round the Marra range and smaller volcanic areas are frequent in the north and west. A typical landscape offers extensive views over flat plains dotted with the black volcanic plugs in one area or broken up by the jagged ridges of basement rocks in another.

THE CLIMATE

As the sun and the Inter-Tropical Convergence Zone move north in the northern hemisphere summer they bring the rains to Darfur. Total rainfall decreases from south to north but mountain areas, Jebel Marra in particular, create local variations in this pattern and have swung the distribution somewhat so that rainfall decreases more from southwest to northeast than simply from south to north. The region rises to the north and to the west so that dry season temperatures are somewhat lower in these directions.

There are three main seasons. The Kharif, or rainy season starts sometimes as early as April but more normally in May and it extends throught to October. Temperatures at first fall after the hot dry summer and then climb again as the rains taper off. This is the time of the harvest, called Darat. The cool dry winter season, the Shita, lasts from December to February. After that, the main summer dry season, the Sayf, sees much higher temperatures. **DARFUR - 1980s**



Rainfall distribution is crucial. A low annual rainfall spread over a whole year would be of little use. At high temperatures the balance between precipitation and evaporation is always negative and no crop can survive. If, however, the same total rainfall is concentrated in a few months it becomes possible to grow crops. The difference between a good year and a bad one in Darfur often depends on how much of the rain falls in early or late months and how much in the main crop season. The season is shorter in the north and a greater proportion of the total rainfall is can be useable by the crops. Crops can be grown further north than the absolute level of rainfall would suggest. (Ibrahim, 1984)

A failure is still possible, even when the season is short and the total rainfall within the cropping period is adequate, because the rain may be spread out in numerous small showers, too small to provide useable moisture to crops, or because of long dry periods between each storm. Complex relationships between precipitation, evaporation, crop variety and soil type determines how much rain is useful, or effective. Rainfall in Darfur is relatively well concentrated seasonally and it usually takes the form of storms large enough to provide effective moisture. It is the second danger, that of long dry spells or over-concentration in the wrong period that most often threatens crops in the region.

Figure 1.2 is a good illustration. Despite a long dry spell in September 1977, heavy well-distributed rain in August, the key growing period, ensured a better crop than in 1976 when the annual rainfall was only 5 millimetres lower but the few heavy and effective storms were widely separated and August was the worst of the three principal rainy season months.

Rainfall is variable spatially as well, as over time. An area that did better than its neighbours one year may do worse the next. This has its benefits. It is only in extreme drought that all suffer a crop failure but, equally, it is only in very wet years that all are guaranteed success. And in wet years, the narrow areas of good alluvial soil along the wadis are vulnerable to floods. Strategies to cope with all these risks are central to the way farmers and stock keepers manage their activities.





DROUGHT

Figure 1.3 shows rainfall for Western Sudan as a variation against the mean. Like the rest of the Sahel and much of Africa, there has been an unprecedented period of poor rainfall, starting in the mid-1960s. It shows no signs of coming to an end. There has been a great deal of debate about the causes of this drought. The key question is whether it is in any way the result of what is happening in Darfur, in which case it might be possible to combat it. If it is not and the cause lies outside the region, then drought will have to be treated as a fact of life.

The debate still seems a long way from any firm answers. A 1985 report by the United Kingdom Climatic Research Unit concluded:

"The most obvious gaps in our knowledge are:

We do not know why the present drought exists;

We do not know why droughts have occurred in the past;

We do not know how long the present drought will last"

(Farmer & Wigley, 1985)

This list of our ignorance is pretty comprehensive. Of the various possible causes - global warming, deforestation, ocean temperatures and the greenhouse effect - research has only lightened the gloom in one respect. It now seems reasonably well established that there is a link between the African monsoon and changes in the temperature balance in the world's great oceans. The ElNino of the Pacific is part of this wider pattern. It is most probable, therefore, that the driving force behind the drought is external to Sudan. "In a semi-arid environment like Sudan most moisture originates from outside the region and hence land cover change can have only a marginal effect on

moisture recycling." (Dr M. Hulme, Figure 1.3 personal communication)

Farmers and stock herders in Darfur are successful managers of the risks they face. Nevertheless, many argue that they face problems they cannot manage. First, traditional drought avoidance strategies may help to secure a livelihood under difficult conditions but they have limited scope for raising production and hence incomes. Second, they may only be effective in a balanced equilibrium between population and environment. Development, leading to population increase and rising standards of living, threatens that balance. It will be argued here that this is not the case. There remains scope for a decent living in Darfur,



even at these lower levels of rainfall. Although drought has made conditions much more difficult, it is the way the people of Darfur have seen their opportunities blocked by economic and political factors that has led to economic decline and outright famine. Drought alone they could have dealt with.

AGRICULTURE

Many parts of Darfur are of little or no agricultural use: especially those in the far north. 96 per cent of the the rainfed cropped area and one hundred per cent of the irrigated area is confined to the twelve zones listed in Table 1.1. The other zones, which cover 36 per cent of the land area of the region, are of virtually no farming interest. Even within the twelve better zones, only 5.6 per cent of the land area is cropped: perhaps a little more if allowance for expansion since 1976 is added. The descriptions of some of them as 'heavily eroded', 'steep slopes', 'sand and stone desert' show that the proportion of useable land even within some of these better zones is small.

Nevertheless, Darfur remains 'land-rich' in the sense that there are still reserves of useable arable land that have not been put to use.

Table 1.1 THE ARABLE FARMING ZONES OF DARFUR

		Total	Croppe	ed Area	
Zone	Description	Area Km ²	Rainfed -	· Irrigated	
20110	NORTHWEST - JEBEL	M II	I M	I MII	CROPS
01	Steep mountains with volcanic and basement soils. Dense or open woody cover, medium grass cover.	11,887	525.4	14.3	Millet, Tomato, Potato & Wheat on terraced
02	Steep mountain slopes with volcanic soils and dense woody cover.	1,206	100.9	5.2	volcanic soil; Orange, Onion, Garlic irrigated from streams.
	NORTHWEST - BASEMENT/WADIS				CROPS
03	Jebels in heavily eroded pedimisnts. Basement soils. Scattered Acacia with sparse grass cover.	74,693	3,084.8	10.0	Millet, Sorghum, Okra on alluvials; Groundnut on
05	River valleys. Alluvial soils. Thorn thickets/medium grass in south, scattered bushes in north.	4,719	943.1	15.8	lighter soils; Chilli, Tomato on residual moisture; Onions, Mango,
14	Undulating sand and stone desert. Scattered trees and bushes except where concentrated on watercourses	45,538	710.4	-	Lines on irrigation.
19	Flat wadi and wadi fans. Alluvial/stoney soils. Sparse woody cover with patches of dense grass cover.	27,064	671.2	-	
33	Undulating basement steppe. Shallow soils. Scattered Acacia, sparse grass.	4,408	1,204.7	1.8	
34	Steep scarps/undulating sandstone plateaux. Shallow soils. Scattered Acacia, sparse grass.	2,969	566.8	0.9	
35	Gulleyed/undulating pediment. Eroded soils. Dense Acacia thickets, sparse grass.	4,987	436.4	-	
43	Undulating basement with wadis through.	2,582	190.0	3.9	
	SOUTHEAST - GOZ				CROPS
11	Gently undulating sand sheet. Sandy soils. Woodland with medium grass cover.	114,367	7,391.7	-	Millet, Groundnut; Sorghum in depressions.
	SOUTHEAST - ATHMUR/NAGA'A				CROPS
41	Undulating with extensive drainage network. Mixed sands and alluvials. Medium woody cover, medium grass cover.	17,039	1,497.7	-	Millet, Sorghum, Groundnut on athmur dunes, Barbari Sorghum on residual moisture.
	Total	311,459	17,323.1	51.9	
					Source: VRA/RMR, 1997

For farming Darfur may be divided into two major areas: the north and west and the south and east, referred to as north/west and south/east from now on and marked as such in the table. In the first area, alluvial soils along the wadis of the basement zone are the most important source of crop land. The volcanic soils of the Jebel Marra massif are also important. In the second, south/east, area, most of the crop land is on the large areas of windblown sandsheet, called goz. The athmur, sandy dunes which are found in the middle of the alluvial areas, are also farmed. Figures 1.4 and 1.5 illustrate the way the different crops are grown according to the soils and topography of each of these two major areas.

Three factors determine the way the Darfuri farmer manages his crops: ease of cultivation, soil fertility and access to water. Ease of cultivation matters because farmers who only have hand tools cannot manage heavy or hard soils, even though they are usually more fertile. The light goz sands, which are easiest of all to hoe, are infertile but the yield difference between light and heavy soils is not always as great as might be expected and ease of

cultivation more than compensates. The importance of water is self-evident; areas without drinking water cannot be farmed, however good the soil. Both pre-season work and, especially, harvesting have to be done well outside the rainy season, so cropping is impossible if there is no way to store water near to the fields for these periods.

The division between north/west and south/east reflects the influence of all three factors. The north/west group is more varied but fertile soils are available. Some are too heavy to work but others are well suited to traditional hand cultivation, especially along the wadi valleys where the best alluvial soils are found. By contrast the soils in the south and east are either light but infertile sands (goz and athmur) or compacted soils (nagaa), which can be more fertile but which are impossible to cultivate without tractors.

Table 1.2 compares the availability of water between the various arable zones. Water is relatively well provided in the north/west group where shallow wells along the many wadi courses can last through the dry season. The best land is also found along the wadis so there is a good match between water supply and crop land.

In the sandy south/east there is no such match. Until the introduction of deep boreholes, dry season water was only available along the lines of wadis or buried watercourses (ar regeba), where wells can be dug by hand, or in depressions where ponds of standing water can last. In general, this meant that dry season water was only available in the alluvial areas, where the soils are too hard or during the rains too wet to be useable. For this reason, farming in the south/east was largely confined to the boundaries, where the sandy goz for farming (zone 11) was in reach of the the water sources in the alluvium (zone 41), and to those parts of the alluvium where there were sandy, athmur ridges that could be farmed. Much of the history of agricultural development in Darfur over the last century reflects the way in which the water problem on the goz was solved, so that it now provides the largest single area of cropped land: 41 per cent.

North/West Zones	N. Darfur S. Darfur	r
01	-	14.10
02	-	18.14
03	3.04	8.38
05	23.69	-
14	0.09	-
19	1.31	-
33	1.59	-
34	3.30	-
35	0.20	-
43	-	2.69
South/East Zones		
11	0.13	0.40
41	-	0.79
All Zones	0.63	4.92
		Source: VRA/RMR,1977

Table 1.2Density of Waterpoints per km² - 1976/77

The north/west group may be seen as heartland of agriculture in Darfur. It includes Western, Central, Northern and Southwestern districts of North Darfur and Azum, Jebel Marra Wadi Salih and Central districts of South Darfur. This area largely corresponds to the central territory of the Fur state and was the focus of development under that state. At the 1983 census some 66 per cent of the settled rural population lived in those seven districts. Yet, even when the vast northern desert is excluded, they cover only 37 per cent of the land area.

With increasing population and urbanisation and with improving transport, the Darfur economy has moved some way away from subsistence. Demand has developed for food grain, to feed the towns and food deficit areas, and for oilseeds for sale in expanding domestic and export markets. The south/east, where cultivable soils are extensive albeit rather infertile, is well suited to these commodity crops. It has seen a rapid expansion in the cropped area as a result. Grain and oilseeds are the most important crops in the north/west also but there has also been an increase in production of fruit and vegetables destined for both urban and rural markets.

Farm sizes are larger in the south/east. Even household sizes appear to reflect the difference although reliable definitions of a household are difficult to reach. In the area of the Western Savannah Development Corporation (WSDC), which is typical of the South/East, the average household had 6.22 residents in 1982. In the Jebel Marra

Figure 1.4

CROP:SOIL RELATIONSHIPS - South & East Darfur





CROP:SOIL RELATIONSHIPS - West Darfur



Rural Development Project (JMRDP) area, typical of the North/West, there were only 4.98 residents per household in the same year. (WSDC, FS83, JMRDP, WS83) While the north/west - south/east divide is a useful way of understanding changing patterns it should be stressed that it is a gross over-simplification of a kaleidoscopic pattern.

THE CONTEXT

Darfur's boundaries touch Libya in the north west and Chad and the Central African Republic in the west. Inside Sudan it marches with Bahr al Ghazzal to the south, Kordofan to the east and Northern region to the far north. Historically, the region has tended to look northwards towards Egypt and westwards towards the states of the Saharan Sahel and the Central African Savannah rather than east to Central Sudan. It was only under the Anglo-Egyptian Condominium that the link with the east began to dominate and Darfur was the last region to be

added to the Condominium, in 1916. 'Darfur as befits a child born as an afterthought to a large family has always had an identity very much her own.' (Gillan, 1939)

Darfur is frontier territory in many senses. It lies on Sudan's boundaries with three other states. It lies on the watershed between three of Africa's largest drainage systems. The southern boundary of the region marks the divide between muslim north Sudan and non-muslim south.

There is one other, special sense in which Darfur is frontier territory. The region still lies on the frontier between the 'desert and the sown'; between the world of the nomad, who moves over a landscape with his animals and who does not change it, and the world of the cultivator, whose activities inevitably lead to a permanent change in the shape of the land. In economic terms Darfur therefore lies on the extensive rather than the intensive margin but the man:land ratio has risen following some decades of rapid population growth.

One view, the Boserup Hypothesis, is that such a shift will lead to an agricultural transformation by bringing about 'autonomous intensification'. The counter-argument is that autonomous intensification cannot keep up with the high population growth rates of Africa and that 'policy-led intensification' is essential to avoid poverty and environmental damage.

Superficially, drought, desertification and famine in Darfur all point to a failure of autonomous intensification. It will, however, be argued here that the opposite is true. The evidence from Darfur supports the Boserup Hypothesis in most respects. Where not constrained by external factors, the people have shown a capacity to adapt rapidly. Policy-led intensification has been a failure, by contrast.

There are, however, two critical areas in which this laissez-faire conclusion does not hold: summed up in the words administration and supply. The development of the Darfur economy in the mid-twentieth century depended on administrative improvements: in security, in public order and in justice. The decline in recent years has been accompanied by a deterioration in those same areas. Where there are good grounds for believing that Darfur can make the most of its technical opportunities, there are few for believing that it can generate an internal solution to these social problems. And some solution is essential to the Boserup transition. More intensive agriculture will require more trade, more exchange, more specialisation. That can only happen if markets are free to operate, if different groups in the region can feel able to trust one another and if all are able to rely on the judiciary to resolve disputes promptly and even-handedly.

A massive failure of national policy - on prices, on export tax policies etc - has blocked the supply of inputs and incentive goods. Transport and foreign exchange are two critical factors. Both administration and supply are inextricably linked with politics in Sudan and it will be argued that the principal reason for the current difficulties is not excessive population pressure but rather a breakdown in the political arena.

A second fundamental question concerns the acquisition of new technology. Or, for areas which are not developing, why it is not acquired. A number of different answers have been proposed:

- That farmers are hindered by tradition,
- That farmers lack the capital needed to acquire new technology,
- That social structures are a block, both inequitable ones that allow monopoly and other exploitative behaviour and equitable ones such as communal tenure that are vulnerable to externality problems,
- That modern technology is not 'amenable to transfer', especially for agriculture,

At bottom the anti-Boserup hypothesis, that population growth is outstripping the capacity to acquire technology, depends on some or all of these being true. 'Amenability to transfer' is a critical issue. Many have concluded that research to adapt techniques specifically to poor farming areas and training to enable farmers to absorb new techniques is essential. The evidence from Darfur points to a different conclusion: that farmers are perfectly capable of acquiring new technologies when they are profitable. The major block is that so few are profitable. Because development has been blocked by failures in the political arena, there is no demand for the technologies research can produce. Because supply has been stifled there are no inputs, no consumer goods and no markets for crops. In effect, an 'induced innovation' model of technology acquisition is more convincing and the lack of progress reflects a lack of inducements.

In other words, the Darfuris' problem is not that they are incapable of absorbing new technology nor that there are no western technologies which might suit them. They face a far simpler problem, which is that western technology is kept out of their reach by a grossly mis-managed national economy.

To try and establish these points, the next chapter summarises a number of different models or theoretical analyses of agrarian change, or non-change, while the subsequent chapters consider the Darfur economy in detail and in the light of those analyses. The conclusion will be that regardless of which model of agrarian change is applicable to Darfur, none are working because of what is termed political and economic compression. The

political and economic forces driving that compression are outlined in the last chapter. To do more would need a separate thesis.

2. MODELS OF AGRARIAN CHANGE

Models of agrarian change can be divided into two groups. One takes the characteristics of traditional agriculture as more or less fixed; typically this unchanging agriculture forms part of a dual-sector model, in which it is treated as a residual, almost exogenous, component attached to the modern sector. In such models internal development within agriculture only starts when its traditional characteristics have been broken down by development in the modern sector. The second, more dynamic group treats the characteristics of smallholder agriculture as part of the model; they change as the balance of resources changes or under the impact of trade, for example. Agrarian change in these models is a continuous process.

TRADITIONAL AGRICULTURE AS A RESIDUAL

In residual models smallholder agriculture acts as a source of cheap labour for the modern sector, as a source of wage goods for the modern sector and as a market for the modern sector's produce. Without relatively rapid growth in agriculture, that market will be limited. For all these reasons the importance of the traditional sector is acknowledged but it remains the passive partner, which will only develop under external stimulus. "For most of the developing countries, rural development will be needed on a massive scale for decades. But the progress of rural development will be crucially dependent on the outcome of the green revolution, measures of land reform, land settlement at the extensive margin, new forms of rural institutions, and various special programs designed to increase the incomes and productivity of the rural poor." (Meier, 1989)

The Lewis model is the classic example of a two-sector model treating smallholder agriculture as a residual, subsistence sector. It is too well known to need discussing here but there is one central concept that has echoes throughout discussions of agrarian change. That is the idea that the labour force in subsistence agriculture is not fully employed, in one way or another. For brevity the term disguised unemployment will be used for this, without discussing the different possible grades of under- or unemployment. Disguised unemployment is to be found, less explicitly, in models of agrarian change that are, in other respects, very different from the Lewis model. One is the Boserup hypothesis that agricultural intensification is a function of population density and the other is Myint's vent-for-surplus model. Both of these have considerable relevance to the Darfur case where the Lewis model does not.

Disguised unemployment seems most likely in a situation of high population and scarce land; not in general the case in Africa. African smallholder agriculture is, however, frequently considered to have much the same subsistence characteristics and there are factors which might give rise to disguised unemployment. One is the sharp seasonality typical of many parts of Africa, which might mean that labour can only be fully employed for part of the year. The other is that it can be easy to cover basic subsistence but there are few opportunities for cash cropping or for growing higher value crops, so that labour cannot be fully employed beyond a subsistence ceiling. (Boserup, 1965)

Another possibility is that smallholder agriculture lacks the complementary capital needed to ensure full productive employment: ".. scarcity of capital has led to such a substitution of capital by labour that the marginal product of labour is not zero; thus a withdrawal of labour will reduce the rural output somewhat. ... It is however likely that a relatively small amount of investment may make good the loss of rural output." (Sen, 1960) This is not quite disguised unemployment but it points to the same conclusion, that smallholder agriculture can release large amounts of labour at low cost.

Disguised unemployment depends on what are believed to be two institutional peculiarities of subsistence agriculture: a reliance on peasant family labor and the consequent absence of a market-determined wage rate and the fact that peasant families share their food so that members who are not fully employed eat the same, receive the same subsistence wage, as those who are. (Nurkse, 1957) The evidence from Darfur is that there is considerably more scope for varying the subsistence wage than is recognised. The family size, leave the household quickly to seek other opportunities if a better 'wage' can be found elsewhere. The institutional mechanisms of disguised unemployment do not seem to exist. This still leaves the possibility of seasonal unemployment or unemployment over the subsistence ceiling, more complex issues which are discussed later.

EFFICIENT BUT BACKWARD

Various reasons are put forward why smallholders might not take the same decisions as a profit-maximising firm. The fact that they are not in the market, that they are sharecroppers rather than tenants, that they are risk averse or merely the nature of the smallholder family firm, in which production and consumption decisions are treated jointly are some examples. An implicit feature of many of these ideas is that the peasant family is tightly

knit. Unlike the business firm it cannot vary its labour force by hiring or firing in order to maximise profit. The point has already been made that the Darfur family appears to be much more flexible in the way it allocates labour than these ideas allow for.

Many studies have tested the allocational efficiency of peasant households, principally by analysing the costs and returns of smallholder farming. This study does not attempt to repeat that approach for two reasons. One is that farming in Darfur uses so few inputs, apart from labour which cannot be valued with any certainty and land which has no recorded market value, that testing for optimum allocation is difficult. The other is that real market prices have been extremely unstable for many years making comparisons close to meaningless. Instead, the focus in the chapters that follow is on the techniques and strategies that farmers use. In this sense it matches the sociological and anthropological studies that Schultz recommends as preferable to forcing "any estimates, however weak, into a Cobb-Douglas type of production function." (Schultz, 1964) Particular emphasis is placed on analysing the skill revealed in farmers' agronomic practices.

Schultz's work provides the first starting point for this thesis, standing as it does as an early statement of what is still implicit in most attempts to 'Transform Traditional Agriculture'. As far as efficiency is concerned, the evidence from Darfur points to exactly the same conclusions as Schultz:

- that crop combinations, timing, techniques etc "are all made with a fine regard for marginal costs and returns."

- that there are no significant indivisibilities.
- that product and factor prices are flexible.
- that no productive factor is unemployed.

An important overall conclusion is that "an outside expert, however skilled he may be in farm management, will not discover any major inefficiency in the allocation of factors." (Schultz, 1964) It follows that no growth can be expected without the introduction of new techniques, almost certainly embodied in new agricultural inputs. Much of what follows is to record the failure of a large number of experts who have attempted to show otherwise in Darfur.

Schultz dismisses the concept of disguised unemployment, at least in the sense of a zero marginal productivity of labour (MPl) and he suggests that in traditional agriculture the MPl will be the same as in other sectors net of transfer costs. (He also suggests that it is in first world agriculture that MPl is less than in other sectors, thanks to political support programmes: an important reversal of perceptions.) He does, however, acknowledge the existence of 'idleness' and 'unthriftiness' in traditional agriculture, as responses to simple economic facts: low returns to work and to saving. This explanation marks a critical departure from earlier analyses such as Sen's, which suggest that scarcity of capital is the cause of idleness, because that would imply that returns to work are low but that returns to savings would be high, if there were any.

Schultz models the supply and demand of 'agricultural factors'; a market in which the price of such factors is determined by the income stream each one produces. (He takes this approach for the same reason as others - Scott, Dennison etc - to avoid "the serious conceptual and logical difficulties inherent in aggregating capital and treating it as a stock".) The dominant characteristic of traditional agriculture is that the "marginal preference for acquiring agricultural factors as sources of income (arrives) at an equilibrium with the marginal productivity of these sources and net savings (approach) zero." At this equilibrium no growth or development can occur. He thus hypothesises that the rate at which farmers in such a traditional agriculture will accept new factors of production is a function of its profitability, just as for farmers in modern agriculture, but that "traditional agriculture has certain strong built in resistors": notably the need to learn to handle new risks and uncertainties.

Schultz describes his traditional agriculture as 'penny capitalism': efficient in allocating resources and integrated into cash markets for smallholder crops. The central puzzle of penny capitalism is why it survives, given that it is exposed to markets in which it can acquire additional agricultural factors. The conclusion is those factors are too expensive. "Clearly then the critical problem is to determine why the supply of permanent income streams in traditional agriculture is so costly."

Costly factors implies a low rate of return on investments in agriculture. This in turn provides "a logical basis for a low ratio of savings to income, for little or no foreign capital entering into traditional agriculture, and for a low rate of net capital formation." Schultz thus rejects alternative explanations for low investments, such as a low propensity to save among poor farmers, a lack of entrepreneurs or disjunctions between savings and investment. "All of these explanations rest on the presumption that the rate of return of such investments is high." (Schultz, 1964)

It is not easy to measure rates of return in order to decide which is correct. Rural money-lenders reportedly earn very high rates of return but this is principally lending for consumption, not investment, and it is widely

debated whether the real rate is in fact that high, net of transactions costs and default. Another argument is that the scarcity of reproducible capital in poor agricultural communities is self-evident proof of high rates of return. Which is far from self-evident, since low capital stocks might just as easily be the result of low rates of return, and which also ignores quite substantial capital tied up in livestock, wells, housing etc. (Schultz, 1964) It should be remembered that those stocks may not be large absolutely but they will certainly be large relative to income in a poor area.

There are two propositions to consider. One is that investment is wrongly allocated between factors and the other is that the general level of investment is wrong relative to the general rate of return. In regard to the first proposition, penny capitalism allocates investment between factors efficiently, something that the evidence from Darfur supports despite a number of reports to the contrary.

On the second proposition, Schultz argues the level of investment is not wrong. The low level of investment correctly reflects the low rate of return. In truth this is no more logically sound than the opposite belief, that the low level of savings must mean that rates of return are high. Low savings can mean high returns or low returns can mean low savings and vice versa. It also clashes with Schultz' own suggestion that capital stocks in traditional agriculture are not as low as is often suggested.

As this shows, the scope for incomplete analysis on this point is considerable, something widely evident in discussions of capital in Darfur. In general the evidence does not support Schultz. The Darfur economy expanded very rapidly for much of the twentieth century, principally through extension but a number of significant new agricultural factors were adopted with enthusiasm, implying that agricultural factors were quite cheap. More recently, severe macroeconomic and political problems have made those factors much more costly bringing about a severe slowdown. But this merely demonstrates that rates of return in smallholder agriculture are subject to external forces like all other sectors.

It is widely ignored in these discussions that the equality of savings and investment in the macro-economic model does not mean that they are the same thing. People do not save primarily to invest. They save for insurance, for pensions or generally to spread their consumption over a different profile from their income. At the margin, rates of return may affect the propensity to save but they do not affect the fundamental motive for saving. The fact that people continue to save at negative real interest rates, even in the first world, is evidence enough of this. It is explicit in the Lewisian models that the propensity to save in the subsistence sector is low relative to that in the modern sector and that it is only savings out of profits that are important. If investment were the only motivation for saving this might be true. It ignores, however, the possibility that the demand for savings as a means to spread consumption will be far greater in the subsistence sector. This point is emphasised because it will be shown that in Darfur the propensity to store food grains is extremely high, with the result that the region holds a very significant proportion of its product in grain stocks. Storage losses alone mean that these must show a negative return.

The hunger for non-productive assets in relatively poor societies, such as gold in India, suggests that saving of this kind may be widespread. This saving may be termed subsistence saving, to emphasise that the volume of savings is almost entirely a function of the demand for insurance, in turn a function of risk, and for pensions and that it is probably inelastic with respect to interest rates or returns on investment. (As an aside, this might imply that rapidly falling mortality in developing countries would lead to higher savings ratios for pension purposes. But then it would be necessary to disentangle how much of the resources devoted to having children should be classed as an investment in pensions and how much as consumption.) To sum up, it is not possible to deduce anything useful about returns to agricultural factors from the level of savings or vice versa.

Having identified expensive agricultural factors as the problem, rightly or wrongly, Schultz goes on to analyse possible reasons why it might be so and hence to make policy recommendations on how to make them cheaper. His conclusions have been immensely influential in the 'real' world of development policy and aid as well as in the theory, if only because they offer the optimistic hope that "traditional agriculture can be transformed into a relatively cheap source of economic growth." (Schultz, 1964)

The argument depends partly on the standard case that research and extension have strong externalities which make the social returns high but which leave the private returns too low to stimulate private sector interest. The case appears to be supported by studies such as those of Griliches showing extraordinarily high social returns to research into hybridisation in the USA. (Griliches, 1958) (It may be noted that it is close to impossible to capture all the costs of research in order to calculate these returns. What was the cost of Mendel's work? Where does that come in the calculation? And should not the cost of egregious research failures such as Lamarck and Lysenko be included? To show high returns from the successes only is not to show very much.)

Schultz explicitly sets the case for research within the context of the Solovian residual, technical change, arguing that the potential for transforming traditional agriculture has been neglected because it has been concealed in

'technological change', as a non-factor. It is important to note, therefore, alternative explanations of technical change, in particular those that suggest that research and innovation are responses to changing circumstances not causes of change in themselves.

Liebenstein draws the distinction between Allocative Efficiency and what he termed X-Efficiency. Having shown that the contribution of Allocative Efficiency was small, in that monopolies and tariffs did not cost much relative to GNP, Liebenstein found an alternative in motivation: "people and organizations normally work neither as hard nor as effectively as they could" "The responses to (competitive pressure and other motivational factors), whether in the nature of effort, search, or the utilization of new information, is a significant part of the residual in economic growth." (Liebenstein, 1966)

X-Efficiency may be summed up as the potential efficiency that human idleness normally ignores but which can be called forth fairly readily if the incentives are there. Once again the underlying concept is one of unused capacities; disguised unemployment with the additional concept of what might be termed disguised intellectual unemployment. A central implication is that neither the generation of new knowledge by research nor the transfer of knowledge by teaching and training are involved. "The knowledge may have been there already and a change in circumstances induced the change in technique. Motivational aspects are involved <u>entirely apart from additional knowledge</u>". (My underline.)

There are three forms of X-Efficiency. 'Intra-plant motivation efficiency' relates principally to the extra effort that can be called forth by new payments systems and other incentives. UK figures show effective workforce incentives can call forth <u>sustained</u> increases of 7.5 to 291 per cent, as only one example. 'External motivational efficiency' sums up all the pressures of competitive markets. The importance of this is seen in the fact that up to two thirds of all research work done by commercial firms in the US was shown to be "passive, forced on the firms for defensive purposes." In other words, two thirds of innovations would not occur without competitive pressure.

The last of Liebenstein's three efficiencies is 'non-market input efficiency', ie management. Because traditional micro-economics assumes that individual firms are rational and efficient, it also assumes efficient management. Management is not, therefore, a market input in traditional analysis. This is obviously unrealistic. The quality of management depends on what it is paid and what pressures are applied to it, just like any other productive factor in the economic process. This concept has particular importance for less developed economies where non-market institutions are important.

Another view on technical change is that of Scott, who holds that the residual is in fact a mirage. This is because depreciation should not, he argues, be deducted from the capital stock because true depreciation, exclusive of strict replacement, is not properly a cost. If the capital stock is the sum of gross investment over time rather than net investment, then there is no residual or it is much smaller and it is investment itself that is the driving force behind technical change. Scott also reviews a number of studies pointing to the conclusion that innovation is market driven. (Scott, 1989)

Intuitively Scott's case is a little difficult. He argues that depreciation is not a cost because it represents the erosion of profits on a particular capital item as productivity in the economy grows and hence the share of wages on a given vintage of capital. But surely that productivity growth is driven by technical change. So perhaps depreciation is the correct measure of technical change after all, despite the fact that Scott is quite correct to point out that it is costless to the economy as a whole. This underlines the crucial feature of technical change; that it represents a potential for growth which does not depend on higher savings ratios, higher investment and growth in the capital stock. It depends instead on raising returns from the existing capital stock, by making more efficient use of it or by replacing it with more rewarding factors. The potential for raising returns by replacing subsistence savings with productive assets would seem very great, for example, and it would come under the heading of technical change not increased savings ratios and capital growth.

Many will argue that this is to miss the point, because both efficiency and new capital in fact represent the embodiment of investments into human capital, training and education, and into research. The crucial distinction lies between this view and X-efficiency; because the latter suggests that technical change does not spring from the emergence of new technologies and skills but instead from responses to the pressures and incentives of the market. It is a central purpose of this thesis to assess which is the most convincing in the circumstances of twentieth century Darfur.

The technical change debate is predominantly concerned with the the developed countries, where growth is the norm and the sizeable residual demands explanation. Even for developing countries, however, the residual appears to exist; between 1948 and 1973 only 23 per cent of the growth of output in developing countries was attributable to capital. (Cassen, 1986) It nevertheless seems plausible to expect it to work rather differently in developing countries, especially so because so much technology is already available in the first world and waiting only for its efficient implementation in the third.

In line with this expectation, Schultz' case for research and extension depends on the characteristics of traditional agriculture and on the specific nature of agricultural technology. In traditional agriculture, farmers are not well-educated, they may wish to avoid the risk of experimentation and marketing is weak because in "a typical poor agricultural community costs of entry are generally high and the market for a particular factor is small." He presents no evidence on any of these points, although the lack of literacy can perhaps be taken as given.

As far as experimentation is concerned, it is becoming increasingly recognised among the practitioners of farming systems research that peasant farmers do indeed experiment quite widely. Far from it being "highly improbable that any small farmer would engage in a search for new factors unless there were some experimental plots nearby or through some cooperative arrangement," small farmers are always on the lookout for new factors and rapidly adopt those that work. On the last point, most penny capitalist economies are characterised by feverish informal marketing activity in very small quantities; penny packets are what make penny capitalism. It is difficult to see why entry in the market for agricultural factors should be so difficult, when the costs of entering the market other commodities rarely extend beyond a piece of cloth on which to spread a few wares. This is certainly true for Darfur. The same point might be made more formally by saying that if returns in penny capitalism are low, then traders in agricultural factors might be expected to accept lower returns than in the first world, offsetting at least to some extent any externalities and high entry costs that might discourage them.

The core of Schultz' argument lies, however, in the nature of agricultural technology. Muscat has summed up this position well, drawing a distinction between industrial technologies, which are the concern of the private sector, and agricultural technologies "which are the proper concern of government, (and) are not amenable to direct transfer from abroad." This is because agricultural technology has to be 'adapted' to suit soils, rainfall etc. But, the argument goes on, the methods for solving technical agricultural problems in a systematic scientific manner are "amenable to transfer". (Muscat, 1966)

The prescription is, therefore, for scientific research to generate the necessary adapted technologies, for extension to overcome the barriers to dissemination in traditional agriculture and for education, because agricultural technology typically comes as a combination or package: "the new combination of inputs that accounts for the large increases in rice yields, notably in Japan, have not been adopted in those countries where the farm people are predominantly illiterate". (Schultz, 1964) Since the green revolution, that new combination has spread very widely and it is an open question whether that is because of education over the last 20 years or so or perhaps because the strong incentives offered to Japanese farmers have become more widespread.

In essence, Schultzian penny capitalism is populated by farmers of outstanding economic rationality, when it comes to allocating resources, but extremely limited capabilities, when it comes to learning anything new, let alone innovation. The barrier to technical change and the consequent limits on the capacity to absorb new agricultural factors, or capital more generally, is that "human capabilities do not stay abreast of material capital." (Schultz, 1964) In what follows it will be argued that the Darfuri farmer is, on average, just as capable as he is rational and that any agricultural technology of genuine worth is perfectly amenable to transfer. The reasons behind the low returns to agricultural factors must be sought elsewhere. If the choice lies between between technical change as the embodiment of investment in human capital and research and technical change as a response to motivation and circumstance, the latter seems to fit the Darfur case more fully. The next two models of agrarian change take far more account of motivation and circumstance.

VENT FOR SURPLUS

The ways in which trade can act to bring about agrarian change are analysed in Myint's 1958 paper 'The "Classical Theory" of International Trade', which presents three possibilities. The first of these is the conventional trade theory of comparative advantage. Myint considers the Ohlin version. Under this theory trade brings about specialisation, where "specialisation merely means a movement along a static 'production possibility curve'". (Myint, 1958)

The other two possibilities are both drawn from from Adam Smith's statement that trade "carries out that surplus part of the produce of their land and labour for which there is no demand among them, and brings back in return for it something else for which there is a demand." (Smith quoted in Myint, 1958) The first idea springing from this is that trade provides an outlet for surplus product above domestic requirements. In Myint's interpretation, this can be directly linked with the 'African' or land-rich version of disguised unemployment discussed above. "The increase in output per head seems to have been due to an increase in working hours and in the proportion of gainfully employed labour relative to the semi-idle labour of the subsistence economy." (Myint, 1958)

The second Smithian idea is that trade opens up the scope for productivity gains: "By means of (trade), the narrowness of the home market does not hinder the division of labour ... from being carried to the highest perfection." (Smith quoted in Myint, 1958) Productivity gains may come about through the pure efficiency gain

of greater division of labour or through increasing investment as trade leads to higher returns. In the terminology of the earlier discussion, the growth caused by the second of these can be attributed to increases in the capital stock while the first represents the technical change residual. But in either case the prime cause of growth is trade.

Myint argues that in those underdeveloped economies that saw rapid export-led growth in the 19th and 20th centuries, neither comparative advantage nor productivity improvements were at work. It was the vent-for-surplus mechanism that was dominant. "Instead of a process of economic growth based on continuous improvements in skills, more productive recombinations of factors and increasing returns, the nineteenth-century expansion of international trade in the underdeveloped countries seems to approximate to a simpler process based on constant returns and fairly rigid combinations of factors. Such a process of expansion could continue smoothly only if it could feed on additional supplies of factors in the required proportions." (Myint, 1958)

As with the preceding models, his reasoning is based on a particular view of the characterisics of subsistence agriculture. This is necessary to explain why there should be any unemployed labour in a land-rich economy. "The crux of the matter is the question: why should a country isolated from international trade have a surplus productive capacity?" Myint's answer is the rigidity of an underdeveloped economic organisation. Conventional trade theory assumes effective markets which give the capacity to adjust factor prices until all are fully employed. But before trade such markets do not exist as it is international trade that introduces the money economy. In addition, "with their meagre technical and capital resources, the underdeveloped countries operate under conditions nearer to those of fixed technical coefficients than of variable technical coefficients." (Myint, 1958)

At first sight, Darfur appears a classic case of vent-for-surplus in action. The twentieth century saw several decades of rapid increases in production, largely driven by trade and largely the result of expansion in the cropped area using the simple techniques of hoe agriculture. Until the late 19th century and even beyond it was a predominantly non-monetary economy, apparently matching Myint's description of economic rigidity. On closer examination, however, the situation is not so clear. First, the so-called rigidities of the subsistence economy are not evident. In the pre-money era alternative mechanisms for adjusting factor prices were working. Second, immigration has been substantial, indicating that the labour needed to expand production was not drawn from disguised unemployment but came instead from other areas, where it can only be assumed that production fell. Third, there has been a considerable amount of specialisation and technical change. Because it has occurred within a relatively simple system and because it has not been accompanied by substantial investments, this is not immediately obvious. (Giving rise to the thought that the same might have been true in other well-known examples of vent-for-surplus such as nineteenth century SE Asia and early twentieth century W Africa, which might bear re-examination.)

There is an observational trap in smallholder agriculture on a relatively abundant land resource. This is because it is easy to observe an apparently unchanging technology, such as hoe cultivation, dominant across large areas and take it as an indication of rigidities in factor allocations. All it really proves is that the factor endowment is more or less the same everywhere, hence so is the optimum factor mix. Furthermore, comparative advantage would only make this more true not less. Without trade the local economy has to produce a relatively diverse range of products giving an impression of a more varied factor mix. After trade starts, specialisation makes a limited number of factor mixes more dominant.

Changing transport technologies have played a crucial role in Darfur, which makes it necessary to pick up one last point in Myint's paper, that improvements of transport and communications are "methods of increasing the total volume of resources rather than methods of making the given volume of resources more productive." This strange statement cannot be let pass because it is quite clear for Darfur that improved transport technology has vastly increased the productivity of resources, by substituting lorries for vast herds of camels in particular.

THE BOSERUP HYPOTHESIS

It is not clear why Boserup has a hypothesis rather than a model; perhaps it is because the conclusions are at odds with the consensus and therefore cannot be given the status of a model. Perhaps it is because, uniquely among those discussed so far, Boserup pays detailed attention to the technical side of agriculture. The hypothesis is explicitly anti-Malthusian as it argues that production growth is a function of population growth rather than population being a function of production. Even though the developed world appears to have escaped the Malthusian trap, the less developed world does not, so the question is still highly relevant: witness the increasing emphasis on population control and resource conservation.

Frequency of cropping is the central concept; this is the mechanism which produces more food as population grows, by shifting more land into shorter fallow systems not by working a given patch of land more intensively to raise yields. (Boserup, 1965) Agricultural development can be mapped in terms of frequency of cropping from its earliest stage of long-cycle, forest fallows, in which one or two years cropping is followed by twenty years fallow,

through shorter bush and grass fallow systems right up to annual cropping and multi-cropping systems. This progression can be identified in Europe, where forest fallows existed into the middle ages, but in the modern world it is particularly relevant to those parts of Africa with sparse populations where forest and bush fallows are still common. Darfur is a typical example.

The implications of this concept are considerable. One is that African fallow systems are not an expression of the poor quality of the land, of an endowment which can only be used in this way. Instead it is an expression of the man:land ratio. "(Soil) fertility may be the result of the use of intensive methods of land utilization and not vice versa." (Boserup, 1965) (There is an alternative possibility which is that the survival of fallowing on African soils reflects their poverty and that it was a better endowment in Europe that allowed the process to continue. This is a critical weakness in the hypothesis but it is not one that can be pursued here.)

Another implication is that technology is also a function of population density and that it is not new techniques that enable changes in cropping systems. Instead they follow them. Thus the progression in frequency of cropping is paralleled by a progression in tools and in fertilisation techniques. "The hoe is not introduced as a perfection of the digging stick. It is introduced when an additional operation (weeding) becomes necessary ie when forest fallow is replaced by bush fallow." Bush fallow is replaced in turn by shorter, grass fallows. Grasses are tougher and more cultivation is needed so it is at this stage that the plough is introduced. At the same time the grass provides the fodder needed for draught animals. Boserup traces a similar progression in fertilisation techniques: from ash under forest fallows, through manuring in short grass systems to chemical fertilisers.

Without the plough, short fallows are avoided. Weeds are kept down instead with long periods of continuous cropping giving what Boserup describes as the African eight year cropped, eight year fallow type of rotation. She suggests that it is not possible to change from this to a short fallow. Instead the progression has to jump immediately to annual or multi-cropping. This is important because Darfur seems very typical of the African rotation.

That technology is an expression of the current frequency of cropping marks a critical distinction from Schultz because it implies that it is not the costliness or otherwise of new agricultural factors that prevents their introduction in this kind of agriculture. It is merely that the time, or the man:land ratio, is not ripe. It is not that farmers lack the capabilities to adopt new techniques or that the private returns to research and extension are too low or that the technology is not amenable to transfer. Once again it is merely that the time is not ripe. This may be seen in the fact that most of the technical elements for the agricultural revolution had been known for centuries: "the transition in Europe from short fallow to annual cropping was not the result of contemporary innovations; more plausibly ... (it was) the spread of various methods which, although known since antiquity, were little used until the increase of urban population raised the demand for food and the increase of rural population provided the additional labour needed ..." Additional proof, is provided by instances of 'technical regression' when man:land ratios drop; such as in France where marling was abandoned between the Black Death and the 16th century or in the new world where "observers in South Brazil tell us that the colonists have lost many of (their) techniques. ... even such simple practices as the use of the plow and crop rotation and the inclusion of livestock and forage crops for the maintenance of soil fertility." (Boserup, 1965)

Boserup specifically argues that the failures of research and extension in the late colonial and early independence era are not due to any cultural inertia, because many new crops had been very successful. It was merely that many of the innovations being promoted offered only lower returns to labour at a given population density. Given the extremely disappointing performance of agricultural research and extension in Africa since Boserup was writing, this point deserves very careful consideration. Much of the evidence from Darfur certainly points in this direction.

Just as technology follows the man:land ratio, so does land tenure, progressing through the spectrum from free access through communal, usufructuary rights to private ownership. Bush fallow systems typically have communal tenure with rights allocated by tribal chiefs. As land becomes scarcer so the individual family's interest in tenure increases and "pledging" or lending land becomes more common than abandonment. "Redistribution of land thus becomes a less important and less frequently exerted function of the chief and in the end it disappears altogether." (Boserup, 1965) This description matches the present situation in Darfur very closely.

It is, however, the last implication of the hypothesis that is both most important and most difficult. That is that output per manhour will drop through the progression. Boserup suggests that there is no <u>a priori</u> reason but that the agronomic requirements will make it so. There is in fact one <u>a priori</u> argument. If farmers at every stage are rational and wish to keep their output per manhour at its maximum, it may be concluded that if they choose a forest fallow system at a low man:land ratio it is because it gives the best return. A shift to shorter fallows must therefore be forced upon them, implying a lower return. In other words, intensification will only take place without population growth if "output per man-hour can be raised with little capital investment." (Boserup, 1965)

Whatever the <u>a priori</u> case, output per manhour is more likely to fall than rise as frequency of cropping increases for simple technical reasons. "It takes much longer to hoe and weed one hectare that to clear one hectare superficially with axe and fire. ... (giving) a strong presumption that the transition from forest fallow to bush fallow will be accompanied by a decline in output per manhour." Transitions from bush to short, grass fallow reduce clearing effort but once again raise the cultivation work to be done and, in addition, work now has to be done to preserve soil fertility and to maintain draught animals. Ploughing is hard work for both farmer and animal and the plough "is to be regarded as a means to prevent a fall in output per manhour rather than a means to raise it." (Boserup, 1965)

If increasing frequency of cropping reduces output per manhour, how then did it raise production enough to feed the growing population? The Boserup answer is, once again, disguised unemployment. There is a progression, from forest fallow where subsistence is met from a few hours of work evenly spread, through bush fallow where there is hard work in one or two peaks to short fallow where the peaks are even sharper ending finally in the "hard toil of intensive agriculture". "Before the point is reached where peak activity becomes exceedingly heavy the individual cultivator could, by working harder, produce more without needing to invest or change his system of cultivation. However, he is unlikely to do it because he has not reached the stage where daily work from being a habit has become almost a physiological necessity. We can safely assume that he could go in for such changes only under the compulsion of increasing population or under the compulsion of a social hierarchy." (Boserup, 1965)

There remains, however, one substantial problem with the Boserup hypothesis. Which is that it does not in the end offer any escape from Malthus, merely a postponement. Increasing the frequency of cropping and raising the labour effort can extend the capacity of a given land resource to support population far beyond what might have been expected but while the trend in output per manhour is downwards, however slowly, the time must come when the process reaches its limits. Those limits might be seen in what Geertz has described as 'agricultural involution' in Indonesia, where an "enormous population (exists) at a comparatively very homogeneous, if grim, level of living." (Geertz, 1970) In other words, the hypothesis may explain how very intensive agriculture can support a very large population at low incomes but it does not explain how an agricultural revolution comes about, leading to ever larger industrial populations supported by a rapidly decreasing agricultural population. Boserup offers three possible explanations for such a revolution without detail:

- that as farmers get into the habit of more regular work they start to work more efficiently,
- that increasing population opens the way to increased division of labour,
- that a growing urban population brings with it better technologies, better administration and so on.

These "secondary effects can set off a genuine process of economic growth, with rising output per manhour, first in non-agricultural activities and later in agriculture." (Boserup, 1965)

The rate of population growth is an issue. Boserup argues that primitive communities with rapid population growth have a better chance than slower ones but she acknowledges that this will depend on investment keeping up and also that there are certain stages when declining outputs per manhour may not be compensated by secondary effects and that there may be considerable political and social tension. Others argue that rapid population growth will outpace the capacity of Boserupian autonomous intensification. "The relevant question in the context of Africa is whether the catalyzing factor of population is ahead of or behind the pace of farmer-based innovation." (Lele & Stone, 1989) Lele and Stone answer their own question by suggesting that autonomous intensification cannot keep up and that the only solution is 'policy-led intensification'.

Boserup does not cover the movement of peoples, beyond a suggestion that once the cropping frequency reaches an annual rotation the poorer land may be abandoned to grazing while all efforts go to intensification on the best land. Clearly, however, migration was a major factor in the process of development in many places. In Europe, for example, population densities and possibly even production in marginal areas such as northern Scotland and western Ireland, are only just recovering to the levels of the 18th century before the clearances and migration to industry or to the new world. This is of particular importance when considering marginal lands such as the very low rainfall areas of the Sahel, which includes North Darfur.

There has been one important attempt to test the Boserup hypothesis on the ground, in Machakos district in Kenya. Where economic, population and environmental changes were analysed between 1930 and 1990. Almost throughout this period Machakos has been considered an area vulnerable to overpopulation and environmental degradation. The study nevertheless concluded that "the general Boserupian hypothesis has been validated in Machakos but there is a difficult early stage in population growth when natural resources come under acute pressure. Continuing population growth, in association with market development, has generated new technologies which have supported both increased productivity and improved conservation of the land and water resources."

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(It may be noted that Boserup predicted that 'difficult early stage'.) The study did suggest two modifications of emphasis. One was that high value cash crops were a significant element in raising productivity. This, in turn, highlights urban demand and export demand. "The importance of the two external demands is that they were for higher value cash crops, which required more labour inputs in growing and in processing, transportation and marketing." These in turn generated multiplier effects in higher local demand for consumer goods and services. The other critical factor was transport infrastructure, which is bound to be an external factor for a single district. Even here, however, "the trunk routes which from the beginning of the century traversed and area of low population density did not stimulate the growth of urban centres until population growth pushed settlement in their vicinity in the 1970's". One last crucial point from the study was that "policies that raise farm-gate prices are probably the single most important action required from governments that want to encourage soil and water conservation and the maintenance of the productivity of the agricultural resource base." (Tiffen, 1992)

SOCIAL BOSERUP

A certain view of the institutions of traditional agriculture is more or less explicit in all the models of change discussed so far. In most cases those institutions are considered to be static, an inherent characteristic of the sector: subsistence wages, Chayanovian family welfare maximisation, economic rigity and so on. Boserup is the exception who indicates some link between changing population densities and institutional change. The mechanisms are not, however, worked out in any detail outside of land tenure.

An explicit model of what may be termed Social Boserup is presented by Hayami and Kikuchi who link the balance of resources, the distribution of income and institutional change: "the distribution of income (between) landlords, tenant operators and landless labourers responds to changing resource endowments through adjustments in the institutions governing the use of land and labour." Water rights, financial and market institutional changes in response to "changes in resource endowments, technology and government policies." Such institutional changes involve costs and most institutional arrangements involve externalities with the accompanying risk of free riders. This creates a need for "political entrepreneurs" to negotiate and enforce the arrangements in return for benefits to themselves. (Hayami & Kikuchi, 1981)

The costs and benefits of institutions and of institutional change depend on what Hayami and Kikuchi term the 'tightness' of institutional structures and this in turn is a function of population density. The Social Boserup hypothesis thus runs: "We hypothesize that the basic force underlying the tightness in community structure is relative resource scarcity - the scarcity of non-labor resources to labor. So far as a resource is abundant, there is no need to coordinate its use among community members. The need arises only when the resource becomes scarce." (Hayami & Kikuchi, 1981)

This model of institutional change has five key points:

- that institutions coordinate the use of resources,
- that institutions work through social compulsion based on social interactions,
- that the costs of enforcement (and presumably of negotiation) are lower in tighter social structures,
- that both institutions and structures change in response to relative resource scarcities,
- that relative resource scarcities are a function of the endowment, of technology and of market conditions.

This model was developed against the background of the irrigated rice economies of South East Asia, especially Indonesia and the Philippines. It is built on a particular view of village communities and institutions which is influenced by that background. It is argued that agricultural activities are "strongly interdependent", which is why strong institutions are necessary to internalise those externalities, and that the risks of agriculture create a need for "collective actions to combat production uncertainty." For this reason, relations are complex and multi-faceted; too complex for specific market-type contracts and exchange is typically through "highly personalised relationships" such as sharecropping, gift-giving and so on. The contrast is thus drawn between exchange through non-market institutions articulated through "social interaction" and exchange in the market.

One explanation for a society dominated by social interaction is that of the Moral Economy, which suggests that the driving force is a subsistence ethic designed mainly to guard against risk. It is suggested that such an economy tends to break down in the face of penetration by the market economy leading to social divisions and subsistence crises for the poor. The counterview is that non-market institutions are vulnerable to free riders and to exploitation by the elite and that they are fundamentally just as selfish as the market. (Popkin quoted in Hayami & Kikuchi, 1981) In this view it is the high externalities and high information costs of smallholder agriculture that make non-market institutions more appropriate, an analysis springing from the Economics of Information which

argues that costly information is the explanation for the specific characteristics of markets in less developed economies and for institutions "which in neo-classical theory appear anomalous and/or inefficient." (Stiglitz quoted in Meier, 1989) It may be presumed that the transition to a full market economy would be easier from such 'selfish' non-market institutions.

Selfish or not, it is suggested that non-market institutions depend on social interactions whereby "A's welfare depends not only on his own personal income and consumption but also on how B looks at A's income and consumption levels." This is an important point because in Darfur the outsider trader plays a crucial role in the transition from non-market to market exchange precisely because he can insulate himself from the costs of 'social interaction'.

It will further be argued that changes in the Marginal Utility of Own Income (A's Income) compared with the Marginal Utility of Altruism (B's Income) are the driving force behind changes in institutional forms. This is an idea dating back to Adam Smith who attributes altruism by the better off to a lack of anything on which to spend their wealth other than by supporting their clients: "In a country which has neither foreign commerce, nor any of the finer manufactures, a great proprietor, having nothing for which he can exchange the greater part of the produce of his lands, consumes the whole in rustic hospitality. ... But foreign commerce and manufactures gradually furnished the great proprietors with something for which they could exchange the surplus produce of their lands without sharing it with tenants or retainers. For a pair of diamond buckles perhaps, or for something as frivolous and useless, they exchanged the maintenance of a thousand men for a year, and with it the whole weight and authority which it could give them; and thus for the gratification of the most childish, the meanest, and the most sordid of all vanities, they gradually bartered their whole power and authority." (Smith, 1776) On this view, poor returns to selfishness are the driving force behind altruism.

The principal thrust of Hayami and Kikuchi's work is to show how the "social interaction" market can adjust to changing resource endowments etc just as cash markets do. They analyse in detail the way harvest labour contracts in the Philippines and Indonesia, in which payment is made in kind, have changed so as to adjust wage rates as populations rise and technologies change. They do, however, imply that the adjustment may be slow because "It usually entails a significant cost to violate time-honoured village rules." (Hayami & Kikuchi, 1981)

Compared with any rice economy, Darfur is extremely sparsely populated and social structures are extremely loose compared to Indonesia or the Philippines. As already mentioned, society is highly individual. There are relatively few externalities in bush fallow agriculture with the hoe. On the other hand, it is an extremely risky way to earn a living. There is a strong moral obligation to hospitality in that few will refuse to share food with travellers and loans of cash, of goods and of land are frequently made without charge. Yet such altruism is not set in a context of tight, multi-faceted relationships. Complete strangers are welcome to eat as much as neighbours.

Despite this, the model is relevant. That social tightness is a function of the man:land ration seems amply proved in Darfur where social relations are loose in an area of sparse population. Non-market institutions are not strong, reflecting an agriculture where there are few externalities. Sharecropping does exist as do labour contracts in kind but the majority of farmers work as individuals on their own land. Social interaction is nevertheless important but more as a matter of a subsistence ethic than as a function of multi-faceted economic relations; indicating that even the distinction between the moral economy and information theory views of non-market institutions is a matter of population density. It is not that one or other is the more correct. Rather that in areas where populations are low and risks are high the moral economy motive will dominate. As populations and production externalities increase, then the information theory model will become more appropriate.

Despite these differences, the central point stands and that is that the so-called economic rigidities of subsistence agriculture - communal land tenure, institutional wages, sharecropping contracts etc - are largely false. "Institutional wages' based on work sharing can adjust to the neo-classical equilibrium through institutional innovations." (Hayami & Kikuchi, 1981)

STATE SOCIALISM AND BUREAUCRATIC CAPITALISM

None of the preceding discussion has considered the macro-economic framework, something that cannot be ignored. Development successes clearly owe something to macro-economic policy, such as high interest rates in Taiwan, while many of the failures of agriculture in Africa are even more clearly the result of strongly disincentive policies. It will be argued that Darfur is experiencing a process of economic compression that owes much to the national situation and little to the capabilities or otherwise of the Darfuri. The term compression is used to draw a distinction with the concept of financial repression, although that is a major factor in the process, and to emphasise that it is not some unrealised potential that is being restrained but rather a realised potential that is being pushed back again. Darfur has seen active development that is now on the point of being reversed.

How this is happening will be discussed in the chapters that follow. What is at issue here is why it is happening and what are the mechanisms. Muscat's detailed study of Development Strategy in Thailand attempts to place agricultural development in this kind of context and for all the differences between Thailand and Sudan there are some important parallels, most especially in the relationship between the non-market institutions of the elite and national policy. What Muscat terms Bureaucratic Capitalism. (Muscat, 1966) If Hayami and Kikuchi present a micro-economics of non-market institutions, then Bureaucratic Capitalism forms part of the macro-economics.

Muscat was writing before Thailand achieved its current status as an Asian Tiger and he was attempting to discover reasons why the country was still under-developed, after a lengthy period of export-led expansion in agriculture and primary commodity production. Agricultural expansion was principally through extension of rice production on the Central Plain; a vent-for-surplus process that generated large investible surpluses for a small initial capital outlay in land clearance and tools. The capital should therefore have been available to develop the country but it was absorbed instead in foreign remittances and in "expenditures by the elite on current consumption, residential and temple construction, and foreign investment and hoarding." In the late 19th century gold imports were very large, reflecting the hoarding. The behaviour of the elite is specifically attributed to their non-market characteristics. "The problem of the elite was not that they acted irrationally in the market place, but that they were not under any necessity to act in the market place at all."

As the major economic sector, agriculture was the target of persistent government interference. Rice was subject to export monopolies or taxes equivalent to up to half the international price: a heavy tax on farmers and a "powerful stimulus to official corruption." After the second world war, marketing and transport monopolies and cooperatives were variously justified by "rationalizing language as a screen for bare-faced self-interest" or by chauvinist attempts to break the Chinese dominance of marketing. This reached such a level that an industry as small as duck-egg export was destroyed by export licensing procedures and administrative pricing.

The pattern was similar in the industrial sector, where government intervention also expanded after the second world war. But state enterprises were not, Muscat argues, socialist in tone. Instead, they were state funded or supported but run as "personal preserves" of officialdom; this is the pattern he defines as Bureaucratic Capitalism. The roots of it are to be found in the centuries-old Thai state system: "a bureaucratic elite system which distributed its economic rewards in the form of ascriptive rights to land holdings." For this reason, Bureaucratic Capitalism is an "ascriptive, non-economic" system; a non-market institution in other words. As already discussed at the micro-level, non-market institutions can adjust to changing economic circumstance, even if "the tools of unfair competition available (to the elite) are outside the range of economic weapons normally examined by economic analysis concerned with departures from perfect competition." (Muscat, 1966)

The Thai elite has changed very considerably since the 1960's and the mechanisms of that change, driven by changing patterns of incentives, were already evident to Muscat. Initially the elite preferred to invest their earnings from the government system in real estate or overseas or in winning a larger share from the system itself, "in order not to divert their personal efforts away from government with its high psychic and economic returns." After the second world war, however, real government salaries fell, corruption increased and there was a "pervasive spread of Western consumption aspirations." As a result the "psychic income" from government fell, the prestige of commerce rose and "numerous scions of elite families (were found) assuming entrepreneurial roles." (Muscat, 1966) This pattern seems little different from that described by Smith in England two centuries earlier, where the elite gave up much of its social position for "vanities", the eighteenth century equivalent of "consumption aspirations".

In Thailand during this period economic policy was not driven by theory but by political reality, in itself a reflection of history and current circumstance. The elite was founded on a well-intentioned tradition of paternalism. This was vulnerable to corruption and patronage but it also held a genuine strand of mistrust towards trade and competition, largely the domain of outsiders, in this case the Chinese. Pervasive government interventions in commerce were driven by both these motives at once. The result was that "several reforms long pressed by foreign experts, eventually adopted in cabinet decisions, in their detailed implementation turned out to be meaningless gestures." (Muscat, 1966) As the incentives of commerce grew stronger, the elite began to make an accomodation with the Chinese entrepreneurs and to abandon their mistrust of trade.

Muscat rejects Myint's Economic Rigidity and presents considerable evidence that agricultural markets are efficient and competitive, when out of the reach of Bureaucratic Capitalism. He also presents evidence that in the industrial sector technological change is strongly demand led; that "the lack of skilled labor in preceding decades reflected absence of demand for it and did not constitute a deterrence to industrial investment", for example. He nevertheless accepts the Schultzian view that smallholder agriculture is an area where technology transfer is inherently difficult and that government must play a role. To do this he is forced, by evidence of extremely rapid growth in non-rice crops, to make a distinction even within smallholder agriculture between a subsistence sector

and a cash crop sector; suggesting that even for the individual farmer "it is the incremental factors (ie surplus to subsistence) which are dynamic. they can be experimented with, they can be transferred readily from one crop to another, etc." Similarly, he argues that Thai horticultural farmers are able to use high technology because it is profitable enough to "to attract the same type of educated and determined farmer." The Schultzian model is only relevant therefore in the rice sector.

By using this argument, Muscat in fact fails to complete his model because he does not make the link between the impact of the elite's behaviour on policy and the agricultural sector most affected by that policy: rice. Policy was strongly disincentive and it must be an open question whether the lack of technical advance in the rice sector is due to inherent difficulties in technology transfer or whether it is merely due to the unprofitability of the exercise. In other words, evidence that subsistence agriculture is an appropriate field for government action may in fact indicate that it already suffers from too much government, not too little. It will be argued that the evidence from Darfur points very much to the conclusion that there is no inherent difficulty in technology transfer in any section of agriculture. Slow progress is evidence of very low returns which are in turn a reflection of an elite which has proved unable not merely to keep its own demands within limits but also to mediate between the competing demands of major groups in society: notably the trades unions and tenants on the large government agricultural schemes. One particular similarity with Muscat's Thailand concerns the elite's inability to reform economic policy, however well-advised it may be, because it would be in conflict with the political imperatives of Bureaucratic Capitalism. The striking failure of structural adjustment in Sudan is almost entirely due to this type of pressure.

There are, however, some critical differences in the Sudanese case. One is that social relations at the national level are just as loose as those in the village community, again reflecting a much sparser population. There is no King or elite that can trace its history back to the 15th century as the Thai can. The Fur state did have a small elite with ascriptive rights to land like those Muscat describes but it was relatively tiny. Another difference is the pattern of economy developed by the colonial state. That state was politically weak and low taxation was a central tenet of policy as a result. (Daly, 1986) No major natural resources were available such as tin or teak in Thailand. The state was forced, therefore, to rely on four sources of revenue: export taxes, import taxes and monopolies and large scale commercial ventures. The largest of all of these was the Gezira irrigation scheme. There were other such schemes and the railways were another major source of government income. The result was that the colonial state in Sudan paid lip-service to laissez-faire but established great control over the commanding heights of the economy. One colonial official described the Sudan of the 1930's as "a country where state socialism is practicable and to some extent actual." (Daly Ed, 1985) The structures of state socialism proved especially vulnerable to bureaucratic capitalism.

Another important difference relates to Sudan's position as a relatively well educated but poor Arab nation in the post-OPEC era. It has seen very high levels of emigration at all levels: skilled labourers and semi-skilled as well as graduates. The severe political problems posed by the division between Muslim north and Christian and animist south were another factor that is not matched in Thailand.

Partly because of its difficulties but also because of its strategic position in relation to Egypt, Libya and the Arabian peninsula, Sudan has also been one of the world's most important recipients of foreign capital, both aid and loans, when measured in per capita terms. This is not necessarily a drawback. South Korea, one of aid's success stories, would not have received anything like the same amount of aid if it had not been for geo-politics. Nevertheless, Sudan is not one of aid's successes, more one of its grim warnings. A number of reasons can be suggested. One is that the Asian success stories, Korea and Taiwan especially, had 'tighter' social structures reflecting the Social Boserup influence of large populations. Another is that their aid was dominated by one donor, the USA which had a close engagement in the affairs of both those countries. Sudan has been able to play a number of competing donors, few of whom had a particularly close relationship with the country, off against one another.

Bauer has suggested that "Aid increases the money, patronage and power of the recipient governments, and thereby their grip over the rest of society. It thus promotes the disastrous politicization of life in the Third World." (Bauer & Yamey, 1982) The implication is that aid allows the state and politics in general to play too great a role in economic life. At first sight, the Sudan seems a good example. Aid flows were until recently quite huge and the economy disastrously affected by government intervention. A closer look reveals, however, another possibility; not that aid puts politics into the economy but rather that it takes the economics out of politics. Because it allows a weak state to survive without the need to raise domestic revenue, it destroys the processes by which the state, the ultimate non-market institution, can adjust to changing resource endowments. If institutional change depends on 'political entrepreneurs' who can find sufficient reward in bringing about such change, then the relatively vast sums that such entrepreneurs can win from negotiating a new aid deal for relatively little work make genuine change a remote possibility.

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Recent developments in Darfur seem clearly at the mercy of national events which reflect in turn a long running failure by the ruling elite, which has changed rather little through several changes of regime, to tackle those macro-economic problems. Some consideration of the forces that are driving this process is unavoidable.

CONCLUSION

The aim of the chapters that follow is to consider four issues arising from this discussion:

- the way in which trade has driven development in Darfur over the last 90 years and the extent to which the process has been one of vent-for-surplus, of division of labour or of comparative advantage. (Chapter Three)
- the evidence for or against the Schultz proposition that agricultural factors are inherently costly to smallholder farmers in Darfur and that research and extension are required to overcome this. (Chapters Four and Five)
- the Boserup prediction that the man:land ratio drives development and that population pressure creates its own solution. (Chapter Six)
- the Social Boserup mechanisms of institutional change in a 'loose', sparsely populated society and as an adjunct the impact of foreign capital on those mechanisms. (Chapter Seven)

There is, inevitably, considerable overlap between the various topics

3. A CASE OF VENT FOR SURPLUS?

"Merchants are the cause of the prosperity of the lands."

From 18th century laissez-passer of Wadai Sultan to a group of Darfuri merchants. (O'Fahey, 1980)

The recent past is given undue weight in first attempts to understand unknown areas. Visitors describe the people they meet and what they do as 'traditional'. Then they talk to the people themselves, who are naturally most concerned with recent events and conclude that what has happened in the last ten years is the first change in centuries to affect a 'traditional society'. That first change seems overpoweringly important when seen from this perspective: disastrous, revolutionary, the collapse of a golden age and so on. In Darfur this foreshortened view of events is very strong. Coming to wider attention as it did in the 1970's, after the Sahel drought, that drought was seen as the epochal change that explained everything that is happening in the region. The subsequent droughts of the 1980s only seemed to confirm this. There has been a series of gloomy analyses marked by apocalyptic interpretations of what happened and correspondingly radical predictions about what would have to be done if disaster is to be averted.

A typical comment: "Darfur has far to go. It is almost at the bottom rung of the development ladder. If the people's possession of material goods is any indication they are among the poorest in the Northern provinces. Other indices such as levels of adult literacy, crude birth rates and life expectancy tell the same story.

"Rapid expansion of human and livestock numbers has severely reduced the carrying capacity of the land and the subsistence pastoral economy has been replaced by an agricultural one. Present social and political institutions are inherited from the subsistence economy, especially the systems of land and water rights. In the presence of a stagnant primitive technology, rapidly expanding population and declining rainfall the destruction of the environment is accelerating at an alarming rate." (HTS, 1974)

This line of thinking provided much of the rationale behind development projects established in the 1970's and 1980's. It is still widely accepted. It is, however, based on several false concepts, summed up by the use of the word 'stagnant' which is quite the opposite of the truth. The Darfur economy has expanded quickly for most of the twentieth century. Any technical changes that were practical were rapidly absorbed. The social and commercial framework shows every sign of adapting effectively to circumstances where given the chance. Even the unsophisticated political institutions 'inherited from the subsistence economy' have proved more robust and more useful than the variety of more modern forms offered since independence.

The assertion that the people of Darfur are, or were in the early 1970's, the poorest in northern Sudan is open to question. The 1967/8 household survey showed an average rural income in Darfur as high as that in Northern province while the cost of living, as measured by the average household expenditure, was only just over half. (Dept of Statistics, 1970). The crude birth rate in 1955/6 was similar to Northern province, Kassala and Khartoum while the death rate, an equally important measure of general welfare, was the second lowest in Sudan. (Dept of Statistics, 1956).

Darfur presents a classic example of the 'vent for surplus' process mobilising "surplus labour and land in underpopulated areas with a smallholder production system. It is presumed to be a costless type of growth which could be largely self-financed by small farmers and local traders. Governments or private firms only have to provide improved transport, communication, and access to markets." (Eicher & Baker, 1982) Which form of vent-for-surplus is applicable in the region is best considered later, after first describing what happened. In Darfur the extensive savannahs provide the surplus land and the labour has been available either locally or drawn in from the west. However, there are two crucial constraints: transport and water.

Haaland has described the development of Darfur as a process of 'monetisation' brought about by the 'vent for surplus', exactly matching Myint's model of an economically rigid subsistence economy monetised and mobilised by the vent-for-surplus. In the beginning no commodities had monetary value: not land, nor labour, nor crops, nor livestock. Cropped areas and the level of economic activity as a whole were determined by the need to cover subsistence requirements only. Once the door to trade was opened currency immediately became necessary. Trade brought a supply of consumer goods that could only be bought with cash. At the same time it opened the way for produce to be exported to earn that cash. In a situation where land is freely available the main result of rapidly consumer needs stimulated in this way is that "there is virtually no limit to the area a household wants to cultivate provided they are able to mobilise the labour." (Haaland Ed, 1980)

An incidental effect is that non-money exchange relations such as communal work parties are no longer important, as workers want cash. These parties are called Nafir in Darfur. The result is that "where production is for the market and where labour can be mobilised from outside the local community, communal land tenure gives

a great advantage to those who have the resources to mobilise wage labour. This invites agricultural mining i.e. exploiting an area as long as one makes a profit and moving to another area when it is exhausted." (Haaland Ed, 1980)

The suggested evil interaction between monetisation and communal land tenure is false. The reasons for shifting cultivation are rooted in the technical nature of the soil and the vegetation. They make it easier to clear new land rather than protect the old. This is equally true in subsistence and cash economies. The move towards cash cropping and increased production, which is inevitable if there is to be any development at all, will of course increase the pressure on the land and so accelerate the pace at which any land exhausting cultivation cycle operates. But that would be just as true if there were an increase of population under a subsistence economy. It has nothing to with monetisation or cash cropping per se.

More importantly, agricultural expansion through labour mobilisation on a free land resource started long before the development of a full cash economy. First, there were many quasi-currencies in circulation. Salt, thread and cloth were common examples and standard exchange rates with grain and livestock were formally established. There were even mechanisms for adjusting those exchange rates. (Kapteijns, 1985) Iron hoes, so small as to be merely symbolic were in widespread use as a currency not merely in western Sudan but even as far away as Lake Albert and Lake Victoria. (Baker, 1877) In the days of the Fur sultans, cloth was used as currency, in standard lengths called 'Taqiya'. This takes the history of the economy still further back in time since cloth currency was found the West African kingdoms such as Bornu, long predating even the Fur sultans. (Arkell, 1952) Prior to the Mahdia, "There (was) very little money in cash in Darfur. The northern Arab tribes who supply transport for the great caravan road between Assiut and Darfur have a small amount of gold and silver coin, in all other parts of the province payments are made principally in 'Takia', a sort of native-made cotton fabric or in European grey cotton cloth." (Slatin, 1896)

There was considerable export trade in the era of cloth and other quasi-currencies. This trade was controlled by the state, which claimed export goods like ivory by right. This meant that exports were generated without any domestic currency exchange. (Kaptjeins in Manger Ed, 1984) Indirectly, however, exports were still used to finance agricultural expansion. The Fur sultanate of the eighteenth and nineteenth centuries mobilised labour through the Hakura, or estate system. Some estates were worked by slaves and others by tribal communities. Either way it was the surplus production they generated that underpinned the structure of the state. The estates were in turn managed by an elite whose reward came in the form of imported prestige items bought with the state's exports. (O'Fahey, 1980) In the end, therefore, the linkages may have been more complex but the parallel development of trade and cultivation under the Fur state was a first, pre-monetary stage of the process analysed by Haaland.

Trade and expanded cultivation may have even strengthened non-monetary, nafir forms of labour mobilisation well into the monetary era. Links to the market economy "enforce the cohesion of the nafeir group which becomes the main referent to achieve all the labour intensive activities." In order to increase production to meet wider opportunities nafirs become more rather than less active. (Salih in Manger Ed, 1984) A similar pattern may be seen in the Jebel Marra area, where the nafir work group is most commonly found on the upper parts of the Jebel Marra mountain itself. This is by far the richest section of the district thanks to cash crops of potatoes and oranges. (JMRDP, WS87) In short, it is not currency or monetisation that is crucial to a vent-for-surplus development. It is the opportunity to exchange surplus production for imported goods, by whatever means, that matters.

Governor General's reports from the period of the second world war illustrate how crucial imported goods were in stimulating production in Darfur. In order to supply the armies in Egypt and the Middle East, Government had an urgent need for sheep and cattle from Darfur. The area also exported considerable quantities of grain. The result was that "the large amount of cash circulating among the people seriously interferes with the Darfur economy, for the proceeds of exports which are known to have been over \pounds E350,000 in 1945 cannot be absorbed by the present volume of imports. Consequently there is little inducement to the countryman to sell large quantities of his grain, to offer his services on the labour market or turn his attention to such laborious tasks as improving the quality of his hides or butter. The countryman has perforce remained largely self-supporting." (Sudan Government, 1945) Because of the war nothing could be done about this situation because imports were rationed.

PRE-COLONIAL TRADE

Darfur's economic history may be described in terms of six export commodities: slaves, ivory, ostrich feathers, gum arabic, groundnuts and livestock. Each in turn has led the way in stimulating the economy and strengthening its links with the outside.

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Darfur's involvement in the slave trade dated well back into the 18th century. Situated as it was on the frontier between Muslim and pagan and with a direct link to Egypt via the Forty Days Road, it served as an ideal base for raiding the negro tribes and sending them north. Napoleon, when in Egypt, wrote to the Sultan AbdalRahman asking for '2,000 esclaves noirs ayant plus de 16 ans, forts et vigoureux' to be sent to him. History does not record whether he got them.

The export of slaves did little directly for the economy. It hardly provided a great source of employment. Its major contribution lay in the imported consumer goods it financed. These were critical to the apparatus of the Fur state. Arms, armour, firearms, horses, shawls that became required dress at the Sultan's court and so on, they all went to support the ruling elite and maintain its loyalty to the Sultan. By the nineteenth century, "the (slave) raiding/trading cycle had probably become crucial in maintaining the elite in the style to which they had become accustomed, but the foundation of their position still lay in the lands, people and herds they held within the sultanate." (O'Fahey, 1980)

Internally, labour for the expansion of cultivation was the most important contribution slavery made to the development of the economy. The development of the Fur Sultanate into a more formal state during the 18th century was also attributable to "the employment by the sultans of slaves as soldiers, labourers and bureaucrats." (O'Fahey & Abu Salim, 1983) The close links between trade and the development of the state are perhaps best revealed in the import of paper: a vital commodity for the establishment of justice and administration. Imports of European-made paper from Egypt date back as early as the Keira Sultanate of the 17th century. By the mid 19th century, the French Consul in Cairo estimated that up to 2,400 reams a year went to Darfur, 5 per cent of all Egypt's paper imports. (Daly Ed, 1985)

Slaves had one important feature as an export. They can walk, they are a self-transporting commodity. With the region's long lines of communication this was of paramount importance and transportability remains critical to this day. Before the railway reached El Obeid in 1913, Darfur had three principal routes to the outside world: the Forty Days Road starting at Kobbe north of ElFasher and running through the desert to Assiut on the Nile in Egypt, a route north and west through Wa'iti, Kufra and Tripoli and a route to the east through ElObeid. The journey for the camel caravans was arduous and slow on all of them. Ivory and ostrich feathers are almost as portable as slaves, giving high value for a low weight. Although they may seem rather trivial items to consider in an economic history the fact remains that the Victorian era in Europe, that time of ivory billiard balls and ostrich plumes, was in this way reflected all the way to Darfur. In 1905, Gleichen listed the principal exports of Darfur as 'feathers, ivory, pepper, rhino horns, tobacco, camels and cattle from Wadai.' The importance of ivory and feathers was shown by the fact that they alone bore a royalty of 20 per cent. (Gleichen, 1905)

The shift away from the two northern routes and towards the eastern began in the nineteenth century, under the Turco-Egyptian regime. The first step in the decline of the Fur Sultanate came when slave traders from Khartoum and ElObeid began to compete with the Darfuri raiding parties in southern Sudan. Zubayr Pasha, the greatest slaver of them all, first won control over Bahr ElGhazzal and then began to encroach on the southern boundaries of Darfur. In the end, it was his defeat of the Sultan Ibrahim Qarad at the battle of Menawashei in 1874 that opened the modern era; although Darfur had already lost Kordofan in 1820. From then on Darfur was ruled from Khartoum, first under the Turco-Egyptians and then under the Mahdia. The last Fur Sultan, Ali Dinar, managed to re-establish the Sultanate as a tributary of the Anglo-Egyptian Sudan in 1898 but that was only an interruption. The Sudan Government invaded and conquered Darfur in 1916. From then on, the expanding railway network leading to Port Sudan virtually eliminated the northern routes.

Cattle had little value in this early period. Slatin Pasha, who was governor of Darfur before the Mahdia, describes how he agreed to the transfer of a section of Darfur to Bahr el Ghazzal because the only product of the area was cattle of which Darfur had more than enough. "I had a surplus of cattle tribute from the numerous baggara tribes which fetched an exceptionally low price in the market." (Slatin, 1896)

Anther sign of economic change during the 19th century was the introduction of two important minor crops: tobacco in the 1820's and tomatoes in the 1870's. (Lampen quoted in HTS, 1966)

THE ANGLO-EGYPTIAN SUDAN

Before the great developments in Nile irrigation, Kordofan was by far the most productive part of the Anglo-Egyptian Sudan. In 1904, government revenue from Kordofan was more than one quarter of the total. None of the eleven other provinces came close to this. Darfur was not within the Sudan at this point but it is similar in many ways to Kordofan and it may be presumed to have been similarly well off. Part of the production attributed to Kordofan must have come from Darfur.

Kordofani gum arabic was of overwhelming importance in the Sudanese economy of the early 20th century. "The main stimulus to an economy that was recovering from utter stagnation (in the Mahdia)" gum made up 54

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per cent of the country's export earnings in 1903. (Beshai, 1976) Even as late as 1923 it was 39 per cent and in 1983 a still important 7.5 per cent. The fall in the relative importance of gum was because other sectors, especially cotton, were expanding even faster, not because the gum arabic trade did not continue to grow rapidly. Figure 3.1 illustrates the pattern of gum exports over nearly a century. The growth shown up to the 1960's can only be described as spectacular. Neither the first world war nor the great depression halted an expansion that averaged 2.9 per cent per annum for the sixty years between 1907 and 1967. Only the second world war slowed this trend and the greatest boom of all came in the post-war period, the 1950's and 1960's: 3.5 per cent per annum on average.

Gum arabic has a long history. It was used for embalming pharaonic mummies and in Europe Philip V of France imposed a tax on it in 1349 AD. In those days and until the early 19th century the trade went through Tripoli in Libya and Trieste. In the modern era gum is mainly used in foodstuffs, confectionery and pharmaceuticals as it is non-toxic, soluble in water, scentless and practically colourless. Sudanese gum from the Acacia senegal tree (Ar Hashab) is of the highest quality and no other producer has challenged Sudan's monopoly of quality.

One reason for the growth in demand in the 20th century has been a shift in European tastes away from boiled sweets to gums in the 1920's and 1930's; another illustration of how the remote west of Sudan has been integrated into the world economy and sensitive to European fashions for a long time. A given weight of gum has a high value, which meant it could be profitable even in the days of camel transport through Libya and Egypt. Nevertheless the arrival of the railway at ElObeid in 1913 and Nyala in 1959 gave a substantial added stimulus.

The collapse of the gum trade in the early 1970's was as spectacular as the earlier growth, although the second half of the decade saw some recovery. Labour emigration, declining rainfall and increasing interest in crop production may all have contributed to the decline but price and hence returns to labour were the major problem. Prices rose very high just before the collapse and this drove users in the industrial world to find substitutes in synthetics and in gum made from the guar bean. Prices were never again so attractive to the western Sudanese collectors. Government interference was an important factor. Gum Arabic had always been subject to high government royalties, since the days of the Mahdi and before, but it was the attempt to squeeze the last drop out of high export prices in the 1970's that drove consumers to seek alternatives.

In earlier years Darfur was a small gum producer: 1,231 tons in 1941 compared with 10,211 tons of Kordofan gum. Nevertheless, gum was roughly equal in value to Darfuri cattle and twice as important as tobacco and ghee, the other principal export goods. In 1948 Darfur exports were listed as 'cattle, sheep, camels, tobacco, hides and skins, gum, melon seeds and samn (ghee): much by lorry to railhead at El Obeid four days away but camels are still extensively used.' (Tothill Ed, 1948) Darfur's share of the market rose and by the early 1970's the region produced around 20 per cent of Sudan's total exports. This late expansion indicates that the reason that Darfur was less important earlier was that the capacity to trade was restricted, the 'vent for surplus' was not open, rather than that the area was not capable of producing the crop in quantity.



The prosperity of Kordofan was an indirect benefit to Darfur. Government was encouraged to invest in the western regions, most notably by extending the railway. Prosperous neighbours provided Darfur with markets for goods such as tobacco and ghee. The importance of the tobacco crop was such that there were riots in N. Darfur in the late 1940's over the level of royalties on the crop. (Sudan Government, 1951/52)

While Darfur took second place for gum, it was always the dominant producer of cattle. Between 1939 and 1941, recorded sales in S. Darfur alone were between 94 and 136 per cent of the whole country's exports. (Sudan Government, 1939/41) That some Darfur sales were transfers within the herding community does not detract from the region's dominance. Sales in Darfur still exceeded the nation's exports, even in the early 1980's and they probably still do. In 1980/81 more than 31,000 head were sold in Nyala market alone, the vast majority adult bulls. In 1981 Sudan only exported a little over 18,000 head.

Cattle exports from Sudan and hence the demand for Darfuri cattle have been extremely erratic. Two extraordinary boom periods, during the two world wars, were divided by equally sharp depressions. In the booms the normally restricted demand for live cattle became virtually limitless, as the British tried to maintain their armies in Egypt and the Middle East. Even the recent strong demand from Saudi Arabia and other middle eastern countries has failed to raise exports much above half the level achieved in 1942. Figure 3.2 illustrates Sudanese cattle exports since 1907 and figure 3.3 shows sheep exports. The latter paralleled those of cattle until the 1970's when they began to expand independently, in response to Arabian and Middle-Eastern demand.



Figure 3.2

The colonial era also saw increasing imports of consumption goods from world markets. In a significant change from the days of the Fur Sultanate, these were no longer the luxury items of a African court elite. Instead, they were mass consumption goods for the ordinary population: cotton, sugar, tea etc. These established their dominance of Sudanese imports very early and there has been little change since. Cotton imports in particular marked an early step away from the subsistence economy for Darfur, which had been used to rely on its own produce from a local variety of tree cotton grown around Jebel Marra.

Groundnuts, the third great export commodity from western Sudan, was the last to achieve importance. After the second world war demand in Europe rose rapidly at a time when India, which had been the major exporter with 44 per cent of world exports in 1929, dropped out of the market. India had no exports by 1965. Nigeria was the first to take over followed by Senegal and Sudan. The latter had 11.8 per cent of the world's trade in 1965. (Beshai,1976)

Sudanese exports began to expand rapidly in the early 1950's, continuing up to 1965. The railway reached Nyala in 1959 enabling Darfur to participate and by 1964/65 Darfur produced 36 per cent of the national crop.

Kordofan was second, with 29 per cent. (Low, 1967) There followed a setback to 1970 and then a second even more explosive rise to 1976. From then until now there has been a disastrous slump. (Figure 3.3)



BOOM AND BUST ?

The evidence of the three major export goods, gum arabic, cattle and groundnuts, is that Darfur has been through a number of periods of boom and bust but that there has been strong underlying growth through the first 75 years of this century. The strongest and most prolonged boom came after the second world war, when gum arabic exports entered their period of most rapid growth, when the wartime cattle boom was extended and when the early expansion in groundnut exports was under way.

All three commodities slumped after the mid-1960s. Cattle and groundnuts recovered in 1970 but gum did not until 1975. Exports do not, however, tell the entire story as far as cattle and groundnuts are concerned. As the great irrigation schemes of the Gezira and elsewhere became established and the Khartoum metropolis expanded, rising urban and irrigated sector incomes have meant that domestic Sudanese consumption of both meat and groundnut oil has been rising steadily. This has at least cushioned the impact of export problems for the Darfur producer.

The result was that the quantities of major commodities marketed through Nyala, which is the largest market by far and the best indicator of demand for the Darfur producer, did not fluctuate as much as national exports. Cattle throughput was particularly steady. Even the export ban of 1975/6 failed to greatly depress Nyala sales. The market is relatively more sensitive to local events. Cattle sales rose rapidly in the 1980's as the result of destocking driven by fears of the rinderpest epidemic of 1983 and by drought. Groundnuts is almost entirely a cash crop but the quantities marketed are almost independent of short term price changes. They are principally determined by the rainfall. On the other hand, sales of gum arabic, which depend on export markets entirely, are sensitive to price and show the clearest trend, downwards, since the late 1960s. (WSDC, 1985) The reasons behind these patterns are discussed below.

To sum up, the farmers and livestock herders of Darfur make the most of market opportunities. Production is raised rapidly during boom periods and it is usually maintained during short term market fluctuations. Darfuris developed groundnuts from virtually nothing in the late 1950's, before the railway reached Nyala, to a crop second in importance only to millet by the mid-1960's. In the livestock sector, Sudanese cattle owners, the Darfuris predominant among them, were able to raise their export surplus from 8,000 head in 1938 to 50,000 in 1942.

Although production is maintained through short term set backs, this does not mean that farmers of the area will not withdraw from a particular enterprise if prices turn against it more permanently. The Condominium government's experience of the 1940's showed how the people of Darfur were quite capable of moving into the

cash economy when it was profitable and of moving back out again if there were no consumer imports worth buying with the money they might earn.

All these developments were almost entirely the result of private initiative. Even the crucial introduction of the Barbeton groundnut variety, now grown by almost all, is popularly credited to one merchant's initiative. Until well after independence, Government's role was restricted to the introduction of auction markets. This changed in 1969, after the accession of the Numeiri regime with a largely left-wing programme. The Gum Arabic Company and Sudan Oilseeds Company were created with monopolies in the export of their respective crops. Despite the relatively rapid removal of the Sudan Communist Party from government and a turn back to more right-wing policies, trade in western Sudanese produce has never again been free of government intervention. Cattle exports never fully recovered from a ban on livestock exports in 1975. Gum arabic was severely damaged by the mismanagement of prices during the 1970s boom. Groundnuts have suffered from repeated changes in the status of the Sudan Oilseeds Corporation, which sometimes had a monopoly and was sometimes required to compete with private traders. Lack of a clear policy over producer prices compounded the problem.

Survey data on the ownership and use of hashab, the gum arabic tree, in the 1980s reveal the extent of the slump. Some 30 per cent of households in the main growing areas of South Darfur own hashab. Each household owns some 2,400 trees, approximately 3.6 hectare. Yet in 1982 only 40 per cent of owners tapped their trees and 35 per cent in 1983. The survey did not record whether they tapped all or only some of their trees but it is likely that the proportion of trees that was actually tapped was even lower. (WSDC, FS83)

Migration to the newly rich OPEC states was another factor behind the slump beginning in the mid-1970s. A decline in export production from western Sudan was probably inevitable, given the loss of labour to the gulf and rising remittance incomes leading to increased domestic consumption. It seems clear, nevertheless, that it was direct government intervention combined with the gross macroeconomic distortions discussed below that turned a decline into a slump.

THE IMPACT OF TRADE

Trade in Darfur produce has changed the internal balance of the economy. The heartland of the Fur state, around and to the west of Jebel Marra, was well suited to a subsistence economy, growing grain on the heavier wadi soils and volcanic soils of the mountain itself. The export products - gum, cattle and groundnuts - are all better adapted to the lighter soils of the south and east of the region. The result has been a significant shift in the region's centre of gravity. This pattern of development has a long history, beginning with the establishment of the capital of the later Fur sultans at ElFasher, on the plain to the northeast of Jebel Marra, in the eighteenth century. This set the seal on the Sultanate's move down from the mountains to the wider crop lands of the savannahs. The establishment of Nyala and the extension of the railway to that town marked a second shift of emphasis to the goz crop lands and the cattle herding areas of South Darfur.

Other factors have contributed. Rail and motor transport undermined one of the great strengths of the north, its vast herds of pack camels. The inclusion of Darfur in the Sudanese state, conclusively turning its attention eastwards, also weakened the north of the region. "All the early towns of the region have now disappeared with the exception of ElFasher and Kabkabiya. All were directly associated with caravan traffic (in the north) and most could not survive the era of road and rail transport. The southern parts of Darfur had no caravan routes and hence no towns." (Abu Sin in Pons Ed, 1980) The largest and most rapidly growing towns are now in the south.

Following the droughts of the 1970's and 1980's, it has been easy to blame the drift of people from N. Darfur to S. Darfur solely on drought and desertification. This interpretation is misleading. The drift to the south dates from before the droughts and it contains a strong positive element, the exploitation of export opportunities. "The persistent migration from north to south has been checked by good rains over the northern areas. Lack of water in the north and easy living in the south, combined with increased public security everywhere encourages this southward drift, a natural and inevitable movement." (Sudan Government, 1945)

The movement and growth of population are key indicators of the way the Darfur economy has developed, although care is needed when interpreting the figures. Population change in Sudan has often been described in very extreme terms. It is usually said, for example, that drought and famine during the Mahdia killed a very large proportion of the population. British reports of the early Condominium describe vast tracts of Kordofan where nothing is to be seen except deserted villages. Under the Condominium, however, the deserted villages were soon repopulated. This interpretation was very much in the British administration's interest. It served to highlight its benevolence and to justify the original invasion of Sudan. Nevertheless, it may well have been the genuine opinion of early observers. It is very easy to be deceived by the speed at which people move in and out of drought affected areas. It gives an exaggerated idea of both the decline and the recovery.

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The first population census of the Sudan was in 1955/56, on the eve of independence. Estimates from before that time have to be taken on trust, especially so for Darfur, the last region to join the Sudan. The later censuses, in 1973 and 1983, were also regarded as less than 100 per cent successful. With those caveats in mind, populations from 1920 onwards were as follows:

Table 3.*	D	ARFUR POPU	LATIONS - 1920 to 1983		
		Population	Annual Growth Rates - %		s - %
		-	Total	N. Darfur	S. Darfur
	1920	450,000	-	-	-
	1945	734,000	1.98	-	-
	1955	1,330,000	6.12	7.12	5.03
	1973	2,150,000	2.71	1.65	3.79
	1983	3,110,000	3.77	3.12	4.29

Sources: Balamoan, 1981, Tothill Ed, 1948, Department of Statistics 1956,1973,1983

The jump between 1945 and 1955 indicates that the early estimates were too low. Nevertheless, it seems clear that population in Darfur has been growing at a rapid rate for most of the twentieth century, since before the advent of the great advances in health to which such high rates are usually attributed. One explanation is immigration, especially from West Africa, but it seems that natural increase was more important. In the 1955 Census the excess of births over deaths was already 28.8 per thousand, greater in fact than the annual population increase over the next fifteen years. If there was immigration, it seems to have been balanced by emigration. This too is confirmed by the 1955 census which shows more Darfuris resident elsewhere in Sudan than there were outsiders resident in Darfur. (Dept of Statistics, 1956)

As far as can be judged from the early data, North Darfur saw more rapid growth in the colonial period up to 1955. Since independence, the balance has shifted strongly towards the southern province reflecting the shift in importance away from the north/west and towards the south/east. This did not mean that populations in the north fell, merely that those in the south grew faster. Table 3.1 shows the settled rural populations of the districts in 1983 together with the land area and the population density of each for 1983 and 1955/6. The table clearly shows how the heartland districts, marked NW, were more densely populated in 1955/6, especially Western District of North Darfur which is Dar Masalit. It also shows the spectacular growth in the three SE districts and also in the more southerly of the NW districts between the two censuses.

Table 3.*FARM POPULATION DENSITY

	Farm Popn	Area	Density -	person/km ²
	1983	Km ²	1983	1955/6
North Darfur Distric	ts			
NW Northeastern	93,954	119,543	0.79	0.62
NW Eastern	104,235	29,992	3.48	1.68
NW Central	184,455	21,670	8.51	4.48
NW Western	371,191	18,894	19.65	15.21
NW SW & Northern	242,276	26,534	9.13	3.41
Total	996,111	216,633	4.60	2.77
South Darfur District	S			
NW Western	195,180	12,383	15.76	7.64
NW Wadi Salih	150,383	25,928	5.80	3.82
SE Central	393,333	34,012	11.56	2.27
SE SW & Southern	407,715	43,980	9.27	1.92
SE Eastern	183,947	41,367	4.45	1.30
Total	1,330,558	157,670	8.44	2.60
Regional Total	2,326,669	374,403	6.21	2.70
	=====	=====	====	====

<u>Notes</u>:

1. 121,966 km² of northern desert is excluded, as is the far southwest of S. Darfur.

2. There have been several boundary changes between censuses. Districts do not correspond exactly.

The rate of urbanisation provides another striking measure of development in Darfur and of the changing balance between north and south:

Table 3.* URBAN POPULATION GROWTH RATES - PERCENT PER ANNUM

	Total	N. Darfur	S. Darfur
1955-1964	6.0	4.9	8.6
1964-1973	5.2	4.3	9.5
1973-1983	5.3	4.7	6.0
		Source: WSDC.	1985

Patterns of growth were different in each of the three largest towns: ElFasher, Nyala and ElGeneina. In 1955, ElFasher, which was the administrative capital, had a population of 26,000, twice as large as the other two. In 1983, Nyala had 115,000 inhabitants, a third larger than ElFasher's 85,000. ElGeneina was still smaller than ElFasher but it was much closer in size than it had been. Some smaller towns, notably ElDaein and Umm Kedada in the groundnut growing areas, had also grown rapidly. Although the rate of growth overall was higher in the earliest period, the differences between north and south were most marked in the middle period, when ElFasher grew rather slowly and Nyala expanded at over 10 per cent per annum.

Nyala was exceptional, not just in Darfur but also in the Sudan. Of all the Sudanese towns, only Juba grew faster over the whole period between 1955 and 1983. Gedaref, the centre of the Mechanised Farming boom in eastern Sudan grew faster between 1955 and 1964. Otherwise, Nyala was unchallenged. Before the annexation of Darfur in 1916, Nyala had not even existed, beyond a "mere nomadic camp". In the 1920s and 1930s it became a "small service village" as the administrative centre for Southern Darfur. (Abu Sin in Pons Ed, 1980) Zalingei, Kuttum and ElGeneina were all more important. The decision to extend the railway from ElObeid to Nyala indicated that its importance was increasingly recognised and the arrival of the railway in 1959 opened the way for its explosive growth.

The origins of the new urban populations show that urbanisation was driven by increasing opportunities, not by rural unemployment. In the 1955/56 census, there were more urban-born Darfuris living in the rural settled sector than the other way around. There were even more urban-born among the nomads than there were nomad-born in the towns. The rural settled sector had in fact drawn in more people from all sectors than it had lost to them: urban, nomad and outside Darfur. For the towns, all of the additional inhabitants apart from population growth came from outside Darfur. (WSDC, 1985) Similar analyses are not available for the later censuses. Urban growth rates were higher in later years, almost certainly indicating some immigration from the countryside. Nevertheless, immigration from outside Darfur continued to be a very important factor. "Two distinct but concurrent migrant flows have been responsible for Nyala's urban explosion." From central Sudan there came "traders, investors, crop dealers and government officials." These introduced the urban lifestyles of the Nile valley. They activated the urban economy and gave an "impetus to the diffusion of the urban economy into the rural hinterland." Most importantly, they moblised capital from both inside and outside Darfur for investment in Nyala. (Abu Sin in Pons Ed, 1980)

The other flow came from the west. West Africans have made the Hajj pilgrimage to Mecca since the King of Takrur in the 11th century. For almost as long, they have sought work along their route, to pay their way in a journey that can take years or never even reach its end. The slow march from west to east was "inextricably interwoven with economic factors in the form of a search for jobs."

In the end, Darfuris began to join the flow into Nyala and the other towns. It is impossible to judge how much of this was the result of bad rainfall in North Darfur and how much the response to the continued attraction of a town showing rapid economic growth and to the decline of the northern trade routes. Groups such as the Zaghawa of the far north-west, who had dominated those routes, quickly developed important trading communities in the southern towns while others sought urban employment alongside the western immigrants.

Large as Nyala is, it remains a 'country town'. A lot of the work, in the groundnut mills and the brick kilns, is seasonal. In 1974, the labour office estimated that dry season employment was five times the wet season. Almost everyone continues to farm. In 1973, it was estimated that 73 per cent of the Nyala population "remained wholly or partially dependent on agriculture." Even among railway employees, in the most modern sector of the economy, 45 per cent had cultivation plots near town. (Abu Sin in Pons Ed, 1980) In 1988, in Zalingei, a much smaller town, over 90 per cent were farmers. (JMRDP, PH88)

By the mid-1970s, Nyala included "in addition to the long standing West African community, an ex-nomadic community and an ex-rural sedentary community. It is thus not surprising that Nyala tends to preserve a somewhat

'rural' demographic profile and what may in some senses be considered as a 'rural' social structure and a 'rural' set of values." (Abu Sin in Pons Ed, 1980)

THE DEVELOPMENT OF GOZ AGRICULTURE

By producing surplus grain to support other sectors and groundnuts for export, goz agriculture in the south/east has provided the main driving force for several decades. Without new technology to raise yields or labour productivity there was limited potential for increased production on the wadi alluvial soils of the northern and western areas, the old heartland of the region. On the goz, on the other hand, there were extensive lands on which cropping was, and is, very profitable.

Four circumstances have contributed to the development and expansion of farming on the goz: strong markets for millet, the introduction of a new crop, groundnuts, improved water supply and the widespread availability of cheap steel hand tools, for clearing as well as for cultivation. Increasing population has been the main reason for the demand for millet but a strong local preference for millet over sorghum and rising incomes, which enabled the people to pay for that preference, were also important.

It is frequently argued that the introduction of cash crops to subsistence economies has made African farmers more vulnerable to famine. Cash cropping, it is suggested, has exposed them to unstable commodity markets. This is not the case in Darfur. Millet and groundnuts are a good crop combination for the higher rainfall sections of the goz: good in the sense of security just as much as profitability. They are also a good technical match, as explained in the next chapter.

Millet is just as much a cash crop as groundnuts. Many farmers sell millet either as a major cash enterprise or, more frequently, in small quantities to pay for necessities or small luxuries. Although the underlying demand for millet is generally strong the crop faces the inescapable problem for all farmers: good yields lead to poor prices and vice versa. Prices for an export crop like groundnuts may be variable but they will not vary in step with the local rainfall. Groundnut farmers are, therefore, able to reap the full benefit of good harvests. In general this means that farmers are able to build up their activities more quickly with the help of groundnuts than they could have in the face of the setbacks inevitable when growing a crop for local markets only. It also means that even the poorer farmer has a chance of getting cash for their consumption needs without being forced to sell so much of his grain crop in a good year that he would risk running short in the next bad year.

The importance of groundnuts in the cropping system is emphasised by the fact that production, at least up until the early 1980s was almost completely unaffected by price changes. Gum arabic sales on the other hand were price sensitive. (See next chapter for details.) The important conclusion from this is that no <u>a priori</u> judgements can safely be made about the merits or otherwise of cash cropping.

None of this would have mattered if it had not been possible to develop ways to support life on the waterless goz. Even during the rainy season, the sandy soils drain the water away so quickly that drinking water can be a problem. During the dry season there is no water at all. Before the introduction of deep boreholes, groundwater was wholly out of reach, lying at depths of several hundred feet. Only in a few places does a layer of impermeable soil below the sand trap water in reach of hand dug wells. Goz cropping would have been restricted to the margins of the sands alongside alluvial areas, where there were shallow wells, if it were not for the development of a specialised technique using <u>Tebeldi</u>, or baobab, trees, roots and watermelons.

"The main stems of these trees are hollow by nature and the cavities they contain can be substantially enlarged. During the rainy season water was collected in excavations made at the base of the trees from which it was hauled up in leather buckets (Ar. Dalu) and poured into the hollow stems through a hole cut in the top. As soon as the main stem of the tree was filled it was sealed up. They grow to a great age and in some cases have been known to hold as much as 3,000 gallons of water." (Sarsfield-Hall, 1975)

This description illustrates the intense effort required to gain the water needed to support life in the goz. Once filled and properly sealed water stored in the <u>tebeldis</u> remains sweet to the end of the hot weather and good trees were a valuable form of property, to be let or sold with or without the adjacent land.

It is claimed by the Hamar of Kordofan that one Mekki Ibn Hajj Mun'im was the first to hollow out a <u>tebeldi</u> tree for water storage, in the mid-19th century. (MacMichael, 1922) Although it is likely that the idea was considerably older, this may indicate that the widespread use of the technique is recent, possibly linked to the boom in Kordofani gum arabic exports in that era.

Water is so crucial that even watermelons play a significant role. In the past, whole villages, including the horses, cattle and other stock, used to depend on them. (Gleichen, 1905) Even today it is normal for the traveller to be offered melon rather than drinking water and young calves are kept alive on chopped-up melon.
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<u>Tebeldi</u>s allowed some of the goz to be cropped but it was a limited technique. There are only so many baobabs and some areas have few. The labour needed to raise water to pour it into the hollow trunk and then lift it out again was considerable and a tebeldi could only be filled once a year. Even with full tebeldis and a large crop of watermelons it was not possible for everyone to spend the whole year on the goz. The important thing was to be able to stay long enough to complete the harvest and gum tapping. After that the grain would be buried in pits (Ar <u>mathmur</u>) before the bulk of the household left with the livestock for the alluvial areas, where they could pass the dry season near the wells. A few old men would stay behind to guard the grain.

Deep boreholes have radically changed the situation. The extent of the change is best measured by the fact that the largest tebeldi held 3,000 gallons, whereas the modern borehole tank holds 12,000 and is usually filled twice a day. The result is that all the goz is accessible to farmers except where the underlying rock is basement rather than water-holding sandstone.

The first boreholes on the goz were drilled in the late 1940's at the larger market towns. The real expansion came in the late 1960's. Figures for the WSDC area, which covers almost all the boreholes in S. Darfur, show the pattern:

Table 3.* Installation of Borehole Water Supplies - 1951 to 1975

Period	Bores Drilled
1951-55	8
1956-60	28
1961-65	26
1966-70	239
1971-75	104
Total	405
	Source: WSDC, 1985

The boreholes are deep and it would be impossibly expensive to sink them so close together as to put all the land within walking distance. For this reason, one further development has made a considerable difference. With a Bedford truck axle, complete with wheels and old tyres, flat one-horse carts are made to carry 44 gallon oil drums full of water to farms up to twenty kilometres from a borehole. This is the ubiquitous Karu, also used for carting all kinds of goods around the towns of Darfur. On the flat sandy grassland of the goz the big truck tyres travel easily and the small Darfur horses seem to have no trouble pulling water considerable distances.

There are two essential tools: the axe (Ar <u>fas</u>) and the flat steel hoe or hashasha. Although the bush on the goz is not dense, considerable effort is still needed to clear crop land, even with the help of fire. Trees are felled in the first year, to let them dry and to let the termites start to attack them, before coming back the next year to burn them. Even though the wood might have some value, the effort needed to cut it up and transport it to a market or to store is just too great. Without reasonable axes the effort of clearing would have been a major obstacle to expansion. The essence of goz farming is speed in operation. Wooden hoes are not adapted to the rapid sweep action suited to the sands. The cost of steel implements is therefore a critical factor.

Steel has become much cheaper in the last few decades, largely as the result of scrap from a more advanced imported technology: old car springs. Local blacksmiths are probably the most widespread and active of all local craftsmen and they now forge nearly every tool used in Darfur out of scrap: from arrow heads to gin traps large enough to catch a buffalo. Before this development hoes and axes were a major import for Sudan: 'metal goods such as axes, hoes and Fasses'. (Gleichen, 1905) In an even earlier era, the mid-17th century, iron hoes were so valuable that they were currency in Kordofan. (MacMichael, 1922)

Land is free, or virtually so, but some capital is needed to start goz agriculture. Clearing the land is a major effort and preparing tebeldi trees would have been a cost in the earlier era. The cost of moving to the new land may not be great but the farmer and his family still need to live in the period between clearing and their first harvest. For some reason the yield the first year after clearing is often poor so it may take two years to reach full production and there is always the risk of a bad season, which may further delay the time when a full return is received for the effort invested.

Farming households can finance this kind of investment provided they work slowly, perhaps not clearing all the land at once and maintaining their old farm until the new one is in full production. However, this is only possible if the new land is merely an extension of an old area or close to it. To develop an entirely new site, it is essential that a relatively large area is cleared at once because the uncleared bush harbours birds and other pests and cropping is impossible if they are not driven far enough back. For these reasons, it seems certain that credit

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mainly from family sources but also from traders has played a role in the development of the goz. There are various ways in which farming households can finance their subsistence needs while waiting for their farm to come into full production: credit from small traders, labouring for established farmers or in the towns during the dry season, advance crop sales, and 'sharaka'. The latter may be interpreted as sharecropping but understood slightly differently. Instead of the sharecropper paying the owner of the land part of his crop as rent, it is not unusual for farmer with his own land to contract a share of his crop to someone else in return for food and expenses during the cropping season: in essence sharecropping capital rather than land.

Entrepreneurs have also been investing in goz agriculture, principally for groundnut farming. They pay for clearing and farming larger tracts on a commercial basis. Up to 100 hectares is not uncommon and gangs of labourers are hired from the towns to do the farm work. In an earlier era, the establishment of Hakura estates under the Fur sultanate to be farmed by slaves represented a similar larger scale investment.

AGRICULTURAL DEVELOPMENT FOR THE DOMESTIC MARKET

The export goods - cattle, groundnuts and, to a lesser extent gum arabic - are also grown in the north/west, non-goz area of Darfur. However this area also benefited from the expanding domestic markets arising out of the general development of the region and out of urbanisation in particular. The greatest opportunity arose from the demand for a wider diet including new crops. The earliest examples were tobacco, introduced in the 1820's, and tomatoes, which were first grown in the 1870's. A number of other new crops have been introduced since. Foremost among them were potatoes, citrus fruit and mangoes. Others include guava, sugarcane and coriander. Demand also increased for existing minor crops, used to add savour to a limited diet: especially okra, chilli and onions. To take one example, the area of citrus in Darfur in 1943 was reported to be 40 feddans (17 hectares). By 1977 there were 913 hectare of fruit trees in the main Jebel Marra area alone. This did not include substantial areas on the eastern side of the same Jebel and smaller areas elsewhere.

All these crops are high value fruit and vegetables. Some are grown for the urban communities of Nyala, ElFasher and even Khartoum: especially oranges and potatoes from the upper slopes of Jebel Marra. Others have become important staple additions to the local diet: dried tomatoes (Ar salsa), dried okra (Ar waika) and onions in particular.

Oversimplifying a very complex pattern, Darfur became increasingly integrated and interdependent as each area and sector specialised in different classes of agriculture according to their comparative advantage. While the south/east provided the export earnings to finance imports, the north/west concentrated on consumer luxuries and semi-luxuries to support the growing urban communities and to add variety to the diet of a rural community seeking a higher standard of living.

Irrigation was an important factor in the development of horticultural production for these new domestic markets. In arid lands like Darfur the attraction of irrigation is very strong and so is the temptation to overestimate the potential There have been several government and overseas-led attempts to identify major irrigation projects. Detailed plans were drawn up for large scale dam construction along the line of the Wadi Azum, west of Jebel Marra, during the 1960's but these had to be abandoned as quite uneconomic. The technical feasibility was also doubtful. There is one borehole irrigation scheme at Saq El Na'am near El Fasher, which has been in operation since the 1960's, but it is believed to be hopelessly uneconomic because of the fuel cost in raising the water from depth. A number of larger boreholes have also been drilled in the Wadi Azum area, where the water is not so deep, but only a few have ever been commissioned. Quite large irrigated 'development areas' were planned around these wells but these could not be implemented because the land was not available to justify it. There were also problems with the quality of both the soil and the water and with the social framework planned for the schemes.

The development of an active small-scale, private-farmer irrigated horticulture, in response to the growing market demand from both urban and rural sectors, stands in sharp contrast to the failure of the larger state-led schemes. There are four forms of irrigation in use: gravity fed from the perennial streams on the higher slopes of Jebel Marra, from shallow wells lifting the water by hand, from shallow wells using pumps and, lastly, by flood spreading.

Irrigation from the mountain streams has a long history, perhaps back to antiquity. "The Tora a 'mysterious' people of neolithic times are credited with the introduction of the distintively terraced cultivation of the Jebel Marra and Si massifs as well as the exploitation of streams by contour irrigation." (Balfour-Paul quoted in HTS, 1958) In the modern era navel oranges irrigated from these same mountain streams have become by far the most important commercial fruit in Darfur. They are grown on the lower slopes of Jebel Marra and, most especially, at the middle levels around Golo and Suni. Incomes in the orange growing areas are substantially higher than most other parts and Jebel Marra oranges are marketed as far as Khartoum. Despite the antiquity of the contour irrigation system on Jebel Marra the switch to orange production dates back only to the 1940's and the most rapid

expansion was during the 1970's and 1980's stimulated initially by government nurseries and then by the construction of a tarmac road from Nyala to Zalingei. (JMRDP, Annual Report 1989).

On the lowlands, 'Onions, the chief annual crop grown under irrigation, appears to have expanded rapidly' stimulated by the introduction of the shaduf 'which was unknown in earlier studies and appears to have been introduced only in the last five years.' (HTS, 1977) The shaduf is a centuries old technique in Egypt and elsewhere that uses a bucket hanging on a beam, with a counterweight at the other end of the beam, to assist in raising water short distances. Such a well-known and common traditional technology cannot have been unavailable to Darfur had there been a need. It can only be concluded that its very recent introduction reflected the appearance of markets for irrigated onions not the sudden discovery of a new technology. Diesel pumps have since appeared as onion production continued to expand.

The JMRDP area is the major centre of irrigation in the region. The expansion started in the early 1970s continued unchecked so that by 1987, 51 per cent of settled households in the area were growing irrigated crops while 18 per cent had fruit trees either irrigated or rainfed. In the areas of greatest activity, along the Wadi Azum, 80 to 90 per cent of households were irrigating. Similarly, in Golo district over 80 per cent had orange orchards. (JMRDP, PH88)

The only break in the dominance of onions was immediately after the 1984 drought. In 1985, only 40 per cent of lowland irrigated plots were planted to onion and 22 per cent to wheat. By 1987, however, wheat had disappeared and 62 per cent of the irrigated area was under onions. The nature of the other crops helps to emphasise how irrigation is serving a market for what may be termed minor luxuries: 8 percent watermelon, 7 percent sugarcane (sold as a titbit not for crushing), 6 percent okra and 5 percent garlic. No grain was grown at all. (JMRDP, IR88)

Darfur onions are marketed as far as both Khartoum and the neighbouring states of Chad and the Central African Republic. The degree of commercialisation may be seen in the fact that many farmers sell their crops in the field to merchants who bring their lorries up from Nyala and who also bring labourers to harvest and pack the crop before they load it and take it back to the Nyala suq. (JMRDP, IR88)

PROCESSING AND SMALL SCALE MANUFACTURING

Simplifying, the Darfur economy developed in three sectors: export production in the south/east, production for the local market in the north/west and services-cum-industry in the towns. The most striking measure of the power of the economy and the rate at which it has grown is the speed at which those towns have grown over the last three and a half decades. While some of this growth reflects an increasing government presence, by far the greater part belongs to a rapidly expanding private sector including services, especially trade, crafts and industry.

Probably been the biggest single advance for the household economy of Darfur has been the introduction of the diesel-driven hammer mill. These were first introduced in the 1950s. The saving in labour, especially women's labour, offered by these machines is incalculable and there are few market villages left in Darfur which do not have a mill. A survey of 50 villages in the JMRDP area in 1988 recorded that just over half of all villages, not just market villages, had mechanical mills. However, some people still did their milling by hand. The processes of economic compression through shortages of fuel and spare parts as well as falling incomes were well advanced in 1988. It is possible that at least some of those milling by hand had in fact been forced to retreat to traditional methods as a result:

Proportion of Inhabitants	Distribution of Villages
Milling By Hand	Percent
"Most"	12.3
"Many"	22.1
"Few"	40.4
"None"	24.6
Source: JMRDP	, PH88

Farmers travel considerable distances and pay high rates to have their grain milled. After fetching water, taking grain to the mill is the most important use of donkeys and grain milling is the most frequent single cash expenditure for the rural household. 94 per cent in a WSDC survey took their grain to a commercial mill at an average cost in 1984/85 of 30 piastres for 8 ratl of grain (3.6 kg). At that time a family might expect to spend \pounds s 90 a year on milling. (WSDC, FS84) A JMRDP survey of 1987 showed similar results, with 73 percent of

households going to the mill each week. About 5 per cent of total expenditure went on milling. (JMRDP, WS88) Again it is not impossible that the lower figure in the later survey reflects the continuing economic compression.

The hessian sack is another important new input. Before sacks, Darfur produce had to be packed in matting made from dom palm leaves or wicker baskets. Both of these are laborious to make and unsuitable for transporting large quantities of heavy goods like grain and groundnuts. Without sacks trade would be considerably restricted. In 1984/5 sacks sold for more than $f_s 2$ each, some five per cent of the crop's total value. (WSDC, FS84)

All forms of empty containers - bottles, tins, plastic cans, however secondhand - have a high value showing the revolutionary impact of containers in a remote economy. In recognition of this a Nyala merchant established a factory for plastic jerricans in 1986/7. Even so most of the groundnut oil sold in the region has to be packed in re-used containers and a common sight on the major lorry routes is a load of empty plastic cans returning to Nyala to be refilled. On the main tarred road north-west of Nyala in 1988, some two percent of lorries were fully loaded with empty containers and drums. Most lorries carry mixed loads, almost always including sacks or cans. As a a proportion of all goods transported, containers are, therefore, even more important. (JMRDP, TR88)

The transport service based in the towns is a key indicator of developing trade. Before the second world war there were less than one hundred vehicles in Darfur, government and private. There were 66 in 1938. By 1970 there were 786 and by 1987, 2,334. (WSDC, 1985) Maintaining and otherwise servicing this fleet is a major urban activity.

Apart from flour milling, groundnut processing is the most important industry. Up to 1961/2 almost all the groundnuts sold through Nyala market had been hand-shelled by the farmers themselves. Soon after the railway reached Nyala in 1959, merchants began to establish mechanical decorticating plants. The speed at which they did this may be seen in the fact that virtually no hand-shelled nuts were sold by 1972/3. (WSDC, 1985) The next stage in the processing of groundnuts is oil pressing. Once the nuts are shelled they can be sorted and, while the best quality are reserved for export whole, the rest are pressed for oil in Nyala. Medium sized diesel driven oil-mills are used and the oil is filtered and canned in re-used 4 gallon tins or in plastic jerricans for sale locally and export to Chad and the CAR.

The groundnut oil industry has had as an effect on consumption as great or even greater than on production. Cooking oil is one of the three or four most regular items on the Darfuri household's shopping list. Local demand for oil is so strong that when the drought of 1984 had destroyed the local crop, some millers were importing groundnuts from Khartoum to keep their machinery working. This development, which was entirely unaffected by government until after independence, has put cooking oil within the reach of almost all the people of the region as well as expanding the income opportunities of the majority of farmers. On the negative side, the production of ghee has probably been greatly reduced. The Baggara tribes used to pay much of their tribute to the Fur Sultans in the form of ghee. In the modern era it has become a luxury. Very expensive and used only on special occasions.

The edible oil industry in Sudan began to expand well before the second world war. One study of 100 leading capitalists in Sudan in 1976 found a majority involved in this business. For many of them it had provided the springboard for the jump from a relatively small trading enterprise to a major industrial investment. A typical example was son of a man who had started as a trader in the nineteenth century. The father was a supporter of the Mahdi before he collaborated with the British against the Mahdi's Khalifa or successor. The son started as a groundnut trader and in 1918 began to establish traditional, camel-driven oil mills. By 1922 he owned all or part of 20 mills. The earliest modern oil mill in Sudan was established in 1930 and this merchant set up the second one. He had to sell up all his traditional mills and shops to buy it from the UK. By 1938, his relations with his UK supplier were such that they established an office for him in London. After independence he diversified into real estate but he also remained the dominant oil miller with factories employing as many as 700 in both Khartoum and Port Sudan. Although this man was the largest, there were many like him. Industrial production was a very small proportion of GDP in 1955/56 but edible oil milling contributed three times as much as the next largest industry and over a third of all industrial output. It should be stressed that this industry was entirely in private hands. (Mahmoud, 1984)

There are those who believe that the colonial state had a repressive policy towards local industry, the edible oil industry being merely the exception that proves the rule. Be that as it may, there were a number of reasons why it was a success. The raw materials, groundnuts, sesame and cottonseed, were in abundant supply. There was a base of traditional technology and of commercial experience in handling the crop on which to build. The more modern oil-milling technology was simple in comparison, for example, with the requirements of cotton spinning and weaving. Above all, there was limitless domestic demand. International demand was also ahead of supply through most of the mid-twentieth century, as the various attempts to establish groundnut schemes in other parts of Africa showed. The Sudanese industry never greatly penetrated international markets but it did have its own market more or less to itself. This also meant that the Condominium government was free from concern about both

political and financial repercussions of Sudanese production. The contrast may be drawn with tobacco production which was restricted by agreement with Egypt early in the Condominium, apparently in deference to the Greek industry. (Martin, 1921) Government also drew considerable revenue from duties on tobacco imports.

Since the 1970's, however, the groundnut industry has been subjected to relatively continuous government interference. The Sudan Oilseeds Corporation, a parastatal, has variously been given a monopoly and had it taken away. Support prices have been raised high one year only to collapse the next, after it had been found impossible to pay for or transport a large crop. Transport has been particularly critical. In 1976, the crop had to be stored in the schools because Sudan Railways could not move it for more than a year. In 1990, the same thing was happening once again.

In the long run improvements in quality and packing will be important to the development of the groundnut industry. At present the oil is untreated so that it does not keep well and it is often tainted with aflatoxin. In the shorter term, however, more is to be gained from breaking the constraints that are holding the industry back from fully exploiting the markets for its current quality of product.

There are also soap factories in Nyala but so far experiments with groundnut oil have not been successful. Cottonseed oil has to be imported from Khartoum. A glance at the goods on display in the small local shops and markets shows immediately the importance of soap, as do the household expenditure figures, indicating that here too there is an industry with the potential to serve both producers and consumers in Darfur.

Although some of the region's production of hides and skins is exported much of it is tanned locally using traditional methods. This is done in villages throughout the area but there is also a larger operation in Nyala where the leather is dyed as well as tanned. This business is dominated by Fellata, west African immigrants. The leather is used to make all kinds of leatherwork but most importantly saddles and traditional slippers (Ar marqub). The best quality, however, are made from hides imported from Khartoum tanneries. A government financed, modern tannery was established in Nyala in the mid-1970's but it had not overcome the recurrent shortages of key inputs to become fully operational by the mid-1980's.

Among other industries there are bakeries in the main towns and many of the district headquarters. These produce bread from wheat flour for the urban population, especially bureaucrats and merchants. Macaroni is also made in Nyala from wheat flour. The production of agricultural implements, such as hoes, knives, axe heads etc, is centred on the main towns, especially Nyala, but travelling blacksmiths are also found in the rural markets. Associated with the blacksmiths is an active business in converting steel from cut-down oil drums into suitcases, frying pans and many other items. There are also as many as nine foundries in Nyala which melt down aluminium scrap to make spoons and cooking pots. Like tanning, this is a Fellata business. Another scrap-processing business is the production of sandals from old tyres.

With the expansion of the towns there has been a big increase in the demand for bricks and they are now made in most district headquarters. Lime is also burnt for plaster and mortar where it can be found. Also in the construction sector are the carpenters who make the door frames and windows but making furniture is perhaps more important. Most of the timber used is imported and very poor quality. However, there are also local sawmills, some of which are run by the Forestry Department and some private, which produce good quality timber such as African Mahogany. This is mostly used for furniture.

Craft industry at the household level is important but difficult to quantify. Mats are woven from from the cut and dried leaves of the dom palm (Ar za'af), which are a minor trade commodity: 33 truck loads on the Nyala-Zalingei road in 1988. (JMRDP, TR88) Pottery, leather buckets and water bags and stools and string beds are other items found in most markets. Every household uses these goods and many are produced by the household or exchanged between households within the villages without being traded in the markets at all.

The 1970s saw a particularly rapid expansion in industrial activity. In 1970/71 there were only three industrial establishments with more than 25 employees, all oil mills, in the region. By 1980 there were 38 of these larger units. The majority were still in the groundnut and oil industry: 6 oil mills, 28 hulling plants and 2 soap factories. There was also one bottling factory and one large metal workshop. There were two weaving mills, government sponsored, but these were closed at the time of the survey. (Dept of Statistics, 1972 & 1983)

There was an equally rapid expansion among the smaller units, those with less than 25 employees: from 41 to 345. These were also predominantly in the food processing sector: some smaller oil mills, 192 mechanised flour mills and 120 bakeries. Four smaller soft drinks producers disappeared between 1970 and 1980, presumably swamped by competition from Khartoum and the larger factory in Nyala. Outside the food sector, there were two small soap factories and one printer, both new since 1970. Small metal workshops rose from 4 to 23, principally involved in the production of hand tools but two making metal furniture.

Most of this industrial expansion was in S. Darfur, principally in Nyala and ElDaein. There were no factories with more than 25 employees in N. Darfur. Even among the smaller units, 62 per cent of bakeries, for example, were also in the south. Only in metalwork did the north outweigh the south.

The 1970/71 survey also covered handicrafts. The principal activities in Darfur were drinks (25%), weaving (45%), tanning and dying skins (15%) and metalwork (7%). The survey specifically excluded homeworkers. It would in any case be impossible to distinguish between those who are involved in a craft full time and those who are part-time homeworkers. The estimated 1,825 establishments must, therefore, have considerably underrecorded the total level of handicraft activity. There were, for example, very few makers of dom palm matting recorded, when this is one of the biggest single handicrafts in the region. Pottery, furniture making and brickmaking all seem to be under-represented as well.

It has already been mentioned that the dividing line between rural and urban sectors is thin and that much of the processing work in the urban sector is seasonal. Except in bumper crop years the groundnut hullers only work in the dry season, providing useful off-season work after the harvest. Even activities which are not directly linked to agriculture are just as seasonal. Small-scale operations, such as tanning and blacksmithing, slacken off considerably during the rains, when everybody goes off to farm. (Hansohm, 1989) Even officials in the towns have some involvement in farming, if only by providing money or other support to farmers on a sharecrop arrangement.

The industrial and commercial sectors in Darfur serve communities and markets outside the region especially in the states to the west: Chad and the Central African Republic. Darfur is a staging post in the export of central Sudanese produce and even of imported goods but significant quantities of Darfur-made soap and groundnut oil go west as well. The onion growers of the Jebel Marra region have found good markets in that direction while grain and cattle are traded in both direction across the borders depending on harvests in the different countries.

This trade, which is potentially very beneficial to Darfur, has been affected by political considerations. At times it has been exempt by treaty from the heavier export taxes. Outright tax avoidance is also easier on this relatively unpoliced frontier and, for that very reason, there have been a number of rapid changes in policy over licensing trade to the west. These have severely disrupted the markets. Rumours that important export crops like gum arabic or that sensitive rationed goods like sugar were being smuggled to the west have resulted in absolute bans on trade from time to time.

The biggest constraint on all industrial development is the supply of inputs. This is true at every level, from the larger government sponsored factories that operate intermittently to the blacksmiths and other scrap-processing workshops who have to make special trips to Khartoum to arrange supplies. (Hansohm, 1989) By 1990, fuel shortages had reached the level that even groundnut oil, a staple in the Darfuri diet grown in Darfur was rationed, because the oil pressing plants could not run full-time. The widespread impact of this persistent lack of inputs may be seen in every country town in Darfur: in the daily queues outside the bakeries when flour runs out and outside the grain mills when the diesel runs out, in the sudden disappearance of sesame seed cakes, a favourite snack, when the sugar runs out and in the closure of the small cafes when the tea runs out. It is small compensation that one or two local craft products, such as the clay ibriq or ablutions pot, reappear when the cheap Khartoum-made plastic version goes off the market because the plastic has run out.

MARKETS AND TRADERS

Darfur is covered by a network of markets ranging from the smallest of country suqs where little is sold beyond roast meat and beer once a week to the vast and vibrant markets of Nyala that are busy every day of the year. The latter is as large as any market in Sudan.

The system starts at the bottom, with the subsistence farmer. "He is a barefooted, poorly dressed Fur or Masalit (or Arab or any other) man who regularly walks one of his goats to the weekly market to sell it. With the proceeds he buys a blue töb for his wife (and) a few yards of damuriyya, cotton cloth for his children. Carefully saving the last Pound note for some beef, tea and sugar to take home, the rest of the money will be spent on celebratory merissa (beer) and roast meat, to be consumed during the afternoon with his co-villagers in the market." (Doornbos in Manger Ed, 1984) Sometimes the farmer may be selling crops rather than livestock. If he or she is poor, he may only have a a little of his stored grain to sell. During the season, however, there are traders buying larger quantities of grain, groundnuts and other crops, even in quite small countrymarkets.

The typical market will consist of a number of groups of stalls with a straw shelter for shade. Cloth in one, tea, sugar, spices etc in another and so on. There will be an area for tea-shops, usually next to the hitching place for donkeys and camels, and another for the butchers and the roast meat. The farmers lay their crops out for sale in another corner while the livestock market is a little further away. If it is an established market there will be a diesel-driven flour mill as well. Some markets are in a village or on the outskirts but there are some important ones that take place almost in the middle of nowhere, at a convenient distance from a number of villages.

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Statistics on lorry movements illustrate this. "The scale of traffic to four smaller centres is striking: Kuja, Deleij, Tanako and Umm Shalaya. These are typical of a particular class of rural market where the level of trade is far greater than would be expected from the size of the village. On the main market day of the week they act as distribution and collection centres for a wide network of smaller markets." (JMRDP, TR88) Table 3.2 shows the pattern of lorry traffic in the Jebel Marra area in 1988 and 1989. The dominance of the class 'Mixed Goods' illustrates how trade is directed to meeting a range of needs for a widely scattered population of consumers and on marketing the produce of equally scattered small producers.

Table 3.2 GOODS TRANSPORTED IN THE JEBEL MARRA AREA

	% of Al	l Vehicles		% of Al	l Vehicles
Good	1988	1989	Good	1988	1989
Mixed	44.6	40.5	Empty Barrels	0.9	0.5
Onions	8.1	6.7	Diesel	0.8	0.5
Grain	5.1	4.3	Salt	0.6	0.7
Sugar	4.9	4.5	Okra	0.5	0.9
Potatoes	2.2	2.8	Cooking Oil	0.5	0.9
Oranges	2.1	2.1	Flour	0.4	0.1
Sugar Cane	1.4	2.7	Za'f	0.4	0.6
Groundnuts	1.1	1.3	Burush	na	0.6
Atrun	1.1	0.8	Tumbak	0.4	0.6
Salsa	1.1	2.0	Sesame	0.1	0.2
Mango	1.0	1.4	Sweet Potato	na	0.4
Firewood	1.0	0.7	Water Melon	na	0.4
Plastic Cans	1.0	1.1	Cowpea	na	0.4
			Other	5.0	3.5
		Samaa IMDD	D TD00		

Source: JMRDP, TR89

Full lorries also carry an average of around 10 to 12 passengers on top of the load, many of them traders travelling with their goods.

These traffic surveys also illustrate economic compression at its most extreme, reflecting the joint impact of severe security problems and national supply problems. Movements on the main road into the west of Darfur halved between 1988 and 1989: from 8,313 lorries to 4170 in 1989. (JMRDP, TR89)

The markets are quite close together and they fall into informal groups or circuits. Each market in a group has its own day in the week and active traders travel the circuit, for the smaller groups with a donkey or camel load of goods, for the larger ones by lorry. "An increasingly popular weekday tour lasts from early Tuesday to Thursday night or Friday morning: the lorries leave Foro Boranga in the early morning to attend the weekly market at Bindissi. In the late afternoon they will leave for the five hour trip to Am Dukhn, whose Wednesday market is attended by thousands of people offering livestock, dried fish and meat, guinea fowl and honey from Dar Fongoro. On Thursday morning the lorries begin their return trip and will unload their human cargo, trade goods and sewing machines once more in the open air market of Muraddaf, 20 kilometres north of Am Dukhn. ... The lorries will return to Foro Boranga on Thursday night or early in the morning on Friday, in time for the market (there)." (Doornbos in Manger Ed, 1984) Trading activity on these gruelling lorry trips is ceaseless throughout Darfur. Even during the rains, traders and lorry owners take considerable risks in the attempt to keep goods moving. This involves frequently having to dig lorries out of mud-holes. The lorry has to completely unloaded and the goods portered, one sack at a time to the other side of the obstacle. Not uncommonly, a whole lorry and its load is lost in one of the larger wadis.

A further step up the ladder, there are the country towns, such as Foro Boranga in the quote, where the market is housed partly in brick built arcades, partly in tin kiosks and partly in the open air. Such a market may have two busy days in the week but there will be some activity all week. These towns are usually also administrative centres with perhaps a school and a police station and some of the merchants have stores and provide goods wholesale to the smaller traders. They in turn depend on Nyala for their supplies, although some may even bring in goods direct from Khartoum as well as send crops for sale there.

Trade liberalisation is a central tenet of the modern aid prescription, which treats it as though state intervention in trade is a relatively new phenomenon sprung from modern socialist ideologies. This is to ignore both history and the complex motivations behind intervention. The African state has always had a close interest in trade which has been the engine not merely of economic growth but also, to a large extent, of state development. In Muslim Africa this can be taken a stage further, because trade and traders have also been a major driving force in the spread of Islam and of the more sophisticated values of metropolitan Sudan. The colonial state took an equally close

interest in trade. Merchants were licensed and licenses were not issued to groups that British officials mistrusted or to those who could not show what they considered to be adequate capital.

The peoples living along the Nile between Khartoum and the Egyptian frontier have dominated the lower levels of trade in Sudan since the mid-19th century. This merchant class is known as jalläba. Their resentment of the Turco-Egyptian state's interference in the slave trade fuelled the Mahdia while their resentment of British restrictions and of the scope allowed to non-Sudanese merchants and trading companies fuelled the drive for independence after the second world war. The National Unionist party was a particular stronghold of the jalläba.

Darfuri attitudes to traders are very ambivalent. On the one hand they mistrust them, as all customers do their suppliers and all producers do their customers. This mistrust is compounded by a dislike of the jalläba as outsiders. On the other hand, they look up to them as representatives of a more modern world. Paradoxically, they also trust them more than they do their own people. 'A Masalit informant commented on this as follows: "Masalit don't like to buy from other Masalit, they think they will be eaten and the traders get rich. So we buy from Jalläba. If you are a few piasters short, they don't mind, sometimes they give you small things. Masalit never do that. The Jalläba are strangers, they are here to trade and become rich. That is the only reason why they are here. We don't like them but they are straight, they don't eat us." (Doornbos in Manger Ed, 1984) To 'eat' someone or something is the evocative Sudanese metaphor for corruption and exploitation.

If the people somehow prefer to deal with strangers, so the trader prefers to be a stranger. It is only by isolation from the kinship and other group pressures of Sudanese society that he can avoid dissipating his carefully amassed capital on social obligations. "Abroad (jalläba) maintain a cohesive wall of social and ritual exclusivity between themselves and colleagues and other local elements, who might make demands on their credit and savings." Individuals who try to become traders in their home town face great difficulties. Some do manage it but only at the cost of isolation from their own community. To succeed they need to break away from their social obligations to that community. This is symbolised by taking on the 'Sudanised' attitudes of the jalläba themselves, by giving up attendance at merissa drinking parties for example. "The process of moving into the Sudanised ranks is a dangerous and traumatic one, inviting scorn, jealousy, isolation and sometimes even death by poisoning from ones own relatives." (Doornbos in Manger Ed, 1984)

In just the same way as Muscat describes in Thailand, it is this mix of historical and social patterns that have determined Sudanese attitudes to trade and traders, not any short-lived political change such as the influence of the Sudan Communist Party under Numeiri's 'left-turn' of 1970. (Muscat, 1966) The Sudanese will not, therefore, be easily persuaded of the case for market liberalisation. The existing pattern whereby the state attempts to control trade in order to satisfy popular mistrust of traders, while state officials and even the state itself collude in the exploitation of those same controls, is deeply rooted.

There have been many studies of trade in Sudan, with as many conclusions. Some, influenced by the prevalent mistrust and by the fact that trade has been dominated first by large European companies and later by a rather small number of large Khartoum merchants, have found great inefficiencies in the market. Inconsistently, it is also often said that the large number of participants in the lower levels of the trading system also indicates inefficiency, especially with respect to the purchase of export crops. Most serious studies have found little evidence to support either proposition. With regard to the first, "Given the very low level of infrastructural development in Sudan, the existing livestock marketing system works very well. It finances and organises the movement of livestock from the West to the urban centres and for export using a chain of traders, agents and merchants who are linked together in a complex but flexible informal network of financial and trust relationships. ... On average the pastoralists have maintained a reasonable share of the final market price for meat. ... Inevitably, merchants are able to make windfall profits occasionally but generally, the active demand situation and competition among independent traders limit the opportunities for exploiting the producer." (HTS, 1976)

As for the second, "The jalläba are faced with a situation of numerous small sellers and buyers scattered over a vast area, producing a variety of goods for potential sale and demanding consumption goods like sugar, tea, salt, cloth, shoes and household equipment. The jalläba, therefore, delegate the buying function to agents, wakils, out in the local areas. ... Producers are reluctant to make a fast agreement, in consequence of which the transaction may be dragged out over hours. This provides an opportunity for the so-called sibäba, or middlemen: They make a profit out of buying a few animals at a time and then selling the lot to the merchants. ... One frequently hears that the many participants, or middlement, indicate inefficiency in the trading system. ... Given the constraints, these different units perform essential functions of negotiating supply from the scattered producers." (Haaland in Manger Ed, 1984).

To sum up, there is nothing to supports Schultz' idea that rural markets are difficult to enter or constrained in some other way. If there is little or no trade in agricultural inputs, then the reasons must be sought elsewhere.

THE ROLE OF CAPITAL

Capital has had a crucial role, although the investment required has been small compared with the development that has been achieved. Most of the industries in Darfur still use relatively simple and cheap machinery to process large amounts of goods and employ a lot of labour. Darfur agriculture uses a few, very cheap inputs apart from labour. The expansion of cropped area has required little investment while livestock herding needs virtually none. The one exception is the network of borehole wateryards that government has provided but even here the cost is small compared to the value of the service provided.

Trade capital has been more important than fixed capital investment: both to supply incentive consumer goods and to purchase and market Darfur produce. Turnover of trade capital is slow. It is a matter of months between the time a merchant buys cattle in Nyala and the time he receives payment after trekking them to Omdurman. On the import side, the long, slow process of moving goods to Darfur is compounded by the fact that most are sold in small quantities to country traders on credit, who often give consumers credit in their turn. It can be a very long time between the day a Khartoum wholesaler purchases a load of imported goods and the day the Darfuri consumer actually pays for it.

Despite its importance, or perhaps because of it, capital, especially trade capital, is often regarded with suspicion. The Sudanese attitudes to trade already described reinforce these suspicions. Haaland, for example, forecasts a process whereby greater involvement in the cash economy leads to a larger number selling cash crops in order to buy subsistence crops. This will lead to wider price variations which inexperienced cultivators will misjudge and 'thus be forced to sell land or become exploited in credit relations. In such a situation the Jellaba (traders) have an enormous advantage and it is likely that a pattern of landlordism will emerge.' (Haaland Ed, 1980) The reality is somewhat different. For a start, it is impossible for the 'inexperienced cultivator' to be 'forced to sell land' since there are few property rights vested in land and virtually no market for it outside the better wadi soils near to towns.

There is little hard evidence that rural credit is charged at extortionate rates. One small survey of two settlements in the WSDC area revealed a wide range of different arrangements. The two settlements were in different areas but with broadly similar circumstances. Despite this there was a considerable difference in indebtedness: 53 percent indebted at Umm Rakuba and only 7 percent at Al Amud al Akhdar. At Umm Rakuba, there were a number of different arrangements with widely differing implicit interest rates. "The average rate of interest on cash loans where interest was paid was very high: 50 percent. On the other hand, many more loans were made without any overt interest." (WSDC, Settlement Survey 1983) 34 percent of loans were made in cash, without any interest, and only 12 percent for interest. A further 37 percent were cash to be repaid in millet after harvest. In the remaining cases the loan itself was millet to be repaid in cash or kind after harvest. In a larger survey of 359 households across the whole WSDC area in 1984, 19.2 percent of households reported some indebtedness, although many were for small amounts. The differing arrangements were as follows:

Loan	Repayment	Interest	% of Loans
Cash	Cash	No	40.6
Cash	Cash	Yes	23.2
Cash	Grain	?	13.0
Grain	Grain	No	7.2
Grain	Grain	Yes	2.9
Grain	Cash	?	5.8
Terms of	Loan not Clear		7.2
		S	WODC ECOA

Source: WSDC, FS84

Of those who reported that they had debts, 55 percent had borrowed for consumption and 35 percent for agriculture, principally to hire labour or buy groundnut seed. Naturally those who had borrowed grain consumed it and, as might be expected, interest was more frequently required for production loans. The average cash loan for production was larger: \pounds s 268 compared with \pounds s 132. Where a charge was made for a loan the amount varied from five percent to fifty percent but the time period was often only vaguely specified. Formal interest rates at so much per annum were the exception. (WSDC, FS84)

Much is made in the literature about the Sudanese loan system called Sheil: the cash loan at the beginning of the crop season which is repaid in kind after the harvest. In the above survey only 13 percent of loans fell into this category. It is widely assumed that farmers are cheated by Sheil because they get a low value for their millet straight after harvest. In the smaller WSDC survey the situation was very different. This was because the value put on the grain to be repaid was "struck at the time of the loan." The harvest that year was bad and the price at

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harvest was actually higher after harvest than when the loan was agreed. (WSDC, Settlement Survey 1983) This illustrates the need to understand that the fairness or otherwise of this kind of credit cannot be judged a priori or even from a single years' survey data. In the uncertain environment of Darfur, both parties to the debt are taking a risk but both also have the chance to win. The point is emphasised by the fact that in the larger survey those households that bought millet paid very little more than the price received by those households that sold it and sorghum sellers actually received more than buyers paid, reflecting the presence of central Sudanese sorghum in the market, which was cheaper but poorer quality. (WSDC, FS84)

	WSI	DC AREA - 1983,	(N = 359)	
			Av Qty	Av Price
	No Hhds	% Hhds	Bag	<u>, s/Bag</u>
SELLING			C	~ 0
Millet	82	23	4.9	61.3
Groundnuts	127	35	16.9	21.8
Sorghum	8	2	2.4	52.8
BUYING				
Millet	172	48	3.9	63.4
Sorghum	64	18	1.8	48.0

Table *.* Households Selling Grain and Groundnuts and Buying Grain) WSDC AREA - 1983/84 (N = 359)

Source: WSDC, FS84

The relationship between borrower and lender in Darfur is finely balanced. In some ways the borrower is the more powerful. He offers no security and so has none to lose. The lender has no legal right to interest, although it is paid without apparent resentment as an accepted fact in the area. Most important of all, the people of the region are highly mobile and it is a simple matter, and not at all uncommon, for a man to escape financial obligations merely by going away.

With land abundant and capital also relatively cheap, labour is the most sought after commodity and entrepreneurs are forced to pay well for it, either directly or in the form of reasonable credit terms. One example was seen in 1985, in the first good season after a disastrous drought when labour might have been expected to be cheap. On the contrary, those who had survived the drought were able to return to their own land and they were concerned only with their own crops so that commercial farmers could not find labour for hire in Western or Southern Darfur. A relatively minor crop, Kerkadeh, with a heavy harvest labour requirement was enjoying a boom that year so that all spare labour was absorbed by that. The larger groundnut and commercial grain farmers were crowded out.

The idea that cultivators who enter the cash crop market will thereby become more vulnerable to fluctuations in the subsistence crop market also fails to bear examination. The proportion of farmers who do not grow their own grain is very small. Almost all households store large quantities from good years as insurance against bad years. (Details are given below.) As already discussed, the main cash crop, groundnuts, offers a degree of extra security. Lastly, and perhaps most compellingly, the proportion of household expenditure on grain is usually small except when their own grain crop has failed. (See below) Farmers remain vulnerable to drought and crop failure, especially in the poorer areas of N. Darfur, but their most effective defence is diver-sification into cash crops and other activities. Concentration on their subsistence crop only succeeds in concentrating the risk, besides reducing the potential rewards of a good year. That exploiting opportunities for reward is just as important as avoiding risks is a theme that will recur.

There is only one recorded case of farmers failing to secure their subsistence requirements for any reason other than drought, the so called 'kerkadeh famine' in Wadi Salih in the 1960's. Here, it is reported, farmers were misled by a boom in kerkadeh prices and underestimated their grain requirements as a result. (Unpublished Sociology Report, JMRDP Library) It must be suspected that the reasons were rather more complex. Either way this indicates a short term failure to judge the market, not any systematic vulnerability. For all the importance of cash crops as a driving force for development in Darfur, the fact remains that even on the Ma'äliya Goz, the main groundnut area of eastern district, S. Darfur, around a third of households grow only grain and only 5 per cent do not grow grain at all. (WSDC, FS83)

This does not mean that more exploitative relationships cannot exist or might not appear in the future, if the situation arises that land has a value and that the better-off succeed in alienating the larger part of that land. Nor does it mean farmers always achieve the best possible deal and are never cheated or misjudge the market. That would be to describe a market in paradise, as the kerkadeh example shows. What it does show is that in Darfur in

recent decades, the general run of market and credit relations are as fair and honest as it is reasonable to expect. There is one crucial exception, the widespread shortages created by government controls locally and more importantly at the national level and the repeated attempts, not always successful, to exploit those shortages.

Capital is sometimes treated inconsistently. Having raised the spectre of unjust credit relations and difficult access to capital for farmers, Haaland then attributes over-investment in livestock to a lack of investment opportunities: 'Since there was no investment opportunity in agriculture (land being communal) people invested their profit in cattle.' (Haaland Ed, 1980) The view that communal land tenure was a barrier to investment, reflected an implicit belief that only investment in intensification need be considered, ignoring the reality that the most profitable investment was in extension.

The only way that capital can be short in cultivation but excessive in livestock is if there is some barrier between the livestock and farming sectors. Such is not the case. In the WSDC area of South Darfur, 60 percent of farming households owned cattle while 69 percent of the cattle nomads of the WSDC area had crop land. (WSDC, FS83 & NS84) Even among the Fur of the JMRDP area, traditionally settled farmers, 27 percent of households owned cattle. (JMRDP, WS84) There is no barrier to the flow of capital between the two sectors. Haaland himself demonstrated that among the Fur in the 1950's and 1960's there was a tendency to 'nomadise' as they found greater potential for investment in cattle than in their existing farm enterprise. In Radom, on the other hand, the Fellata cattle keepers were going against their traditional wisdom not to combine 'qurun (horns) with jurun (granaries)' and taking up cropping because of high millet prices. Mustafa, writing in the same book, notes that there was still investment in livestock in Radom but that the investors were putting their cattle out to hired herders rather than 'nomadising' themselves. The difference between the Fur around Jebel Marra and the people of Radom was explained by differing distances to rangeland and differing profitability from cropping in the two areas although the time interval between the Fur and Radom studies may also have been a factor. Relative prices and profits from crops and livestock changed between the Fur study in the 1960's and the Radom study in 1975. (Haaland Ed, 1980)

Even within an individual family farm enterprise, there is evidence that investment resources are balanced between crops and livestock. Household size is a critical factor and Table 3.3 shows the distribution of households by cropped area and livestock ownership in a WSDC survey of 1983.

			C	Cattle	S	heep	G	boats
HHD		Crop	%	Av	%	Av	%	Av
Size	Ν	Area HA	Owning	Herd	Owning	Flock	Owning	Flock
1 - 2	47	6.63	53.2	27	10.6	16	40.4	8
3 - 4	73	6.10	56.2	34	16.4	32	56.2	13
5 - 6	66	8.76	53.0	28	6.1	7	59.1	7
7 - 8	48	9.34	79.2	25	14.6	59	68.8	7
9 - 10	31	8.89	64.5	20	3.2	20	61.3	14
11 - 12	13	11.65	69.2	36	15.4	70	69.2	13
> 12	26	11.47	80.7	48	15.4	32	65.4	20

 Table *.*
 Crop Area and Livestock Hodlings by Household Size

Source: WSDC FS83

A regression analysis of the relationship between family size, cropped area and cattle holdings on the data summarised in the table gave the following relationship. (This was the most successful of the various forms tested.)

 $\label{eq:Ln(Area) = 1.1412 + 0.3563Ln(Size) + 0.0046(Cattle)} \\ N=304 \quad R^2=0.1469 \ F \ Ratio=26.005$

This relationship clearly shows that cropping and cattle are complementary and that as the household grows bigger so the investment put into both activities increases. The fact that the power relation shown was the most successful indicates that the increase accelerates. "Farmers do not choose between having a large cattle herd or a large cropped area. Rather they aim to increase their scale of operation in both sectors at the same time. Having a large cattle herd implies having the wealth to run a larger farm and vice versa." (WSDC, FS83)

It should be stressed that the complementarity between cattle and crops is a matter of investment. The two operations are not integrated in the same way as they might be on a European farm, with the crops providing

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fodder to the cattle and the cattle providing manure to the crops. A certain amount of fodder is conserved but manuring is never practised and the bulk of the cattle spend most of their time physically away from the farm. 55 per cent of all herds in the survey were transhumant to at least some extent and 37 per cent were managed by hired herders. As might be expected, larger herds show the investment characteristic particularly clearly: "the larger the herd is, the more likely it is to be transhumant (and) the larger the herd, the more likely it is that herders will be hired." (WSDC, FS83)

To sum up, if there is a capital problem in Darfur it is not a matter of 'unjust credit relations' nor in any sectoral imbalance between crops and livestock but rather in a general lack of profitable investment enterprises, particularly those accessible to the less well-off. In years of better rainfall even the poorest may achieve a surplus, it is in finding a profitable home for that surplus, to protect it from the bad years and allow it to grow, that the Darfuri faces his biggest problem. In essence he has only three options: livestock for breeding, extension of the cropped area by hiring labour or the purchase of trade goods to sell around the rural markets. This closely matches Schultz's model of 'penny capitalism' discussed in Chapter Two. Capital is allocated efficiently between sectors but overall returns are low.

At first sight, the high level of activity in all three sectors seems to point to the conclusion that low returns reflect over-investment. The livestock herd is generally described as overstocked (although it will be argued later that the evidence for this is less solid than the received wisdom would indicate). There has certainly been a rapid expansion of crop cultivation. The numerous small and large markets of Darfur all have a surprising number of traders dealing in each particular class of goods. However, a high level of activity says nothing about profitability. All those herders, farmers and traders may be competing furiously for fat profits and would wish to invest more. On the other hand, they may be struggling over ever smaller shares of low profits. And even low profitability does not prove that there is over-investment, for it may be that there is no alternative. Over-investment only occurs if it can be shown that better returns might have been made elsewhere.

The evidence presented in the earlier parts of this chapter strongly suggests that there has been no overinvestment in Darfur until recently. Profits have been high and substantial development has been achieved almost entirely on the back of locally generated capital. In more recent years, however, there are signs of a serious slackening for reasons that will be discussed. As a result, capital is now moving out of Darfur and a number of the major traders have moved their base to Khartoum in recent years.

The theoretical conclusion is that Darfur is not a case of 'penny capitalism', principally because it still has, or had until recently the potential for growth along vent-for-surplus lines through extension, for which the capital requirements are relatively low.

SAVINGS AND CONSUMPTION

The vent-for-surplus mechanism depends on the provision of incentive goods to stimulate production. For this reason, the best single indicator of the Darfur economy is what people spend their money on. To the outsider standards of living in Darfur still seem very low and it is easy to miss the extent of the changes that have occurred in the last ninety years. The local people are more aware of what development has bought them: simple items of day to day life to the westerner, revolutionary to the countryman of western Sudan. "God bless the (colonial) Government, it brought us matches, torches, soap, shibb and tea." (Shibb is alum from the Red Sea used to purify water) (Cunnison, 1966) Tea and sugar have had such an impact that they are now daily necessities and even more than that. Among the Baggara Arabs special tea-drinking associations with elaborate rituals have grown up called Baramka.

Many items the Darfuri buys are small and taken entirely for granted in the west. In several cases they are no longer even used in the developed world. Washing blue is an example. It costs next to nothing. It went out of use in Europe thirty years ago, with the advent of washing machines and washing powders. It remains on every Darfuri's shopping list, if he can get it. Other examples include matches, small electric torches and the batteries for them and paraffin; all of them nearly forgotten in the west and yet crucial in a world without electricity. Tiny luxuries, sweets, dates, peanuts and so on, also have an importance that no westerner has felt since rationing during the second world war. Such 'tatätif' are also regularly on the shopping list.

Table 3.4 shows the level of weekly purchases of foodstuffs for the Darfur household in the 1980s. Data is taken from surveys of two areas of South Darfur. Caution is needed making comparisons between different areas but both surveys covered quite a large sample of both the poorer and better-off households. The very poorest groups who are not easy to reach were probably not represented and neither were the drier and poorer areas of North Darfur. Nevertheless, the table gives a good picture of day-to-day consumption in the region. The first survey fell just before the famine of 1984, although harvests had already been poor for two years, while the second

fell after the poorest season in the late 1980s which was otherwise a period of recovery. Both may be seen as typical of years with below average harvests but not outright famine.

		WSDC Area	JMRDP Area
	Unit	July-January 1983	June-December 1988
Sugar	lb	4.16	1.96
Tea	OZ	3.72	1.52
Oil	bottle	0.98	0.56
Salt	lb	0.39	0.41
Onion	lb	1.16	0.64
Chilli	lb	0.08	0.08
Salsa	lb	0.30	0.15
Waika	lb	0.07	0.15
Beef	kg	0.71	0.57
Goat	leg	0.20	0.20
Soap	bar	1.35	0.63

 Table 3.4
 AVERAGE WEEKLY HOUSEHOLD PURCHASES

Source: WSDC, Consumption Survey 1984, JMRDP, WS88

The table shows a considerable reduction in consumption of what may be described as the 'staple luxuries' of the Darfur household between the two surveys. That is to say those foodstuffs that are not absolutely essential to maintain life but which would not be considered a luxury in any except the poorest societies: sugar, tea, oil, onions, salsa, beef and even soap. The decline in oil consumption is even underestimated because the WSDC area is one where ghee is produced and a substantial minority bought ghee instead of cooking oil in the earlier survey. Similarly the fact that onion and salsa consumption is lower in the JMRDP area, which is the major producer of these crops, is a particularly strong indicator of declining standards of living. Nevertheless, it is the drop in sugar and tea consumption that stands out: those goods for which the colonial government was most blessed and which continue to have immense political importance. They may be seen as the vanguard of the vent-for-surplus, a vanguard that is in rapid retreat.

Cash incomes give some indication however of the relative importance of the three areas in which the Darfuri can invest: cropping, livestock and trade. 1988 figures for the JMRDP survey, which are typical at least for the main crop farming areas, are shown in the next table while the contributions of the different crops are shown in the table after that.

Source of Income	<u>s</u>	Percent
Crop Sales	1264	42
Livestock Sales	473	16
Wages, remittances, etc	432	14
Trade	712	24
Etc	96	3
TOTAL INCOME	2977	100
	Source: IM	RDP, WS88

At the official exchange rate at the time, this total income would have been worth US\$ 1,190. Resident household size in the survey was 4.6, giving a per capita cash income of US\$ 259. This does not include the substantial value of production consumed on-farm or of the less substantial costs of production. On balance it is more likely to be underestimated for this relatively well-off survey group.

	% by	% of	Av Qt <u>v</u>
Crop	Value	HHDs	Sold - Kg
Groundnut	21.6	16.5	607
Dried Tomato	17.2	17.7	263
Onion	10.9	9.2	675
Oranges (dozen)	9.3	4.5	530
Potato	7.0	4.9	2,316
Millet	7.0	13.0	415
Chilli	5.5	7.3	114
Okra	4.7	10.3	77
Sorghum	2.8	4.2	31
Cowpea	2.6	2.8	287
		C 11	

Table *.*Relative Contribution of Each Crop to Cash IncomeJMRDP AREA - 1987/88

Source: JMRDP, WS88

The main sources of cash income are clear: crop sales, trade, livestock and wage labour, principally in agriculture but also in trade, driving, portering and so on, and activities like building. Despite Darfur's long tradition of emigration, remittances contributed less than three percent of income. One reason is that migrants usually bring their savings back with them as a lump sum or in the form of goods they have bought while away. This in itself reflects the extremely poor financial infrastructure. The banking system is not capable of handling remittances to small farmers. Another factor is the highly individualist nature of Darfur society. Husbands who emigrate are not necessarily considered to be responsible for the upkeep of their families. Nevertheless, the low level of remittances is also an important indicator of the acute constraints on the Darfur economy. What is the point of sending money back when there is nothing to invest it in and few imported consumer goods on which to spend it. The migrant is indeed well-advised to keep the money abroad so that he can buy goods to bring with him when he returns. He helps his family more that way.

In Chapter Two the need to distinguish saving from investment was emphasised. The proof of this proposition lies in one fact above all, the very high stocks of grain held by Darfuri farmers. A series of three surveys in the JMRDP area illustrates the point. Table 3.5 shows the household grain balance for three years calculated from those surveys. It illustrates the key role of storage as a way to manage the extremes between good and bad harvests.

Table 3.5

HOUSEHOLD FOOD GRAIN BALANCE - Kilograms

	1987	1988	1989
Crops in Store			
Millet	na	42	134
Sorghum	na	3	49
Total	+ 200 est.	+ 45	+ 183
Production	+ 822	+ 1,400	+ 737
Consumption	- 808	- 732	- 872
Surplus	> 14	713	48
Household Size	5.54	5.01	5.97

Source: JMRDP, PR87, PR88 & PR89

1988 was a good season between two poor ones. The Crops In Store is the grain left at harvest time from previous years' crops, that is to say what had not been needed up until the harvest. The Surplus represents that amount that was available at harvest time over and above what would be needed for consumption for the next 12 months. It seems certain that after two good years in a row households would have even larger reserves of grain than the 180 odd kilogrammes they held after the good 1988 harvest and that what may be termed the 'propensity to store' food grains is very high. Farmers would probably like to be able to put two full year's consumption requirements into their stores immediately after harvest. That is to say that they would want enough in store to see them through to the end of the season two years ahead, so that if the next harvest is very bad they can survive until the one after. A JMRDP survey in 1983 showed 73% storing grain for more than one year. (JMRDP, Crop Protection Report 1983)

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These figures suggest that at the very least, households would like to hold 25 percent more than they actually need as insurance against a bad harvest. It seems more than probable that if they had two good years in a row they might build their stocks up even higher. Grain is by far the most dominant crop in the region. For a quarter or even more of that production to be tied up in store as insurance represents a massive reserve of capital which could be released if more effective forms of insurance were available. It seems reasonable to assume that a similar proportion of the livestock herd serves the same insurance purpose and to conclude that it is far more than just a quarter of the grain crop that is tied up as unused capital.

It will not be an easy matter to release that capital. It will not happen until some form of macro-economic stability is established in the Sudan as a whole. Three things will be critical: an end to inflation, a guarantee of open markets so that if farmers sell their grain they can be sure of being able to buy some back when they need it and a financial system that makes secure savings available to the majority of Darfuris.

The table indicates another way in which the Darfur household adjusts to cope with drought, by shedding population. In 1988, after the poor harvest of 1987 the average household was smaller than it was in either 1987, after two good years, and in 1989, after one very good year. Other surveys show a similar pattern with households shrinking during the bad times and expanding after. Unfortunately, the destination of those who have to leave can only be guessed. The most likely possibility is that they go to seek work in the towns or in central Sudan.

CONCLUSION

The Darfur economy has demonstrated a potential for rapid growth of a rather straightforward kind. That growth has been led by trade but it has also resulted in greater integration of the region's economy and in very rapid urbanisation. Simple industries have shown some success. Starting the mid-1970s, however, the process has gone into reverse. The droughts of the 1980s have exacerbated the problems and the pull of migration to the OPEC states has also contributed to the slowdown. Nevertheless, the prime cause for the collapse of the economy has been what can only be described as the slamming shut of the vent-for-surplus; by the inexorable decay of the railway system, by the increasing shortages of both inputs and consumer goods and by frequent changes of policy.

Many have drawn the conclusion that the famines of the 1980s reflect the impact of drought on an economy that has been made more vulnerable by monetisation, cash-cropping and development in general. This is not the case. Instead, the droughts were made far more devastating than they need have been by the fact that they coincided with the reversal of development that has been described. Monetisation and cash-cropping offer the only true way to greater security for Darfur but they can only work when the Sudanese economy as a whole recovers from the much wider problems that have afflicted it since the 1970s.

Theoretically, Darfur seems to be a case where Myint's model of the vent-for-surplus mechanism fails on most points. The pre-trade economy shows none of the rigidity that is fundamental to the model. Indeed it is difficult to even identify a point at which there was a pre-trade economy. There have been considerable shifts in factor combinations, most notably in transport. A wide range of new technologies have been rapidly adopted: groundnuts, grain-milling, transport again, and water supply. Increased specialisation is widely evident: cattle owners concentrating on beef animals and reducing production of ghee, farmers in the north/west exploiting opportunities to grow tomatoes, chillis, onions etc, and, above all, a rapidly expanding urban service sector.

It is more difficult to reach a conclusion on the central point of disguised unemployment, where immigration and emigration make interpretation more more difficult. What little census data there is suggests that net immigration to Darfur was not significant. The impression remains that at certain periods it was important. Overall, it appears that mobilising the 'semi-idle labour of the subsistence economy' contributed relatively little to the growth in production and that although immigration was a factor it does not explain the whole. It was the more conventional gains from trade and the Smithian form of vent-for-surplus that were the driving forces behind Darfur's development. The latter came partly through investment and partly through efficiency gains won by division of labour.

Regardless of the particular form taken by the gains from trade, the role of incentive goods seems fundamental. Because life in Darfur still seems very simple it is easy to overlook the the extent to which consumption has increased and diversified since the late 19th century. While the supply of some critical investment goods has also been important, cheap steel, motor transport and mechanical mills especially, the volume does not compare with the supply of what have been termed minor consumer luxuries.

Myint suggests that his version of vent-for-surplus development makes developing countries vulnerable to external disturbances. Because they were surplus in the domestic economy, the resources mobilised by trade cannot be diverted back to domestic production if external markets are lost. (Myint, 1958) The Darfur experience suggests that trade-led development is indeed vulnerable but not because the gains from trade sprang from the special form of Myintian vent-for-surplus. Instead it is trade's inevitable exposure to Government that brings

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acute vulnerability. Direct interference is an important factor but the absence of critical public services, especially security and arbitration, and gross macro-economic mismanagement leading to inflation have done far more damage in Darfur.

4. SCRATCHING A LIVING

Agricultural research has contributed one great success to development: the green revolution. Little of that success has reached Africa where large resources have been put into agricultural research at all levels. "More has been spent on research in Sub-Saharan Africa than elsewhere in the developing world": US\$ 360 million in 1980 as against US\$ 190 million in South Asia. (World Bank, 1989) This poor performance might be because it is still not being done right. If so the theoretical case for research, essentially still that of Schultz, need not be challenged. The alternative is that the potential of research as a stimulus to development is exaggerated and that Schultz needs re-examination. The next two chapters attempt to determine which is the correct conclusion in Darfur.

DARFUR AGRICULTURE

Table 4.1

There have only ever been two surveys of agriculture covering Darfur as a whole: a sample census for the year 1964/65 (Dept of Statistics, 1968) and an aerial sample survey carried out in 1976/77 (VRA/RMR, 1977). However, more recent smaller surveys confirm that the broad outlines have not changed that much. Table 4.1 shows the cropped area in North and South Darfur during the 1976/77 season and the proportion of the national total.

	Rai	Rainfed		Mechanised		Irrigated	
	Km ²	% Sudan	Km ²	% Sudan	Km ²	% Sudan	
N. Darfur	11,278	19.2	0	0.0	7	0.05	
<u>S. Darfur</u>	6,691	11.4	121	1.0	44	0.30	
Total	17,969	30.6	121	1.0	51	0.35	
				Sources J	7 ΟΛ / ΟΛΙΟ	1077	

DARFUR CROPPED AREAS - 1976

Source: VRA/RMR, 1977

Since 1976 there has been fairly rapid expansion of small-scale pump irrigation but the area remains tiny compared to the large central Sudanese irrigation schemes. Project surveys give an estimate of 87 km² of small-scale irrigation 1987/88 for the JMRDP area, which is the major centre of irrigated cropping in Darfur. (JMRDP, PH88) For the whole region this could possibly be doubled.

The mechanised sector is almost entirely government run. It has stagnated or even gone back since 1976. This point should perhaps be stressed because there have been recent claims that "the use of tractors for small-scale commercial production has become well established right across the more accessible areas of North Sudan" and that "western Sudan had developed a north/south divide with the commercial farms in southern Darfur and Kordofan increasingly attracting labour from the undeveloped northern regions as well as nearer at hand." (Duffield, 1990) This is misinformed. The number of privately owned tractors in Darfur is very small indeed. Almost all mechanised commercial farms are near government centres, where the owners can hire tractors from government schemes. In many cases the land itself is also rented from moribund government schemes.

It may seem surprising that the cropped area in the northern province is twice that in the south. The population in the south was slightly larger, even in 1973. The explanation lies in the trade-off between area and yield. In drier regions, especially where the soils are sandy, a farmer can plant large areas with relatively little labour. His yields will be low but so are costs and it is still worthwhile. Where it is wetter, yields are higher but weeding labour requirements are heavy so a farmer plants smaller areas. In terms of returns to their effort, both farmers may come off equal even though the area they plant is very different.

In 1964 the average holding in Darfur was 7.06 feddans per household (2.96 hectare). Over 99 per cent of holdings were managed by one farmer on his own. The tiny remainder was worked in a partnership of one kind or another. The vast majority held their land without any form of rental. They either owned it or had free customary use. In essence the farmers are almost all small but independent agents.

Table 4.2 shows the average area per household of each crop for Darfur in 1964 and for North and South Darfur in 1976. Comprehensive surveys are not available for the 1980s but the table also shows figures from the WSDC and JMRDP project areas which make up the larger proportion of South Darfur. These provide a reasonably good comparison for the later decade.

Table 4.2

RAINFED CROPPED AREA BY TYPE OF CROP Ha Per Household

	Darfur	S. Darfur	N. Darfur	WSDC	JMRDP
	1964	1976	1976	1982	1987
Sorghum	0.51	0.25	0.28	0.69	0.39
Millet	1.77	1.54	2.57	2.85	1.31
Mixed Grain	na	na	na	-	0.17
Sesame	0.05	0.19	0.18	na	na
Groundnuts	0.45	0.63	0.18	0.83	0.26
Vegetables	0.03	0.08	-	na	0.20
Tobacco	0.04	-	0.05	na	na
Peas/Beans		0.04	-	na	-
Maize		0.03	-	na	na
Pepper	0.10	0.04	-	na	0.05
Okra		0.13	0.14	na	0.08
Minor Crops		0.05	0.05	0.23	0.22
Total	2.95	2.98	3 53	4 60	2.66

Note: 1. na for the WSDC/JMRDP surveys means that these crops are included in Minor Crops. This is probably also true for the earlier surveys.

2. Sources: Dept of Statistics, 1968, VRA/RMR, 1977, WSDC FS83, JMRDP WS82 to WS85 (averages)

Despite the long periods between the surveys and the differences in method and in the areas covered, they all show the same pattern. Millet is more important, at least in area, than all the other crops put together and only sorghum and groundnuts are at all important among those others. Okra may be classed as a significant minor crop while sesame was quite important in 1976 but not in 1964 or in the later surveys, presumably reflecting the boom in oilseed exports of the early 1970s.

In the drier north, areas are greater and the proportion of millet and sesame, which are most drought tolerant, is higher. Groundnuts and vegetables need more water and they are more important in the south. The differences between the WSDC and JMRDP results reflect the different soil types of the two areas. The former is typical of what has been described as the south/east sector where goz agriculture predominates while the latter represents the north/west where areas are smaller, yields are higher and the range of crops somewhat more diverse.

Minor crops fall into two groups: those which are locally important but unimportant averaged over the whole population and those which are grown very widely but in small amounts. Watermelon is an example of the first. On the eastern goz it is grown as a field crop, partly for the water in the melons and partly for the seed, which is marketed. Elsewhere it is unimportant except as a fallback in a particularly bad year. Three crops are locally important on the terraces of Jebel Marra: cherry tomatoes for drying into salsa, a staple in the diet throughout Darfur and indeed Sudan as a whole, potatoes which are sold as far as Khartoum and wheat. Potatoes and tomatoes account for much of the larger area of 'vegetables' shown in the JMRDP column in Table 4.2. Okra is typical of the second group. Very many Darfur households grow a small patch of okra, in household gardens called jibräka, but it is rarely grown on the field scale.

There is quite a range of more minor crops, grown in small areas for local sale and consumption as minor additions to the diet. These include roselle, (ar <u>Kerkadeh</u>) which is made into a drink, sesame which makes a popular sweet, sweet potato, maize, which is not eaten as a staple grain but as roasted cobs, and sugar cane, which is chewed as cane. Cowpeas are grown quite widely and occasionally there is a local boom, such as 1988 when the area sown increased around Mukjar in southwestern Darfur. Cassava is found principally where Hausa from West Africa have settled. Among the spices, chilli and garlic are the most important but coriander and fennel are also grown.

Mixed cropping embodies attractive and fashionable ideas of non-chemical preservation of soil fertility and the value of rural peoples' knowledge. In Darfur mixed cropping is limited to specific areas and serves specific purposes. There are only two mixes that are common, even locally: millet with sorghum on the basement wadis and millet with tomatoes on the Jebel Marra terraces. In neither case does the mix offer fertility improvement, the benefit commonly attributed to mixed cropping. Instead the aim is to minimise risk. If the rains take one pattern then one of the two crops will do well. If they take another then the second crop's gain compensates for the first one's loss. Or one crop may be vulnerable to pests but will yield better if there are no pests. Another reason farmers quote for mixing their seed is to help with weeding their grain. Wild millets (ar weewee) and wild sorghums (ar adhar) are common weeds and it can be difficult to identify which is the crop and which is the weed. If there

is a sesame plant next to the sorghum or a watermelon next to the millet, to quote the most common minor mixes, then the weeder can immediately tell his corn from the tares.

The averages in Table 4.2, showing a range of different crops, conceal the fact that many farmers grow only one crop. Apart from their small household patch, they only grow millet or sorghum. Many more grow only the two grain crops. WSDC surveys showed 40 per cent of households growing only one crop in 1982 and a further 11 per cent growing only cereals. The largest single group grew millet and groundnuts. (WSDC, FS83) On the lowland in the north/west in 1987, JMRDP surveys showed that 33 per cent of households grew only millet and 62 per cent grew only cereals. Only on the upper levels of Jebel Marra is any kind of crop combination in general use; about one third grew millet and tomatoes in 1987, one third grew potatoes as well and one third grew wheat as well. (JMRDP, WS87) The prevalence of single cropping has significant implications for the development of new agricultural techniques.

CHANGING CROPPING PATTERNS

The basic cropping pattern is stable but farmers are fully aware of market prices and the response to fundamental price changes can be rapid. The most striking example is the way groundnut farming developed from an item of local consumption to be the second largest crop in the WSDC area and a major export between 1950 and 1965. In 1948 it was written that "About three quarters of the (groundnut) crop is consumed within the country as food. The uneven size and brittleness of Sudanese nuts have contributed to the poor success of local attempts at machine decortication and all the export is undecorticated." (Tothill Ed, 1948) "By 1965 (groundnuts) had become the (Sudan's) second most important export." (Low, 1967)

A response to a more short term price change was seen in the first year after the 1984 drought, when farmers responded to a substantial increase in the price of <u>kerkadeh</u> and planted large areas of a crop that had been of little importance for some years, at a time when they might have been expected to grow grain in preference to anything else. Larger grain farmers were complaining that they could not get harvest labour because people were all working on the kerkadeh, which is particularly hard and slow to harvest.

The phrase 'fundamental price change' was used advisedly. Marginal or even quite substantial changes can have surprisingly little effect. Farmers' cropping decisions are determined at least as much by the particular climatic pattern of a given crop year as they are by price, and frequently more so. This is most clearly shown in the data for groundnuts marketed through Nyala market between 1969 and 1983. The quantity marketed was significantly correlated with rainfall. Although statistically insignificant, the relationship with price was actually negative. More groundnuts were sold when prices were lower. This reflected inflation, which was running faster than increases in the groundnut price. Such a negative relationship with current prices is a measure of the way macro-economic failure depresses export crop production. An approximate correction for inflation can be made by dividing the groundnuts. Even when corrected in this way there was no relationship whatever between sales of groundnuts and the price relative to millet. There was however a weak relation with the price lagged by one year.

It has been suggested that farmers have to choose between tapping gum arabic and growing groundnuts so the price of gum arabic also has an effect. There was a weak negative correlation between the sales of gum and groundnuts in Nyala, supporting this idea, but it was not statistically significant. Like groundnuts, gum arabic sales were negatively related to prices in current terms because of inflation. However, they were quite strongly related with the price relative to millet. Unlike groundnuts, however, lagging the price by one year produced not relationship. The statistics of these relations were as follows. Neither crop showed a time trend over the 14 year period for which complete data was available. (Quantity only was available from 1961. Over that longer period gum arabic showed a strong downward trend but groundnuts still showed no trend. Figures 3.1 and 3.4 confirm that the 1970's were a period of high variability but no obvious trend.)

The simple correlation statistics illustrating these relations were as follows:

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Relation	Ν	R	\mathbb{R}^2	Sig. Level
Groundnut Sales Relative To				
Rainfall (1961-83) 22	0.496	0.246	1%	
Current Prices (1969-82) 14	-0.163	0.026	Not	
Millet Relative Prices (")	14	0.032	0.001	Not
- Lagged (1970-83)	14	0.228	0.052	Not
Relation	Ν	R	R ²	Sig. Level
Gum Sales Relative To				U
Rainfall (1961-83)	23	0.248	0.062	Not
Current Prices (1969-82)	14	-0.185	0.034	Not
Millet Relative Prices (")	14	0.707	0.500	1%
- Lagged (1970-83)	14	0.096	0.009	Not
Relation	Ν	R	R ²	Sig. Level
Groundnut Sales Relative To				0
Gum Sales (1961-83) 22	-0.363	0.132	Not	
Notes: 1. One-tailed Significa	ince test., 2. B	ase Data showr	n in Annex V	Л

Regressions were run for the relationships that showed at least some significance. The results were as follows:

GROUNDNUTS

Q = -301987 + 142102 P-1 + 1102 R - 1.7 GUSE (107447) (61507) (224) (0.8) t -2.81 2.31 4.91 -2.13 N=14 R²=0.73 F=9.14

Where:

Q = Groundnut Sales, P = Groundnut Price/Millet Price, R = Rainfall, GU = Gum Sales

GUM ARABIC

Q = -18158 + 10223P + 134R - 0.12GNSE (18718) (2569) (54) (0.05) t -0.97 3.98 2.48 -2.70 N=14 R²=0.73 F=8.97

Where:

Q = Gum Sales, P = Gum Price/Millet Price, R = Rainfall, GN = Groundnut Sales

Despite the fact that all coefficients in these regressions were significant, when a stepwise test was run all except two variables were rejected: rainfall in the groundnut equation and price in the gum arabic one.

The most revealing way to consider these results is in terms of elasticities, calculated approximately at the average value for each variable:

		Elasticity
Groundnut sales with respect to	Lagged Price	0.64
_	Rainfall	2.24
	Gum Sales	-0.29
Gum sales with respect to	Price	3.22
	Rainfall	1.56
	Groundnut Sales	-0.73

The different market behaviour of the two export crops, groundnuts and gum arabic, highlights two points; first, that it is the technical characteristics of the crop that are paramount, not the fact that one is a subsistence crop and another a cash crop, and second that responses are complex. If groundnuts are price inelastic, this is because the crop is more closely integrated into the overall strategy of dryland farming, especially with respect to labour. That groundnuts responds to a lagged price and that gum arabic does not also has a technical explanation. A decision to plant groundnuts has to be made some months ahead of the sale. The decision to tap gum arabic

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does not have to be made until shortly before marketing it. The very high price elasticity of gum arabic reflects the same fact.

The converse of the belief that cash cropping is inherently bad or too risky for small-holder farmers in drought prone areas, is the belief that drought resistant subsistence crops are good. After the 1984 famine much emphasis was laid on the need for research into shorter season varieties of such crops. It was suggested that farmers would concentrate on millet before sorghum and grain crops before cash crops. Here too things are rather more complicated. Figure 4.1 shows changing cropping patterns through six years in the JMRDP area starting from 1984.

The first clear conclusion from the figure is that farmers grew more sorghum in 1984, not less. By contrast, millet expanded during the recovery phase. As far as cash crops are concerned, areas were down in the drought year although significant amounts were still grown. On the other hand, the area of groundnuts in particular was highest in 1987 which was not a drought but was still the driest year since 1984.





A longer term comparison can be made between a 1976 survey of the same JMRDP area and the average for the six years between 1984 and 1989. There are two factors that might have been expected to lead to considerable changes in cropping patterns between the mid-1970s and the 1980s: the process of economic compression described in Chapter 3 and the steady, sometimes disastrous, decline in rainfall. Both might be expected to force farmers to reduce their exposure to cash crops and concentrate on subsistence grain. This did not happen. As a proportion of the total cropped area groundnuts declined only fractionally between 1976 and 1985-89: from 6.6% to 6.3%. The proportion of the area under grain crops barely changed: from 78.6% to 77.7%. More surprisingly, the proportion of sorghum increased considerably at the expense of millet. The proportion of more minor cash crops, tomatoes, okra and so on also increased. (HTS, 1977 & JMRDP WS84 to WS88)

None of these changes were so large to disturb the overall pattern. Millet remained by far the dominant crop. Nevertheless, they are all in conflict with the simple intuitive belief that farmers would react to drought by withdrawing from cash crops and concentrating on the most drought resistant cereal: millet. Cropping patterns are determined by quite complex interactions of the technical and economic potential of each crop. If sorghum has increased in importance it is probably because the lower, wetter lands suited to the crop become easier to work in dry years while the light, sandy millet land is just too dry to be worth planting. Millet is the preferred crop in Darfur. Although sorghum may yield more, that is only important when famine makes quantity more valuable than preferred quality. If more groundnuts are grown in a dry year it may be because of price or because although rainfall was low it fell at a particularly suitable time for the crop.

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Many minor crops have relatively short growing periods and are more flexible in the ways they can be grown. For this reason, they can become crops of last resort in a bad rainy season. If the grain crop fails too many times then the farmer's only option is to plant a short season crop to try and rescue something from the drastically shorter growing period that is left to him. Coriander is used in this way in the JMRDP area. Nevertheless, the main force behind the increase in the area of minor crops between 1976 and 1985-89 was probably the construction of the Nyala-Zalingei highway which greatly eased the transport of tomatoes and potatoes, in particular, to Nyala market.

FARMING TECHNIQUES

Farming techniques are best understood from the words the farmers use themselves, from the tools they use and from the way they use them. This avoids using English terminology, which is often inappropriate or downright misleading. To Europeans and to many from the developing countries as well, land preparation is the most vital of farm activities. They think of a cultivation process that starts with one or more ploughings followed by harrowing, levelling and so on before any seed is planted. Almost universally, the plough is the symbol of farming. For the farmers of Darfur it should be the hoe; not merely because they do not have ploughs but, far more importantly, because they work their land in a different way and, even when they do cultivate, it is for different purposes. Darfur farmers are still at that stage described by Boserup at which the man:land ratio has not yet reached the level at which ploughing is necessary or feasible and bush fallowing is still the best choice.

With one important exception, the major grain crops are sown straight into the ground without any prior cultivation at all. (This 'traditional' technique anticipates another modern fashion for 'minimal tillage'; that is to say the drilling of seed direct without ploughing.) The language explains why. All 'land preparation/cultivation' operations are grouped under the one word: <u>hash</u>. This is linked to the word <u>hashshish</u>, for grass or weeds, and <u>hash</u> is best translated as weeding: highlighting the farmer's major pre-occupation. His problem is not the preparation of a seed bed for the crop nor is it the maintenance or release of soil fertility. It is not even the conservation of moisture. For the Darfuri farmer, all these considerations pale into insignificance when compared to the problem of weeds.

Because the climate is harsh the local vegetation has adapted to be extremely agressive, to germinate and grow very quickly, in order to take maximum advantage of the short rains. This means that the problem for the farmer is not the inherent fertility of the soil, which he may not be able to change with ease, or the lack of rain, which he certainly cannot change. Instead he must concentrate on preventing the weeds from taking what little fertility and water he does have and completely choking his crop.

The result is that weeding labour takes between 50 and 60 per cent of the total labour effort for the grain crops and 25 to 30 per cent for groundnuts. (WSDC, FS83) Weeding is universally the key labour constraint to an increase in production. This pattern is typical of the African bush fallow described by Boserup.

Seed is planted in widely spaced holes made with a long handled hoe striking downwards. The wooden digging stick with a small iron blade, which is found throughout Africa, is now rarely seen, once again closely matching Boserup's prediction that a shift from long fallow to bush fallow would see the digging stick replaced by the hoe. This shift also reflects the impact of cheap steel discussed in the previous chapter.

After the hole has been made with the hoe, seed is dropped into it and the earth scuffed over with the foot to bury it. With one man on the hoe and a second carrying a bowl of seed behind him, dropping the seed and scuffing it over, large areas can be sown very rapidly. In the WSDC area the average household planted nearly three hectares of millet in 1982, which they could have planted in just seven days if two men worked together. (WSDC, FS83)

Crop establishment is critical. Even in a good year like 1988, crops fail wholly or partially for a number of reasons. In a poor ones, like 1987 and 1989, farmers may have to replant whole fields two or more times. In 1988 the average number of times a field had to be re-planted was 0.87. In 1989 this rose to 2.35. (JMRDP, PR87, PR88 & PR89) It is worth stressing that the principal reason was grasshoppers, not drought. Because of the need to replant the ability to plant rapidly with the hoe is crucial.

Many technical studies of agriculture in semi-arid conditions lay great emphasis on time-of-planting as a critical factor. The reasons seem obvious: if the crop is sown late it will have a shorter growing season and yield less, if it is sown early it risks failure early on, before the rainy season really starts. In Darfur there are other factors as well, most notably pests. However, it requires but a brief acquaintance with the difficulties of crop establishment to realise that it is futile to advise Darfuri farmers to concentrate on time-of-planting; they know the effect of planting late or early but they also know that the pattern of rainfall is so variable that their only sensible strategy is to plant

after every effective rain, early or late. An early planting may be lucky and produce a very good crop. If it fails, both the seed and the effort needed to replant it are relatively cheap, so not much is lost.

The whole strategy depends on flexibility. This has important implications for agricultural development. It means, for example, that advice on things like time-of-planting is more or less useless and that telling farmers to shift to shorter season varieties may help them to survive a dry year only at the cost of losing the benefits of a good one. It would be far more useful to offer a choice of techniques and varieties so that they can choose their strategy season by season, indeed day by day during the planting period. This is the only way they can keep the considerable risks they face to a minimum.

As soon as the struggle to get their grain crop established is over, or even while it is still going on, farmers have to start weeding. The first weeding is called Hash Murr, literally the bitter weeding, presumably in recognition of the fact that it is the hardest job in the farm calendar.

The weeding tool marks the difference between goz agriculture and wadi agriculture. In the south/east, goz area the weeders use a long-handled push hoe, called a hashshashah or jarrayah. In the north/west they use a short-handled digging hoe called a tawriyah. Weeding is slower work bent over with the tawriyah but it is impossible to use the hashshashah on the wetter, heavier soils where the weeds are also more strongly rooted.

The second weeding is carried out with the same tools and in the same way as the first but it is not so arduous and it may be spread over several visits until the crop is high enough for it to crowd out the weeds. The major working period of the farming season then ends. There follows a fairly long slack period until the harvest.

Threshing is done using a wooden flail on an earth floor. Threshing is one of the jobs for which it is most frequent to hire labourers who are paid in kind. In the WSDC area in 1983 this was usually two <u>malwah</u> measures per 30 <u>malwah</u> sack of grain threshed: about seven per cent. The threshers usually come from the areas which have not have a good harvest and they travel around seeking the work. Naturally enough it is the people from the drier North who most often have to seek to supplement their grain in this way and the Zaghawa tribe, especially their women, are noted for their role in threshing. Despite the fact that the degree of social 'tightness' in Darfur is utterly different from that in South-East Asia, quite similar work-sharing arrangements exist at harvest time. The fact that the work is shared across ethnic boundaries to migrant workers raises considerable questions about Hayami and Kikuchi's interpretation of these arrangements as part of multi-faceted inter-personal relationships. (Hayami & Kikuchi, 1981)

Figure 4.2 shows a household labour profile in the lowland areas of the JMRDP area in 1988, which illustrates the pattern of activity. The critical importance of the two weeding jobs, murr and jankab, is clear. They take over 40 percent of all mandays. Because they have to be completed in a relatively short period for all crops, labour requirement is sharply peaked.

Between 60 and 80 per cent of the cropped area is devoted to grain and by far the greater part of the household's labour effort is spent on the millet and sorghum. The only other crop that takes any significant share of the work is groundnuts, which is grown using the same tools but with some changes in method. The ground is cultivated before planting, not after, and it takes longer to sow groundnuts. It took a two-man sowing team longer to plant the 1982 household's average of just under one hectare of groundnuts than its three hectares of millet. (WSDC, FS83)

Figure 4.2 JMRP Labour Profile



Because the hoeing is done first and because the sowing is harder work, the effort required at the early part of the groundnut season is higher and more concentrated than it is for the grain crops. The amount of seed used is also greater and correspondingly more expensive. For these reasons, groundnut is a riskier crop; in the sense that a greater investment has to be made early on. On the other hand, the variety that is grown in all parts of the region, Barbeton, takes only 90 or 100 days to maturity and this means that the crop can be planted quite late, when the rains are well established, and still be harvested before the grain harvest starts. Groundnuts are also generally free from major pests. On balance, therefore, it is probably no more technically risky than grains.

The major effort put into groundnuts, cultivating and planting, comes at exactly the same time as the peak effort on the hash murr for the grains. The obvious question is: why do farmers not delay planting the groundnuts in order to spread the work out somewhat? As for most other things about Darfur cropping the answer is weeds. Because the weeds are so aggressive they have to be dealt with early. Otherwise they can quickly create a vegetation so dense that it becomes more or less impossible to clear them by hand. This means that even though it might be possible to delay planting the groundnuts it would not change the fact that all the weeding has be done at the same time, whether it is for the grain crop which has already been planted or for the groundnuts which will be planted after weeding. This is why farmers use the same term, hash murr, for the weeding they do after planting their grain as for the the weeding they do before planting their groundnuts: it is the same operation done at the same time.

The techniques described above are used over almost all of the Darfur lowlands. There is one important area which is quite different, the upper slopes of Jebel Marra in Golo, Rokirroh and Suni rural councils of S. Darfur. The volcanic soils of this area are fertile but quite easy to cultivate. Temperatures are also lower. This means that, although millet remains the dominant crop, tomatoes, potatoes and, to a lesser extent, wheat are grown instead of groundnuts, sorghum and okra. More importantly, farmers commonly grow more than one crop. In 1987, for example, virtually every household surveyed in Golo and Rokirroh district grew a substantial area of tomato as well as the millet. The two crops are also commonly grown as a mix. (JMRDP, WS87)

The critical difference in technique lies in the fact that all Jebel fields are hoed before the seed is sown and the sowing itself is done by broadcasting the seed and then raking it in, rather than by planting it into spaced holes. Jebel crops are also sown before the start of the rain whereas dry sowing (ar <u>rimayl</u>) is not common on the lowland. The result of these differences is that the labour needed per hectare on the Jebel is much higher than on the lowlands but that the work is spread out much more evenly over a longer cropping season.

With land still relatively widely available, labour is the critical constraint preventing an increase in production. Survey results on labour requirements tend to be highly variable and the best that can be done is to present some estimates for millet adjusted to match the figures to some non-existent average year. These estimates only cover the five main operations: sowing, first weeding, second weeding, harvesting and threshing:

Goz	Basement Wadis	Upper Jebel	
Sowing	5	14	40
Hash Murr	20	40	60
Jankab	15	30	40
Harvest	15	20	33
Thresh	6	15	15
Total	61	119	188
	Sources: WSDC, FS	83. IMRDP WS	87 & WS88

Mandays per Hectare

The figures do illustrate the critical differences between the three cropping areas: the light easily worked goz, the heavier wadi lands and the volcanic soils of the Jebel Marra itself.

Yield estimates also have to be treated with a great deal of caution. Various methods of estimation have been tried but none have proved particularly satisfactory. The farmers' own estimates have usually been as good as any and the results shown here are all based on figures reported by respondents to farmer surveys. The longest series of comparable surveys is that carried out by the Jebel Marra project between 1984 and 1987. The results for both major and some minor crops in the western districts of South Darfur are shown in Figure 4.4, along with the rainfall at Zalingei in Figure 4.5. They illustrate the close relation between rainfall and yield and also the fact that the difference in yield between millet and sorghum can be quite small.





The average yield of the three main crops for 1981 and 1982, taken from earlier surveys in the WSDC area, are shown in the figure for comparison and to make one very important point: that yields on the lighter goz soils of the south/east area are not very much below those on the better soils of the wadis. Given that the labour requirement on the goz is very considerably less, goz farming is likely to be particularly profitable.

The importance of storage was discussed in Chapter 3. In the alluvial areas of the north/west, grain is traditionally stored in large clay pots, dabangas. In modern times, hessian sacks became popular for storage and a 1983 survey found 76% storing in sacks. (JMRDP, Crop Protection Report 1983) After the good harvest in 1988 many farmers were building new dabangas because they could not get sacks. In the same area that year, 62% of stocks were in dabangas; another illustration of how economic compression drives people back to older techniques. (JMRDP, PR89)

If the very harshness of the Darfur environment means that the weeds are fast-growing and aggressive, the same is just as true for pests, if not more so. The migratory desert



locust does occur and can be very damaging but it is the more local pests such as the african army worm, millet head-worm (Ar <u>nafaasha</u>) and, above all, grasshoppers that cause more persistent and damaging problems.

Pest populations are highly variable and the main influence is climate. Good conditions at the breeding time for a particular pest can generate a plague very rapidly, something that must not be forgotten when planning ways to control pests. The temptation to put extra resources into combatting a pest that caused serious damage in the previous year is strong. The risk is, however, that it will not be so serious again but that another different pest will have its turn.

The millet head-worm, in fact a caterpillar, is a case in point. Reportedly, its significance as an important economic pest is new, not just in Darfur but in the Sahel and Sudan zones as a whole. It first appeared after the drought of 1972 and its effect to be related to the lack of rain. In wetter years nafaasha does not cause farmers much concern. Naturally a pest which does most of its damage during drought periods must be especially worrying but this should not obscure the fact that pests that are at their worst in wetter seasons may do just as much, if not more economic damage.

Vegetation harbours pests. At risk of caricature, it is possible to say that while the westerner now sees a tree as an asset, a thing of beauty and a piece of the environment to be protected, the Darfuri farmer sees it as a source of birds and all the other pests that threaten his crop. This affects the way new crop land is developed. A lone farmer who tries to establish a small plot in an area of virgin bush risks being wiped out by pests. For successful settlement in new areas, it is essential for quite a large group to work together so that they can drive the bush back far enough to keep down the level of pests they all face. Proposed new cropping patterns which involve tree and crop combinations, either alley-cropping or tree/crop rotations, face serious problems for the same reasons,

There is relatively little data on pests. JMRDP surveys indicate that they are a very considerable factor. In 1989, for example, 72 percent of all millet plots and 62 percent of sorghum plots were infested with grasshoppers, a major factor behind the extensive replanting that had to be done. (JMRDP, PR89) An illustration of the way each year brings a different pest was the fact that in 1988, a wet season compared to most of the 1980s but only average in the long-term, only ten percent of millet plots were affected by nafaasha. Table 4.3 shows more detailed information on the impact of pests in the JMRDP area in 1987, a relatively dry year. While the data shows that pests can be a major factor, it also illustrates how complex the relationships can be.

The effect of armyworm on the grain crops was large and statistically significant. Yields were nearly halved. Surprisingly, however, groundnut yields were significantly higher with armyworm than without, as were millet yields with nafaasha. The fact that these results do not show a yield effect or show a contradictory one reflects the influence of other factors. It is possible, for example, that early sown millet will mature at the peak of nafaasha but it is more likely to yield well because it was sown early so the damage done by the pest is hidden.

Table 4.3 Effect of Pests on Yield

		Sorghum			Millet		Gr	oundnuts	
	n	Kg/Mk	Sd	n	Kg/Mk	Sd	n	Kg/Mk	Sd
With Armyworm	332	138.58	198.83	1016	176.76	229.23	69	556.17	446.17
Without	231	298.57	316.62	569	246.67	268.67	505	387.80	551.36
With GrassH'r	332	221.59	263.96	969	194.32	230.66	21	491.48	784.64
Without	231	179.26	256.77	616	213.71	268.34	553	404.87	531.32
With Nafaasha	-			255	240.03	243.01	-		
Without	-			1330	194.54	245.80			
					S	ource:JMI	RDP, PH88	3	

The germination period is critical and both armyworm and grasshoppers can be particularly damaging at that stage. Even if they do not reduce yield they may force farmers to replant. There was a measurable relation between the incidence of these pests and the number of times a crop was sown. The differences for the main crops were as follows:

	Av Times Sown	SD	Significance Level
SORGHUM			0
With Armyworm	2.67	1.27	90%
Without	2.48	1.10	
With G'Hopper	2.72	1.13	99%
Without	2.41	1.14	
MILLET			
With Armyworm	2.60	1.13	99%
Without	2.32	1.06	
With G'Hopper	2.62	1.08	99%
Without	2.31	1.12	
<u>GROUNDNUT</u>			
With Armyworm	1.71	0.81	90%
Without	1.51	0.80	
With G'Hopper	1.76	0.94	NS
Without	1.52	0.78	
	Source: JMRDP, 1	PH88	

In almost all cases the presence of armyworm or grasshopper caused a significant increase in the average number of times a crop had to be sown although the absolute difference was small.

With the exception of seed-dressing, the use of pesticides in the project area is not widespread. Less than 3% of plots received pesticide of any kind during the year of the JMRDP survey. Given the high incidence of pests and farmers' high assessment of the damage done, the fact that they rarely use pesticides is a major example of the supply constraint in Darfur. It is not because they do not want to but because they cannot get them.

The parasitic weed Striga should be mentioned. It is common on millet fields, especially on the lighter soils. In the worst cases, 40 per cent of millet fields can have a striga infestation. (WSDC, FS84) It is difficult, however, to establish the extent to which striga is the result of poor rains, low soil fertility or mono-cropping, let alone assess the economic damage or suggest economic ways to deal with it. If anything Striga has received rather more research attention than the insect pests. This seems to be at least in part because it is an unsolved technical question and hence of greater academic interest. Striga is a largely unsolved problem even in the USA. Termites is another pest which seems relatively unimportant in Darfur but which receives attention because it has become a focus of international research. Both of these are minor examples of the way aid research priorities can become 'centralised'.

Studies of drought affected areas frequently focus on the question of variety. What the farmers need, it is suggested, is a better adapted variety: shorter season, more drought resistant and so on. Naturally enough this leads to plans for accelerated research and even breeding programmes. The success of variety-led green revolution technologies elsewhere seem to add weight to these prescriptions. This risks three mistakes. First, it does not take account of the practical difficulties of breed improvement and even simpler tasks such as selection under the

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adverse conditions of the area. There are so many causes of crop failure that research can be a slow and very frustrating business. It is doubtful whether such a thing as an accelerated programme is possible anyway. Second, the idea that there is one set of varietal characteristics that can solve the region's problems is false. Quite apart from the major divides between north/west and south/east, between wadi land and goz and so on, there is wide local variation over short distances. The differences between the circumstances and wishes of one farmer and the next and between what the same farmer may want one year and what he wants the next are even more important. It is not one variety that is needed but a range from which the farmers may choose according to their needs. Third, the green revolution may have been variety-led but it was based on a package involving higher inputs of both water and fertiliser, usually applied to relatively good soils. It is not at all clear that varietal research without these complementary inputs will lead to any great successes.

Taste is another important factor. It is easy to forget, when the agenda is largely set by a perceived need for food security in a drought-stricken area, that consumers have strong preferences over what is, after all, the very core of their diet. Any westerner who has eaten millet or sorghum will quickly learn why. There are few things less palatable than dry bread made of red sorghum flour while white sorghum bread and white sorghum porridge can be very satisfying. As income rises in rural areas of developing countries, one of the major changes may be shift away from the least palatable sorghums and millets towards the more acceptable ones, even at the cost of some loss in yield. These changes are ignored in measurements of development but they can be very important to the consumer. The virtual disappearance of the staple red sorghum in the Yemen is an example. Research would be needed to prove this point. Even for taste, however, one variety may not be enough. There are two classes of sorghum in Darfur; whiter types are preferred for food but the darker, feterita types are still grown for beer making.

Threshing and milling characteristics are another factor. Some sorghums reportedly have to be milled twice in the standard diesel hammer mill before an acceptable flour is produced. Lastly, millet straw is used for hut building and so on while the sweeter sorghum straws are good livestock fodder. On the other hand sweet-stemmed varieties attract pests, especially monkeys (and small boys).

It is difficult to judge how sensitive farmers are to variety. Farmers have names for many types of millet and sorghum, the two grain crops, and many of them can describe the characteristics of those types. Surveys show reasonably strong evidence of the use of different varieties in different areas and on different soils. (JMRDP, PH88) On the other hand, some of the names are used so widely that they may only indicate broad similarity in one respect, not a specific variety. The word bayouda, for example, implies whiteness and it is used of millets grown in areas as different as the slopes of Jebel Marra and the Goz Dango, 200 miles southeast and with very different soils. Moreover, a lot of farmers do not always give a name for the variety they grow. They may just call it 'baladi', or local. It should be stressed that this proves nothing about farmers' willingness to take up new varieties. Instead it demonstrates the lack of convincing new varieties that can show a tangible improvement on what they already have. The successes of groundnuts and some new sorghum varieties show that uptake can be rapid where a new crop or variety does show such an improvement.

One survey is summarised in Table 4.4. "For the main crops, sorghum, millet and groundnuts farmers appeared to have a good knowledge of the particular varieties used. For the other crops a large proportion was merely described as 'local' (or 'baladi')." (JMRDP, PH88)

Table 4.4	4.4 MAIN CROP VARIETIES - JMRDP AREA				
Va	ariety	% of total	Important Rural Councils		
<u>SC</u>	DRGHUM		-		
Fa	sikh	37	Zalingei (70%),Zami Baya (40%),		
			Azum (38%)		
Da	abar	19	Garsila (32%), Mukjar (34%)		
Za	arazira	7	Mukjar (39%)		
Q	adam El Hamam	5	Mostly Garsila		
G	andori	3	Mostly Azum		
Lo	ocal unspecified	18			
M	ILLET				
Da	armasa	36	Nyertete (45%), Zalingei (53%),		
			Garsila (44%), Zami Baya (65%),		
			Azum (49%)		
Ba	iyoudah	19	Nyertete (26%), Azum (23%),		
			Mukjar (51%)		
Di	imbi	14	Golo (67%), Rokirroh (61%)		
Lo	ocal unspecified	24			
G	ROUNDNUTS				
Ba	arberton	49	Mukjar (70%), ZamiBaya (66%),		
			Garsila (65%), Azum (51%)		
Ta	ijarub	16	ZamiBaya (23%), Azum (21%),		
			Garsila (20%)		
To	oskary	6	Zalingei (18%)		
Lo	ocal unspecified	24			
	-		Source: JMRDP, PH88		

The data illustrates a number of points:

- Fasikh sorghume is the traditional long season variety. The fact that it was twice as common as the next variety in a relatively dry year like 1987 underlines the point made earlier, that over-emphasis on short-period drought resistant varieties is a serious error. An improved long-period variety would be attractive to more farmers. The same is true for millet. The most popular millet, Darmasa, is also a relatively long-period variety.
- Dabar sorghum is relatively new. The fact that it was grown on 30% of the sorghum plots in areas where it is popular shows how rapidly farmers will take up a new variety. Small quantities of Dabar were introduced as early as 1976 but wider distribution only began under the JMRDP in 1982. It took only five years to become the second most important variety in the JMRDP area.
- Different varieties were important in different areas. Fasikh sorghum is found along the line of the major wadi while Dabar and Zarazira are more common in basement areas to the south and east. Dimbi millet is specific to the higher parts of Jebel Marra and so on.

The major goal of variety-led research is to raise yields. An analysis of sorghum yields (Table 4.5) illustrates some of the complications.

Variety	Av.Yield		Sample	Significance
	kg/mk	se	n	Level
Gandori	328	95.7	19	-
Fasikh	296	20.6	207	ns
Zarezira	128	19.2	39	99%
Dabar	83	13.5	106	90%
<u>Gadam ElH</u>	50	13.5	32	ns

Table 4.5 The Effect of Variety on Sorghum Yields

Note: The significance test compares the difference between a variety and the one immediately above it.

Source: JMRDP, PH88

Despite the fact that shorter season varieties like Dabar should do better in a dry year like 1987, it performed very poorly compared with Fasikh. So why has Dabar spread so rapidly and become so popular. The explanation is that the two crops are grown on different classes of land. 81% of Fasikh was grown on 'teen' soils and 86% on flooded land, which would be expected to do best in a dry year. Dabar was grown on a wider range of soils, including 12% on 'goz'. Only 42% was on 'teen' and 48% on flooded land. When selecting Dabar for distribution, JMRDP expected it to be suited to drier, more marginal lands. And so it is. On such lands, there always be a risk of poor yield and absolute yield is a correspondingly poor indicator of the value of a variety.

This emphasises one key point: that varieties and, indeed, all agricultural technologies are highly location specific and even field specific. The only way forward is to offer as wide as possible a range of technologies so that farmers can select the best for their own particular requirement. This may be contrasted with the hope that research will, one day, identify a blockbuster new variety that will lead to an agricultural take-off. To some extent the green revolution rice variety, IRRI-8, was such a blockbuster but the Darfur situation is very different.

Variety is also a factor for the dominant irrigated crop, onions. Taste and storage qualities are critical. There are two important varieties: Furia and Kosti. From the names it seems that Furia is the 'traditional' variety while Kosti has been more recently introduced, taking its name from the city of Kosti on the White Nile. Another variety is called Fellatiya, indicating a West African origin and showing how Darfur draws on all sides of Africa for its technologies. Barbari sorghum is another West African variety grown with its own special technique. By preparing seedlings in a seed-bed and transplanting them into deep holes in low-lying clay soils after the end of the rains, a successful winter crop can be grown without any irrigation. Residual moisture is enough.

CONCLUSION

This analysis of farming strategies provides background for the next chapter. It also makes one central point; that Darfuri farmers are unmatched at handling the difficulties of their environment. Thanks largely to Farming System Research techniques the same conclusion has been reached in most other parts of Africa and the strengths of Rural Peoples' Knowledge has come to be widely recognised. The first of Schultz' propositions, that penny capitalism is allocationally efficient seems well supported in Darfur. The second proposition, that penny capitalism finds it difficult to acquire new technologies unaided seems more problematic and that is what the next chapter attempts to address.

5. SMOTHERED RESEARCH

Despite considerable research efforts, progress in Africa has been deeply disappointing. Various reasons have been put forward. That "off-the-shelf' technology was frequently a failure", "often farmers lacked the labour, capital or land necessary" and "Farmers adapted slowly to using modern inputs and equipment. Chemicals for plant protection were not widely understood. High-yielding seed performed no better if not correctly grown." These statements point towards more research not less, in effect supporting the 'not amenable to transfer' thesis. "A new effort to harness agricultural technology to the needs of African farmers is now required". Particular emphasis is laid on proper 'adaptation': for example, "new varieties must be widely tested on-farm to make sure they perform." (World Bank, 1989) In essence, therefore, Schultz's policy prescription of 1964 is unchanged for the 1990s.

There has, however, been one development and that is the increasing recognition of the strengths of what is termed Rural Peoples' Knowledge. "It took organised agricultural research decades to realise that what appeared primitive and unprogressive was complex and sophisticated." (Chambers, 1983) It is even now recognised that traditional farmers are active experimenters and innovators, "people who seek to optimise their advantage through careful strategies and deliberate action." It is even suggested that far from being driven into their traditional shells by their difficult circumstances, "farmers' experiments increase in number and complexity after crises." (Reijntes et al, 1992) This comes close to Liebenstein's concept of research as a defensive response to market pressure. At the same time it casts serious doubts on Schultz' view of a traditional agriculture that finds it difficult to adapt new technologies.

The repeated disasters of the 1980s have led to an emphasis on famine and food security in research strategies: "more attention must be given to developing the rainfed sector." (Bright in Maxwell, ITDG famine book, 1991) This is not new either, dating back at least to the early 1980s, when it went under the banner of help to the 'poorest of the poor'. A more economic justification for the same emphasis sector comes from the fact that the rainfed sector uses very few imported inputs and is correspondingly valuable in cost-benefit analysis terms. All these arguments confuse the desired outcome - more food, help to the poor or greater net foreign exchange benefits according to taste - with potential.

In Chapter Two it was suggested that Boserup offered an alternative to Schultz, that new agricultural technologies would only be adopted when the time was ripe and when the man:land ratio reached the right level. Land in Darfur remains relatively abundant, a point that will be developed later, making Boserup's argument particularly relevant.

There is a divide between the approach with which the research community is happiest and the needs of farmers in land abundant areas. Western researchers, and African researchers trained in western methods, are most concerned with land saving techniques. That is to say with technologies that will raise yields and maintain the value of the land. On the other hand, most African farmers are interested in only one thing: the return to their labour. Yields per hectare of land are secondary.

One reason western research is biassed towards land-saving technology is simply that there is nowhere in the modern western world that is land rich, in the sense that there remain no more reserves of land that can be brought into cultivation for no cost other than the effort of clearing it. A second is that the same is true for that part of the third world, Asia, where aid has had its greatest success, the green revolution. A third lies in the distortions of agricultural policy in all the major developed economies, east and west, where subsidies and quotas reward farmers for raising yield. A fourth springs from the power of the myth of the agricultural revolution in Europe. Every English schoolboy, for example, knows the name of Turnip Townshend, the man who was credited with the introduction of fertility conserving rotations. Few of them go on to learn that the turnip was, in fact, a regular field crop in Suffolk as early as the mid-17th century, a century before Townshend, that "the rise in grain output (in the 18th century) is believed to be due more to the increase in sown acreage than to improvement in yields" or that it was the "generally rising level of prices between about 1760 and 1813 which encouraged and largely brought about the great increase in cultivated acreage and the more widespread adoption of better methods." (Chambers & Mingay, 1978) The fifth and last reason is the recent revolution in attitudes to environmental matters in the first world. This has added considerable new force to the concern for soil and moisture conservation and for sustainable agriculture generally.

There is a second and more pressing reason for the failure of western technology to advance in Darfur, which is that it is simply not available. The problem is not that 'off-the-shelf' technology does not work but rather that the shelf itself is bare. There are two reasons for this. The first is the acute shortage of foreign exchange, which means that virtually no imports beyond the basic essentials are licensed. Merchants have neither the incentive nor the possibility of importing an unproven piece of agricultural equipment, for example, to see whether it might find a market. To put this in Schultz' terms, if the costs of entry to the market for agricultural factors are high this is

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a macro-economic phenomenon and nothing to do with the special characteristics of 'penny capitalism'. The second lies in the inheritance of the colonial 'nanny' tendency which places strict controls on the imports of new technologies. In earlier years the paternalistic justification was that African farmers were too simple to be allowed to try new technologies. They might get it wrong or they might be exploited by the traders supplying the technologies and buying the produce. Unfortunately the twin obsessions of the modern first-world, health and the environment, have provided a new justification for the old attitude. The fear now is that farmers will mishandle chemicals, putting themselves or the environment at risk. Schultz himself admits that bureaucratic/political obstacles of this kind even occured in one of the classic success stories of research, hybrid maize, which was not released to private firms in the southeast USA quickly. (Schultz, 1964)

Without questioning the need for strict controls on the truly dangerous chemicals, it should be recognised that current licensing systems in Africa place little or no control on the use of chemicals, once they have been 'approved'. Instead they place considerable barriers in the way of approval for harmless items such as seed or fertiliser, merely because they have not been subjected to exhaustive tests by the appropriate authorities. Veterinary drugs in Sudan are an extreme example. They remain under the control of the Ministry of Animal Resources and are very difficult to obtain, whereas human drugs that would be on prescription in Europe are freely available.

In Darfur the result is that agricultural development projects such as the Western Savannah Development Corporation and the Jebel Marra Rural Development Project, which are supposed to concentrate on adaptive research and extension, spend a considerable amount of time and lose even more in trying to overcome financial and bureaucratic barriers, merely to ensure inadequate supplies of inputs that are well tried and tested but which only foreign financed projects can hope to import.

There is a third, overriding reason for the failure of western technology: the choking of markets for Darfur crops and of the supply of consumer goods, the economic compression already described. Darfur agriculture has shown spectacular growth using relatively few new technologies when the market was right; right in the sense that it offered consumer goods that farmers want, in exchange for the effort they must put in to raise production, and attractive prices for their extra produce. That growth has now been stifled and it is useless to expect farmers to take up new technologies when they cannot even fully exploit the ones they already have.

THREE ALTERNATIVES

Possible strategies for agricultural development may be divided into three. The first of these, summed up under the title 'Existing Resource Levels, Existing Resource Use Patterns', depends on the proposition that "the application of a little science can provide solutions that have eluded thousands of farmers over many generations and that the major contributor to inefficiency in resource use is lack of knowledge." (Harvey, 1986) The recognition of the strengths of Rural Peoples' Knowledge mean that this position is no longer widely advocated. Nevertheless it is still implicit in some aspects of development programmes; those that urge farmers to pay more attention to time of planting, for example.

The second possible strategy is 'Existing Resource Levels, Modified Resource Use Patterns'. An example of this would be the introduction of a fertility conserving legume crop in rotation with the existing grain crops. Other examples, include closer integration of livestock and crops and alleycropping of tree crops and field crops. There is some evidence that such practices would raise yields in Darfur but one overwhelming piece of evidence that they could not raise yields *by enough*. That is the existing cropping pattern. Grain crops currently occupy around 80 percent of the cropped land. If, in order to raise grain yields, it were necessary to rotate the crops, say by one year grain to one year legume, then those yields would have to rise by two thirds to maintain grain supplies. Quite simply, it is not plausible that the farmers of Darfur would not have noticed and taken advantage of yield gains of this order, if they were obtainable. This problem is particularly acute with agroforestry, where the rotation is bound to be long and the ratio of grain to non-grain correspondingly low: at the lowest one to two and more likely as high as one to five, compared to one to one in the example.

Once again the English Agricultural Revolution is a relevant example. Then, the driving force behind the introduction of rotations of grain and fodder crops was at least as much to meet growing urban demand for meat, dairy products and wool as it was to raise grain yields. (Chambers & Mingay, 1978) In other words, rotations were a response to a market demand for the rotated crop, not to a need for greater supplies of the grain crop.

The last of the three possibilities is titled '<u>Improved Resource Levels</u>, <u>Existing Resource Use Patterns</u>'. This strategy depends on the use of imported agricultural equipment and inputs. However counterintuitive it may seem for a poor region like Darfur in a poor country like Sudan it is, effectively, the only possibility. All other

approaches depend, to a greater or lesser extent, on the assumption of a degree of ignorance or even incompetence on the part of the Darfur farmer, in the sense that they rely on research discovering potential that the farmer has overlooked. The very small achievements of research in Sudan, and in Africa generally make that seem extremely unlikely. In fact one of the few solid achievements is a wealth of evidence that the farmers of Africa have overlooked very little.

Harvey's position may be summed up in Schultz's words: "Another implication is that an outside expert, however skilled he may be in farm management, will not discover any major inefficiency in the allocation of factors," and Harvey is precisely that kind of outside expert having worked on research Darfur for many years. (Schultz, 1964) The fact that he was forced to re-iterate these conclusion some twenty years after Schultz was writing is a measure of the resistance put up against realistic conclusions.

If it is correct that an agricultural transformation cannot be expected until the national economy returns to some form of stability and if such a transformation depends on imported inputs, which are likely to remain unobtainable until that stability is achieved, research is going to be largely academic. At best, it may develop new techniques which are not useful now but which will become applicable when the new day dawns. At worst, it will pursue concerns that reflect the current instability and not the true potential of the area.

The quality of the research itself can also be difficult to judge, if it has to be carried out in a limbo between an existing, highly constrained situation, in which no real development is possible, and a situation of unknowable future potential, when the wider problems have been solved. In effect research may be divided into two types: reactive and anticipatory. Reactive research concentrates on solving problems that the existing situation has thrown up, in line with Liebenstein's finding that two thirds of commercial research done in the USA was for defensive purposes, as a reaction to commercial pressure. (Liebenstein, 1966) Anticipatory research depends on an ability to forecast what the future problems are likely to be. Although reactive research sounds less positive, it is likely to be much more fruitful and cost effective because the results can be put to immediate use, tested and amended to meet changing circumstances as they arise. Despite the modern emphasis on farmer participation and farming systems research, a great deal of agricultural research in Africa is anticipatory; anticipatory in the sense that it focusses on issues such as conservation, which may become important later but which are certainly not important in farmers' eyes at present, and anticipatory in the sense that it depends on some future economic rehabilitation at the national level before it can be applied.

Similar problems may be seen in rural peoples' own knowledge. Because that knowledge embodies a vast amount of experience it will include much that is not applicable at any one time. Western researchers who are, for example, concerned about environmental matters will certainly find local informants who can describe in detail the factors that cause environmental damage and who will agree wholeheartedly with the outsiders' concerns about erosion and so on. <u>This does not mean that this knowledge is applicable at the time of speaking</u>. In Darfur, for example, farmers will generally acknowledge the value of trees like Haraz, Acacia Albida, which provide fodder, shade and, possibly, maintain soil fertility. The fact is, however, that they do not conserve the Haraz. They certainly do not plant the tree. When taking fodder off it they treat it extremely roughly and the number of trees which are 'accidentally' fired at their base, so as to kill them, is greater than coincidence can really explain. There is a strong modern tendency to attribute farmers' reluctance to pay more attention to conservation to population pressure, to drought and, especially, to the evil effects of modern, capitalist economic pressures. In answer to that it may be stressed that as early as 1958 there was a "total lack of the younger class of (Haraz) trees in those areas which are heavily farmed." (HTS, 1958)

Chambers quotes two anecdotes to illustrate the value of rural peoples' knowledge and the fact that 'professionals' ignore it. One concerns the Mukau tree in Kenya, the seeds of which can only be germinated after they have passed through the stomach of a goat and another about the winged bean in the Philippines. (Chambers, 1983) What he does not show is how this knowledge is of the slightest use in research or development terms, given that neither the tree or the bean are more than marginal crops. If there is one way that expatriate scientists are most successful at enraging their national counterparts it is by the elevation of these relatively trivial items of rural peoples' knowledge in a way that simultaneously devalues the counterparts' own status and tells them something of little or no importance. To sum up, it is rural peoples' knowledge in action that matters: what they do and not what they say. <u>Pace</u> Chambers and many others, this can only be seen by measuring what they do with properly designed surveys, combined with adequate time to gain the experience and insight needed to interpret the surveys.

Research in Darfur can be summed up under four headings: soil fertility, varieties and new crops, crop protection and cultivation. The first three are areas in which research is aimed at land-saving yield improvements, at intensification, whereas research on ploughing and other cultivation techniques is principally aimed at labour saving and an extension of area. Irrigation, which is primarily a land saving technique, is considered separately.

The wider issues of environmental conservation are also discussed separately in the next chapter although there is a degree of overlap with what follows.

SOIL FERTILITY

In Darfur, the largest single cropped area is on the least fertile soils, the goz sands of the south/east section of the region. (Zone 11 in Table 1.1) The Western Savannah Development Corporation has been carrying out trials on these soils since 1976. Because of this and because the issues are most clear cut on these soils, this discussion concentrates on the question of goz fertility. It makes a fascinating case study. Particularly so because the "Qoz land system is, of itself, a tough developmental assignment. The natural resources of the Qoz environment, at least in terms of soils, climate and crops, are not the stuff of which Green Revolutions are achieved." (Quin, 1989)

In Sudanese Arabic the word goz means no more than 'sand' but it is also used as a title for the extensive sand-sheets of Kordofan and Darfur. By origin these are wind-blown, aeolian sands produced by erosion from basement rocks and deposited at a much drier period. Nowadays, in their natural state and at current levels of rainfall, they support a bush or woodland savannah with sparse grasses under the trees. They are easy to clear and farm, which means that goz cropping is profitable even at low yields. The following comparisons with standard levels of soil status illustrate just how infertile the goz is:

FERTILITY STATUS OF QOZ SOILS					
Southern Darfur					
	Topsoil	Subsoil			
Acidity	Weakly Acid	Moderately Acid			
Cation Exchange Capacity	Very Low	Low			
Exchange Calcium	Very Low	Low			
Magnesium	Low	Low			
Potassium	Low	Low			
Phosphorous	Deficient	Deficient			
Zinc	Deficient	Deficient			
Boron	Deficient	Deficient			
Manganese	Intermediate	Intermediate			
Copper	Adequate	Adequate			

Sources: HTS, 1974 and HTS, 1976

One might, naively, expect that all that would be required to raise yields substantially on such poor soils would be to add the missing nutrients, plus nitrogen which is always necessary. This might not be economically feasible but technically it should, surely, work. Unfortunately it is not that simple. Relationships between soil, water and crops are extremely complex. On the goz they are still not fully understood but some basic facts are now clear.

The interaction of soil and water is crucial. On a light, sandy soil rainwater drains away very quickly and it might be expected that crops would be particularly vulnerable to drought as a result. There are three reasons why this is not necessarily so. First, although the water drains quickly, it also penetrates the soil fast and to a considerable depth. On heavier soils, which are less permeable, much of the rain may disappear as runoff or evaporation. Second, the crop's roots can make their way through the sand just as easily as the water can, so the crop can reach further. Third, "sand has a smaller maximum water content but most of the water is held at relatively low suction" "The implication is that sand contains a smaller volume of water very readily available but quickly exhausted." (Winter, 1974) The result is that "The ease of cultivation of goz soil and the great depth which is available to water and roots make this intrinsically poor soil into a valuable agricultural asset. Though the nutrient status is low great volumes of soil can be explored by the roots." (Jewitt & Ferguson, 1948)

This combination of highly specific advantages in a harsh environment poses extremely difficult challenges to agricultural research. It is notable, therefore, that the WSDC, when it entered its major implementation phase around 1980, had no top ranking agronomist on staff and agronomy was given a low priority. There was a rationale behind this. The project was based on the premise that social factors, specifically land tenure, were fundamental and that the technical problems were secondary. This is discussed in detail in the next chapter. Here it is enough to stress the conclusion, which is that this whole strategy reversed the true direction of cause and effect. The social framework of Darfur has developed as a response to the specific environmental and economic conditions of the area. They may need to adjust if those conditions change, an adjustment which they are probably quite capable of making, but it is futile to endeavour to bring about a wider economic change by attempting to

impose an adjustment in advance of other developments. Changes in land tenure will not affect the situation if the technology is not available to raise yields substantially and if the economic conditions do not exist to make it worthwhile. The assumption that such a technology existed, or could be found with relatively little effort, was to prove disastrously wrong. In effect, therefore, the project strategy largely assumed that both the Boserup and Social-Boserup mechanisms discussed in Chapter Two were inoperative.

Three approaches to raising yields have been investigated: chemical fertiliser, crop rotations and organic manure. Without going into details about research covering fourteen years, the only positive conclusion has been that phosphate fertiliser, specifically Triple Super Phosphate (TSP), does raise yields; a result that has been matched in other sub-sahelian countries. Relatively low applications, as little as 10 kilogrammes per hectare, raise millet yields in some areas by 40 percent. European farmers might use ten times as much. Research under Darfur conditions is extremely difficult for all kinds of reasons. A lack of positive results cannot be taken as proof that they may not be found in the future. Nevertheless, there is no consistent evidence of a significant yield response to nitrogen fertiliser, to crop rotations or to farmyard manure. Returning, for a moment, to the three alternative strategies which were described above, these conclusions reinforce the belief that the second strategy, attractive as it is, does not work. Both crop rotations and organic manures represent attempts to increase production from 'Existing Resources, Modified Resource Use Patterns'. On the other hand, the fact that imported chemical fertiliser, TSP, does give a response indicates some chance that the third strategy. 'Improved Resources, Existing Resource Use Pattern' might work.

Because the idea of sustainable rotations is so attractive and so deeply rooted in western ideas about how agriculture should be, it is worth underlining some technical facts about how they are supposed to work. The recent fashion for 'organic farming' in the first world makes it all the more important that these techniques are put into their proper perspective. A rotation can only restore fertility if the vegetation, or biomass, produced by the rotation crop is returned to the soil. The nutrients are contained in that vegetation. This may be done directly, by ploughing it in, or indirectly, by grazing cattle over the crop so that it is converted to animal manure that stays on the land. The high temperatures and arid climate of Darfur mean that even if the crop is just left standing, much of it withers and blows away. It does not rot into the soil as it would in Europe. The same happens even to manure in the dry season, when it dries hard and crumbles to dust.

Research into the effects of crop rotation is extraordinarily complicated, since it involves managing trials over several years. WSDC trials have been described as providing "at best confirmation of what local farmers are already aware of, namely that some rotation is better than no rotation for sustaining (albeit at poor levels) the possibility for qoz soils to support millet production." (Quin, 1989)

Fodder crops are the classic example of a rotation that is both profitable and soil-restoring. The profit comes from the animals grazing over the crop while their dung returns nutrients to the soil and restores fertility. For this to work enclosure is critical. It is only with a fence that it can be guaranteed that the animals actually fertilise the field they graze over. (Enclosure was a central component of the English Agricultural Revolution.) In Darfur, the costs of enclosure are high and almost no fields are effectively fenced. Where a crop does have value as fodder, it is harvested and fed to the animals elsewhere. Otherwise the owner would see it quickly grazed off by his neighbours' animals or lose much of its value as it dried out in the field. Besides, the main need is to keep the animals alive through a long dry season. The fodder has to be cut and stacked somewhere safe so it can be rationed out to the stock. For all these reasons, "It is unrealistic to consider that this crop, (cowpea), could ever play any substantial role in restoring soil fertility because when biomass is removed from the land (as fodder), all the soil derived nutrients in that biomass go with it." (Quin, 1989)

The alternative is for the farmer to feed the fodder to his animals away from the field and then collect their manure to bring it back later. Here too the trials results are not encouraging. Even when farmyard manure is collected and physically returned to the land in this way there was "little overall response" in trials on the goz. "While it is very attractive to consider the use of animal manure for crop production in a farming system that contains both crop and livestock components the trials of 1982 to 1985 do not demonstrate that the burden of work that is incurred with manuring actually is worthwhile." (Quin, 1989) This applies <u>a fortiori</u> because the livestock and crop components of Darfur farming systems are not so much integrated as parallel; for much of the time livestock are grazed far away from the crop land. Added to which, because farmers do not cultivate their land considerable additional work would be needed to apply manure and plough it in. Such additional work requires much more than 'little overall response' to justify it.

Manuring is a good example of the problems with rural peoples' knowledge. There is a traditional method of combining crops and livestock called 'diyärat'. In the central areas of South Darfur, farmers on the sandy, athmur ridges used to ask herders to graze their animals over their fields after harvest and, more importantly, to enclose them on the field overnight. "A herd of 30 cows produces enough manure to keep a mokhammas of goz fertile

permanently if they are kept for 18 nights on the field, 3 days on the same campsite, 6 campsites on one mokhammas. This is done after the dukhn has been sown. If such a manure regime is followed the informants claim that buda (striga) does not occur." Payment to the herders was reported to be three ratl of sugar and tea per night. (Haaland Ed, 1980) A number of points arise from this. First, it is only really practical in the alluvium/athmur area (zone 41 in Table 1.1) because the cattle herders pass through it after the harvest anyway, because water is available for the cattle and because there are plenty of thorn trees to make a kraal to keep them on the field. None of this is true on the goz or in many other areas. Second, the cattle do not only graze the field they manure. There would not be enough fodder to keep them for 18 days. There has to be other grazing available nearby. Third, the work involved is considerable, especially in setting up a new kraal every three nights. The result has been that diyärat is rare nowadays, illustrating the point that techniques included in rural peoples' knowledge are not of immediate relevance unless they are common practice.

The reasons for the decline in 'diyarat', if there has been such a decline since we have no evidence how widespread it ever was, may be sought in a number of directions. The most likely seems to be that it dates back to a time when cattle were cheap and grain was not. Such shifts in the balance of the economy have been common. The village of Umm Belut, for example, was established in 1926 by Bani Halba people, a cattle owning tribe, principally because one sack of millet was worth an adult cow. By growing more grain they not only secured their own supplies but also earned the money to build up their own cattle herds again. (WSDC, Visit to Umm Belut 1984) Except at the very height of the 1984/85 famine, the cattle:grain price ratio has never reached this level in more recent years.

What, then, happened to the positive finding, that phosphate fertiliser, which will be inaccurately referred to as TSP from now for brevity, could improve millet yields by up to 40 percent at low rates of application? The answer is that the evidence that it might is quite strong but that it has not been realised so far. TSP was wholly unavailable in Darfur until the mid 1980's, partly for bureaucratic reasons. Research in Sudan has been dominated by the large-scale irrigated sector: dominated not only in the sense that most effort has gone in that direction but also in the way research itself attracted great prestige and was able to give its recommendations something of the force of law. This was quite natural on large irrigation schemes where the cropping cycle is closely controlled and where the state had a major interest in the cost of inputs provided and so on. It has little or no relevance, however, in smallholder rainfed agriculture. Nevertheless, one recommendation was that phosphate was not a required input for the Sudan because the irrigated soils of the Gezira had shown little response to phosphate. The result was that organisations in western Sudan had to direct their research first towards making an adequate case for the approval of TSP and their efforts towards winning that approval and arranging supplies. Even the FAO fertiliser programme in Khartoum had to fight to get licenses to import phosphate and there is a story that in 1983 a donation of shiploads of the fertiliser from Japan were turned away from Port Sudan unloaded because the Ministry of Agriculture would not grant licenses. More important, however, was the fact that Sudan's foreign exchange problems were so great, by the time that the potential of phosphate was recognised, that the only supplies to ever reach Darfur have been aid-financed.

The simplest, quickest and most cost-effective test of the finding that TSP raised yields would have been for adequate quantities to be available so that farmers could do their own tests and make their own adaptations. However, phosphate fertiliser has still not escaped from the grip of the researchers. The range of arguments presented for this has been very wide. First, inevitably, there were the doubts about the whole concept of introducing 'risky and expensive' imported inputs. The fact that only very small amounts are needed to gain a significant yield benefit tended to get ignored. Second, it proved surprisingly difficult to persuade officials to recognise the fact that phosphate was different from a nitrogen fertiliser like urea; different in several ways that meant that the risks involved were much smaller. (This partly reflects the influence of irrigation-dominated research on agricultural training in Sudan). Urea has been available in Sudan for many years and is well understood where TSP is not. Timing is critical with urea. Applied at the wrong time, it can 'burn' a crop or, because it is volatile, just go to waste as it evaporates before the crop is ready to use it. Phosphate is far less sensitive. Even if grossly misapplied it is unlikely to damage a crop and it is not volatile.

A second tendency has been to chase after side issues in attempts to refine the recommendation rather than implement it as it stood. Despite the fact that good results were obtained with TSP, there were suggestions that Rock Phosphate would be more suitable or that acidity and a resulting aluminium toxicity was a problem that could be cured by liming the goz soils.

The third obstacle has been a debate about how TSP should best be applied. This is not a trivial problem for two reasons. First, the major cost to the farmer lies as much in the extra labour to apply the fertiliser as it does in the chemical itself. The labour required depends on how the fertiliser is applied. Second, TSP can affect seed germination if it is in direct contact with the seed, which means that the easiest method of application, by mixing
it with the seed, may reduce plant stand. Once again, the fact that farmers do not cultivate their grain land before planting is critical because the easiest way to apply the fertiliser would be to broadcast it over the ground and then plough or hoe it in. If there is no cultivation, then the fertiliser can only be applied in the same planting hole as the seed or in separate holes or drills.

Besides the effect on germination, putting the fertiliser in the same hole or close to the seed has other complications. An advantage is that the amount of fertiliser needed is kept to a minimum. If the fertiliser is put right by the seed, the dose per plant is high even though the rate per hectare is low. On the other hand phosphate stimulates root growth, which is good but if it is only placed close to the plant the roots may only go where they find the fertiliser; losing that major virtue of the goz, the way the roots can spread far and wide. Third, one of the benefits of phosphate is that it persists in the soil and remains available for crops in subsequent seasons. If, however, the fertiliser is placed in the planting holes in the first year, then the second year's crop will only benefit if the farmer manages to plant the crop in exactly the same place two years running. This is difficult even with two grain crops. If crops are different it becomes impossible because they are planted in different patterns. There is, in effect, a trade-off between the first and third factors. Fertiliser placement by the seed gives maximum economy in the first year but risks losing the residual benefit in the second.

It is interesting, even fascinating, to learn the ins and outs of TSP on the goz. Sadly, it is almost all irrelevant. Because none of these complex interactions detract from the basic finding; that low applications of TSP can produce a significant yield response in the year of application. The research into the other issues appears to have blurred the clarity of that message and it is still not wholly accepted that farmers should be encouraged to try TSP fertiliser. Instead, there is a wish for 'certainty' for an absolute and complete scientific understanding that will justify the research bureaucracy taking on the responsibility of encouraging farmers to try something new.

One experience shows that such certainty is not necessary. In 1985, the EEC distributed TSP throughout Darfur in small quantities on the understanding that its value might not be fully proven but that anything that might assist a recovery from the 1984 drought was worth trying. One area where the fertiliser was taken up enthusiastically was on the terraces of Jebel Marra; that is to say not on the goz at all and in an area where the soils have been assumed to be much more fertile. Little research has been done on the terraces but it is, with hindsight, possible to see why TSP has been successful there; because it is the one area where the fields are cultivated before sowing and where the seed is broadcast before being hoed into the soil. It takes almost no extra effort to broadcast fertiliser as well as seed.

The very earliest trial that indicated a positive phosphate response was in 1948. Indeed the whole history of research in western Sudan seems summed up in that one trial: "Owing to administrative difficulties the sowing was late and the test was further vitiated by attack of pests and birds." (Jewitt & Manton, 1951) A lengthy research process has, in the end, done no more than add refinements to that first finding. The message was quite clear early on and could, in fact, have been predicted as soon as the initial soil surveys were done. It may well be that the current understanding might have been reached more quickly, if the 'administrative difficulties' could have been overcome more often or if better rains and fewer pests had reduced the number of lost trials. However, such a speeding up of the research process would not have added one iota to the impact of TSP. If it has not become established in the goz farming system it is because it has never been widely available and, possibly, because it is still not sufficiently profitable under current circumstances. These are facts that research cannot change. If, however, circumstances had been more propitious it is likely that farmers would, by their own processes of trial and error, have come up with adequate practical solutions to the problems that research has dealt with in such complexity. In other words, if TSP had been viable much of the research would have been unnecessary, despite the fact that our understanding of how TSP and the other nutrients in goz soil act remains very imperfect.

The above discussion has centred around the millet crop on the goz. No other topic has been researched in such detail and it is enough to say that there are no important additions or modifications with regard to the influence of fertility on the other two major crops, sorghum and groundnuts, nor with respect to other areas of the region. It is worth mentioning one other result illustrating the value of a 'rough and ready' approach. Trials on micronutrients, which are also very deficient in goz soils, showed that molybdenum in the form of sodium molybdate could improve groundnut yields. Only tiny amounts are needed: 100 grams per hectare, which is easiest applied as a seed dressing. Rather than pursue further trials to prove beyond doubt how much yields are improved, a simple finding that on "3 occasions out of 4 (significantly so on only one occasion) molybdenum increased kernel yields in the absence of applied Phosphate" is enough to justify the use of the dressing. "Admittedly the case was not absolutely proven. However, on balance (and not least because the innovation is cheap and has proved necessary in other groundnut producing areas in Africa) it was justifiable." (Quin, 1989)

VARIETIES AND NEW CROPS

Better crop varieties can be found through breeding and selection or through introduction from other regions. Introduced varieties need testing for suitability in the area and it may be necessary to develop adaptations to their husbandry but introduction is much quicker.

Breeding is usually considered to be an national or an international task while testing and adaptation are treated regionally, by projects or other agencies. Organisations like the International Centre for Crop Research in the Semi-Arid Tropics (ICRISAT) in India and the International Institute for Tropical Agriculture (IITA) in Nigeria are the summits of this hierarchy. For all of them, the goal is an achievement to match the green revolution of the International Rice Research Institute in the Philippines. Great emphasis is always laid on the need for coordination and feedback between these higher level national and international institutions and the projects that do the local, adaptive research. This coordination is difficult because there is a divergence of interest combined with a severe imbalance in prestige. Adaptive research organisations are often required to carry out complex multivariety trials for the international organisations to provide data for long-term breeding programmes. The return service is much less active. The international organisations do not, for example, offer to send variety material specifically designed for a given area as a matter of course. Because of the differences in prestige and status, local researchers are also hesitant to make their needs clear to the international organisations.

Previously the key role of variety, especially the range of varieties, in dealing with risk and reward was emphasised: avoiding the risk of a bad year and reaping the rewards of a good one. The corollary is that it is important, when judging research results, to consider an individual variety's response to a range of circumstances instead of looking for performance that is 'best of class' in all respects. These ideas are difficult for outsiders and even for national researchers to accept. They go against the most successful research models of the green revolution, which was initially built on only one rice variety, IRRI Number 8, and against the researcher's natural desire for a clearcut conclusion.

Research work in Darfur has concentrated on introduction, with a little selection. Most of the new varieties tested have been supplied by national and international organisations as part of trials designed for their own purposes. To some extent, therefore, varieties that have been tested in Darfur were supplied at random, without consideration of the particular characteristics that the region requires. There have been successes but there has also been a lot of testing of varieties that have little or nothing to offer in Darfur. As already mentioned, drought and famine have led to excessive emphasis drought resistance and shortness in the growing period. This is a perfectly valid research aim but it needs to be balanced by the development of varieties for better soils and wetter years.

Millet cross-pollinates very easily, making it difficult to maintain pure seed. Although this is not the only reason, no millet variety has been identified that does any better than the local ones. Many do considerably worse. There has been limited success with selection in the Jebel Marra area with one local millet variety called Bayouda, success at least in the sense that farmers buy the seed although it is not clear what the advantages are. But the whole point of this argument is that that does not really matter.

Sorghum variety research in the JMRDP area is, probably, the single most successful research intervention in the region. A large number of farmers have bought and grown the improved varieties identified and supplied by the project. The first two varieties to succeed were Dabar and Qadam El Hamam. Compared with other local varieties, these are relatively short-strawed, medium-period sorghums which were developed by the national research authorities, principally through selection from Sudanese varieties. They have been officially released and available in central Sudan for quite a long time and they were originally developed for mechanised farming in eastern Sudan. It has already been mentioned that Dabar was the second most popular variety in the JMRDP area in 1987.

Dabar's limitations illustrate very well the point already made; that the requirement is not for one variety but for a range. Originally, it was expected that it would be a suitable for the drier, more marginal soils of the JMRDP area. It was consequently a good choice for the drought years of the early 1980's. It did much worse in wetter years when it proved significantly vulnerable to fungal blight. Even though it was the second most common variety in 1987, it was sown on only half as many fields as the most common, which was a much longer-strawed, longer-period local variety, or group of varieties, called Fasikh. Because it is sown on more marginal soils, Dabar yields are poor compared to Fasikh: only 160 kilogramme per hectare compared with nearly 600 kilogrammes in

1987. This was a bad year and both yields would be considerably higher in a good one. (JMRDP, PH88) In other

words, Dabar outyields other varieties on the marginal land but any crop on those soils has limited potential compared with the crops grown on the better land, illustrating the dangers of concentrating on relatively good performance in poor conditions to the exclusion of maximum performance in good conditions. Figure 5.1 comparing yields of the two new varieties with local sorghum, predominantly Fasikh, shows that neither of them in fact consistently outvields the local variety. They are, nevertheless, a success and they have been widely accepted by farmers. They may not outperform Fasikh on good land but they do allow sorghum to be grown on land that local varieties could not tolerate. It should be stressed that Dabar and Qadam El Hamam have been successful despite the



fact that they are clearly more rather than less risky, in themselves. They may still reduce risk overall, however, by widening the overall range of crops that can be grown and, probably more importantly, by allowing more to be grown in a good year to build up stocks for a bad one.

A number of even newer sorghum varieties have shown good performance. P967083 (P9) was identified from trials supplied to the project by the national research authorities. It came originally from Purdue University in the USA, indicating the rather random way in which new varieties arrive for testing. Survey results on farmer reactions to the new variety illustrate the complexity of their requirements:

"The main advantages farmers said they had found in P9 were:

entioning
42 %
32 %
25 %
20 %
13 %

Many other advantages were mentioned by a few: good germination, drought resistance, ease of harvesting and threshing, good milling characteristics and good seed characteristics.

- The main disadvantages were:

Proportion Mentioning				
Hard to mill	18 %			
Not drought resistant	12 %			
Poor taste	6 % "			
	(JMRDP, P9 Survey 1990)			

The P9 survey also showed how performance of any variety is highly specific to location:

"The greatest differences in yield were between one extension centre and the next. This was reflected in considerable and statistically significant differences in the degree of satisfaction:

	Percent	Yield	
/ .	Satisfied	SK/ MK	
Mukjar	92.2	7.36	
Garsila	96.3	4.48	
Amballa	43.6	3.74	
Tululu	36.7	3.46	
Zalingei	53.3	3.75	
Dankuch	25.6	2.11	
Nyertete	19.0	1.83	
Golo	26.1	0.54	
Kabkabiya	9.7	1.29	
Overall	48.8	3.54 "	
		(JMRD)	P, P9 Survey 1990)

Groundnuts provides an example of the pressure to conform with national research authorities. No new varieties have consistently outperformed Barberton, which was introduced into Darfur some years ago. The national authorities have, however, identified a variety called Sodari which has been approved for release to farmers throughout the Sudan. Unfortunately, Sodari has failed to perform in trials or on farmers' fields in Darfur. As it has been released there is little harm in its distribution to farmers, who will soon make their own minds up about it. As far as research is concerned, however, the time taken to assess Sodari has delayed attention being given to some other varieties, which are not so well developed, in the bureaucratic sense that they have not been released, but which do show some promise. "The varieties EC-5 and Spancross had yields greater that that of Barberton local on 6, out of a possible 10, occasions. On two of those occasions the differences reached (statistical) significance." "By reason of some frequency of superiority, both EC-5 and Spancross may be alternatives to Barberton." (Quin, 1989)

To sum up, there are three key principles of adaptive variety research in hazardous environments like Darfur. First, the aim should not be absolute improvements in performance, which are unlikely, but "some frequency of superiority". Second, the varieties sought should not be considered as replacements for all existing varieties but rather as alternatives that may do better in certain niches but not necessarily in all of them. Third, early release to farmers ensures equally early indications of success or failure. The success of P9 sorghum on the JMRDP was quickly established by farmer response. A helpful attitude from the sorghum breeders of the national Agricultural Research Corporation, who encouraged the project to distribute the variety to local farmers without insisting on formal release procedures, was especially important. A fourth principle which has still not been widely accepted is the need to be ruthless, in throwing out varieties that have clearly not performed. There are some millet varieties, notably Ugandi, that have been tested again and again with uniformly poor results, merely because they are available and have been released. Public relations efforts by research centres leading to over-estimates of the potential of new varieties can be a significant barrier to a realistic evaluation.

The introduction of a new crop can open up major new development opportunities. Groundnuts in Sudan is only one among many examples: cocoa in West Africa, rubber in Malaysia and so on. More recent, aid-financed attempts to identify crops with potential for Darfur have not had much success, despite strong <u>a priori</u> arguments supporting their potential. "It is very tempting to see pigeon pea as a valuable rotation crop on qoz soils because of its potential for restoration of soil fertility and, as a hedge, acting as a windbreak. Nevertheless, (the research shows) that it does not do well on qoz soils and cannot easily become a component of qoz based cropping systems." (Quin, 1989) Among other crops tried have been guar bean, a source of an alternative to gum arabic, sunflower, fodder crops such as stylosanthes, cotton and rice. Some have been clear failures while others have been technically quite successful but were never followed up. High rice yields on the lowlying, flooded buta areas of southern Darfur were shown as early as 1976. (HTS, 1976) Both cotton and sunflower appear to do well on the harder nagaa soils, also in the southern area.

As always, however, marketing is probably the major obstacle to any of these developments. The relatively slow progress of diversification at present should not obscure the fact that it may well be a major component of agricultural development if Darfur ever does break out of its overpowering constraints and starts to grow once again.

Until that day comes, research is largely condemned to repeating itself without any result beyond deepening levels of sophistication and cost. The negative results of research on pigeon pea quoted above vary only in style from those reported a whole forty years earlier when the crop was said to be "hardy and pest free" but the seed

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did not fetch a good price, a high proportion of the vegetation was "too woody to be relished by animals" and "the labour of hand picking the small pods and the length of time to ripening militate against an increase in area." One reason pigeon pea continues to attract attention is because it is a legume, theoretically capable of fixing nitrogen in the soil and so raising fertility. The aid bias towards 'hero crops' that can raise incomes as well as save the environment ensures that pigeon pea will continue to be tried again and again. This will be in the face of the 1940s finding that "Cajanus (pigeon pea) was given a protracted trial for its rotational value as a deep rooter and a nitrogen restorer with negative results." The same author, reveals that even in 1948 researchers were wearying of trials work that led nowhere. "This native of the far East (Soya bean) has been tried continuously in the Sudan since the beginning of the century with seed and soil inoculants from various parts of the world. For many years it appeared that the fifty-seven values ascribed this plant by its advocates could best be attained by plants better suited to the climate but recent trials at Shendi have given encouraging yields." (Tothill Ed, 1948) Despite those trials at Shendi, soya has still to show any potential in Sudan. And despite that there continue to be attempts to prove that it has some.

CROP PROTECTION

There has been a striking inattention to crop protection, when it is a major concern to farmers. The western slant behind much agricultural research in Africa focusses on fertility and conservation issues but treats chemicals in the hands of peasant farmers with a paternalistic suspicion, because of both the expense and the health hazards. "There will be increasing demand for chemical pest and disease control material, much of which has undesirable environmental effects. Planned programmes will be necessary using limited quantities but increasingly relying on cultural and biological controls." (World Bank, 1989)

There is no doubt that where agro-chemicals are easily available in the third world, mistakes are made and problems can develop. Nevertheless, this over-protective attitude, with its emphasis on 'planned programmes' and 'limited quantities' flies in the face of the realities of rainfed agriculture in difficult areas. One problem, evident throughout this book, is the weakness of government services and the corresponding inability to manage planned programmes. Even if the the national Plant Protection Department, were much better equipped, Darfur agriculture does not lend itself to this style of organisation. There are a number of different pests which develop rapidly at different times and different places. They would test the speed of reaction of any organisation. In addition to that, there is a fundamental contradiction between planned programmes and limited quantities. Planned pest control by government agencies inevitably involves major spraying campaigns over large areas. This is bound to mean that some areas are sprayed which do not actually need it. On the other hand, it also means that small areas which need it very badly may not get sprayed, because the problem has not yet reached a level which justifies a major campaign. Either way the likelihood is that more chemical will be applied than it would be if farmers were allowed to make their own decisions, even if the farmers are not efficient or careful in the quantities they apply.

The 'planned and controlled' approach is particularly strong in Sudan, thanks to the influence of the major irrigation schemes which are naturally suited to large scale campaigns and techniques like aerial spraying. The result is that certain major pests such as Andat, or Sorghum Bug, African Army Worm, Locusts and Grasshoppers are classified as 'National Pests'. This means that they are the specific responsibility of the Plant Protection Department. Given the natural tendency of bureaucracies to allocate turf, this is sometimes taken to mean that other agencies should not take steps to deal with these pests. It also tends to reinforce the idea that farmers should not be encouraged to act on their own initiative to spray their own fields. The lack of imported goods in the market mean that farmers cannot get crop protection equipment and materials, which further reinforces the role of official agencies or, at least, prevents farmers from escaping their 'protection'.

Grasshopper bait is an example of the breakdown of the 'campaign' approach to crop protection. Grasshopper is probably the most widespread and persistent pest and there used to be an established system for the preparation of hopper-baits. These are made by coating groundnuts shells with a pesticide. By placing the baits around the fields the hoppers can be kept out. The collapse of state financed services has meant that baits have not been widely available for some years. During the drought years this did not have much effect but grasshoppers caused major losses in the better years of the mid-1980's, another example of the dangers of ignoring non-drought problems. As is now typical of most state supplied services, once this level of collapse has been reached, subsequent attempts to supply baits have been far from planned. Instead they have been almost wholly reactive, involving attempts by projects as well as the national Plant Protection Department to pool resources and win donor support to carry out a campaign. Since the essence of a successful bait campaign is having the materials available for rapid response to outbreaks this reactive and ad-hoc approach is almost bound to fail.

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Crop protection provides some shining examples of the 'asymetry' between what the first-world does and what it recommends for the third-world, prime among them the seed dressing Aldrex-T. Until 1990, this product was the single most popular modern technology among the rainfed farmers of the region. Crop establishment is the most difficult phase of the season and one reason is the loss of seed to termites and ants before it germinates. By using Aldrex-T as a seed dressing this can be overcome. Over one fifth of grain farmers in the JMRDP area used Aldrex in 1987. (JMRDP, WS87) The quantity used is very small, as little as 60 grams per hectare, about one sixth of the rate European farmers used to use, and the cost to farmers was equally small, less than US\$ per hectare. Although farmers use the dressing primarily to protect against ants and termites, it also controls smut. The use of Aldrex became established without any research work. It appears to have spread spontaneously throughout Darfur after being introduced for use in central Sudan.

Unfortunately, Aldrex contains Aldrin, a chemical which has fallen foul of modern environmental concerns in the first world. Production stopped in 1988/89 and there was a race to buy the last stocks for western Sudan. Once those are finished, there will be no more Aldrex in Darfur. Although it is possible that an alternative which contains Lindane rather than Aldrex will be effective, it was certainly not as popular with farmers who tried both.

The western world used aldrin for decades, at much greater intensities than the Darfur farmer was ever likely to use, before it was suddenly abandoned. However genuine the aid community's concern about the environment, it is impossible not to see it as grossly inconsistent and asymetric when it prevents the use of relatively harmless chemicals by poor farmers in areas that are unlikely to ever face a pollution hazard one tenth as great as those that the west has still failed to adequately tackle, such as acid rain. This is particularly so when it has so far proved difficult to identify many other crop protection techniques that are immediately useful under the present situation.

In crop protection the story of <u>nafaasha</u>, the millet head worm, parallels that of TSP fertiliser. During the dry years of the early 1980s nafaasha was by far the commonest pest on millet, which is by far the most important crop. JMRDP trials did establish that spraying with a synthetic pyrethroid called Ripcord could control nafaasha and raise yields by as much as 30 percent. This proposal met, as always, with concern about the wisdom of encouraging small farmers to use expensive chemicals, although the expense was not great. There were two more practical problems. The first was how to identify when the crop should be sprayed to avoid spraying unnecessarily and yet not leave it too late. The second was labour. Millet grows up to two metres high and the spraying is quite arduous. The sprayer has to carry a knapsack full of water through a dense crop and work to reach the ripening millet well above his head. Water for spraying is another problem. Even during the rains the majority of the millet fields are a long way away from the wells so spraying involves an extra trek to bring the water.

Various approaches to solve these problems have been tried. Ultra low volume (ULV) sprayers are much lighter and need only a little water but the reluctance to propose apparently more sophisticated and expensive techniques has meant that the ULV option has not been fully explored. This is on the grounds that it needs small batteries which might be expensive, although they are one of the few modern items to be found in every Darfur village. The hand-held torch is another of those items that are almost obsolete in the west but which have changed life quite radically in a region without electricity. Another approach has been to try to encourage farmers to plant their crops in neater rows, with rows of another low-growing crop like cowpeas at intervals so that it is easier for the sprayer to walk through the millet.

Above it was suggested that much of the research into optimum methods to apply TSP was not really necessary because it dealt with matters that farmers would probably have solved for themselves, if the fertiliser had been available in the market and had been economically viable. The same applies to spraying against nafaasha. When sprayers are widely available in Darfur, when millet prices are encouraging and when nafaasha is a problem, then farmers will work out for themselves how best to spray. Similarly, if both ULV and ordinary sprayers are made available they will quickly find out which suits them best. It is even likely that both technologies will find a market.

CULTIVATION METHODS

The modern concern for the environment affects attitudes to cultivation technology. "Full scale mechanisation is not the answer", as it results in soil degradation. (World Bank, 1989) Instead the recommendation is for animal traction, hand tools, on-farm storage and threshing machines. African farmers have always had hand tools and on-farm storage. There will always be room for improvement but it is hardly likely to be revolutionary. Animal traction has been well established in many parts of Africa since the colonial era. Considerable efforts during the aid era to introduce it elsewhere have met with extremely limited success, indicating that it had largely reached the limits of its potential already. If anything, threshing machines have done even less well.

Mechanised farming is not important in Darfur at the present. Problems in the supply of fuel and spares have proved insuperable. In the east, however, where imports are closer at hand and so are the political levers needed

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to secure them, Sudan probably has the largest single area of mechanised farming in Africa. The negative side has received a lot of attention. A small group of people have become extremely rich. They pay very low rents and there is a belief that they are not so much farming the land as mining it and causing great environmental damage. More extreme arguments attribute a collapse of the subsistence economy to the "unplanned commercial development" which has left peasants and pastoralists dependent on wage labour in the mechanised sector and which has forced them to abandon 'sustainable agricultural techniques' on their own land. "Having to compete with large scale commercial farming, very often with reduced family labour through migration, has meant that poor peasants have had to intensify their cultivation methods. This has resulted in the appearance of all manner of time saving techniques such as the decline in intercropping, crop rotation, strict sowing or weeding, extensive terracing and so on." (Duffield, 1990) (This sounds more like de-intensification but never mind.)

The fact is that mechanised farming has more or less doubled the rainfed cropped area in Sudan without reducing the traditional sector. Both sectors now account for around 9 million feddans. (Duffield, 1990) To the critics, this merely means that the traditional sector has 'stagnated' but this is to regard as more or less worthless the massive increases in both production and employment provided by mechanised farming. Only ploughing is mechanised. All the other operations are done by hand and the employment generated is correspondingly large. The critical view also depends, by implication at least, on an assumption that the traditional, non-mechanised sector would, in the absence of mechanisation and given adequate investment, have been able to produce a similar level of production. It is hoped that the discussion in this chapter has helped to show how unrealistic that assumption is.

There is no doubt that mechanised farming can cause environmental damage. There is however a critical distinction between those effects of mechanisation which are unavoidable and those which are entirely avoidable but which spring from bad management. There is every reason to believe that the environmental and the social problems associated with mechanised farming in Sudan have everything to do with management, at every level, and little or nothing to do with the actual technology of mechanised ploughing. Excessively low rents are only one example. This point may be made more general by saying that the preponderance, in the development literature, of discussions of the choice of technology may be missing a far more significant area, namely the efficiency with which any one technology is put to use, the X-efficiency.

Technically, there is little or no difference between mechanised farming and manual farming. The ploughing is done after the first rains have encouraged the weeds to germinate so that they can be ploughed in. If the weeding operation or 'hash' is the fundamental of traditional techniques, then Sudanese tractor cultivation with a wide-level disc plough is nothing more than the 'ultimate hash'. All it does is allow a larger area to be cultivated than could be achieved with manual methods. If there is an environmental effect it is more the result of cultivation than it is of mechanisation. Hand cultivation has the same effect, it is merely a matter of scale.

The adverse side-effects of mechanisation, whether real or merely perceived, have obscured the strong economic case for the use of tractors in Sudan. Land is relatively abundant and labour is short, especially so after the start of migration to the Gulf, making intensification difficult and unattractive. By comparison an increase in the area under crops offers a relatively short route to higher production. The pattern of labour inputs (Figure 4.3) shows the scale of the planting/weeding peak. Surveys have identified that constraint repeatedly since the mid-1970s. It is a measure of aid's resistance to mechanisation and development by extension that little has been done to tackle it. Even animal traction has been attacked on occasion on the grounds that it helps only the better-off and threatens over-exploitation of a limited land resource, a criticism that flies in the face of all the evidence. (KTI, 1985)

Animal traction is only important in certain specific parts of Darfur. As Boserup argues and as discussed in Chapter 2, this does not prove that land is in short supply, rather the opposite. (Boserup, 1965) Nor does the limited use of animals for farming show that people do not understand their potential. Camels and bulls have been used as pack animals for centuries. The introduction of the horse drawn cart in the mid-twentieth century made a considerable difference to qoz farming and horse carts, both two and four-wheelers, provide much of the bulk transport around the larger towns like Nyala.

Instead, just as Boserup predicts, the reason behind the limited progress with animal traction lies in the specific nature of Darfur farming. A look at those areas, principally around the town of Kas in S. Darfur, where it has had some success explains the puzzle. Kas has been a focus of camel ploughing for some decades now and both the large projects in South Darfur have attempted to develop improvements to the designs which were already in use there and to extend them to a wider range of conditions and operations. Some progress has been made but it remains a very long way short of a transformation. Just like Dabar sorghum and TSP, animal traction has found a niche but no more than that. Even within that niche, developments owe at least as much to farmers' individual initiatives as they do to research.

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Two surveys have shown the extent of the animal traction niche. In 1983 in the WSDC area some 12 per cent of households used camels to plough part of their farms. (WSDC, FS84) In 1987, in the JMRDP area 24 per cent of households used ploughs. (JMRDP, PH88) The fact that a household uses a plough does not mean that it will plough all its land. Only 14 per cent of plots were ploughed in the JMRDP survey. Almost all of this ploughing was done with camels, apart from a very small proportion hiring government tractors in the Jebel Marra area. In neither area was the use of ploughs evenly spread, it being most important in those parts of each project area nearest to Kas. In this section between 25 and 40 percent of households use the plough. The use of ploughs goes together with groundnuts. In both JMRDP and WSDC surveys ploughs were used on 30 per cent of groundnut plots as compared with 11 per cent for millet.

There are two aspects: cost and technique. On the cost side, it is easy to assume that, because Darfur is a major livestock producer, animal traction should be cheap. After all there are millions of cattle, camels and donkeys in Darfur and hundreds of thousands of horses. This ignores the radical difference between herding animals for beef and keeping them for draught work. A beef animal can be treated fairly casually. It merely has to be directed towards good range land and water and protected against disease and other attacks. For draught work, on the other hand an animal has to be trained continuously, fed well and generally looked after. In countries where draught oxen are important, like Bangladesh, the calves are yoked into pairs almost as soon as they are born to start their training. In Yemen, mature oxen are hand-fed. To maintain a really well trained animal, this kind of attention has to be kept up throughout the year.

No studies have been done on what would be the cost of such intensive stock management in Darfur but it would be considerable. A draught ox would have to be kept close to the village throughout the dry season, so that its training could be kept up and so that it would be ready to plough as soon as the rains start. Water and fodder would have to be purchased, at a time when the majority of the stock have travelled away to free grazing and water. A member of the household would have to give a lot of attention to the animal. Although the dry season is a slack period it does not mean that this would not be a considerable extra burden. The useable sowing period is short and unpredictable. All that extra cost to keep a plough ox in good condition all year would be for a few short weeks of work.

Oxen present the most extreme example of this problem and there are, in fact, no plough oxen in use in Darfur outside government projects and a few merchant's irrigated farms. Camels, horses and donkeys all have significant alternative uses in transport and water haulage and this means that the cost of using them for ploughing is much reduced. This has allowed camel ploughing to become well established, in its niche, and both donkeys and horses are also used.

Because they are used for other jobs as well as ploughing and because they are left to fend for themselves when they are not being used for anything, these general purpose animals are not well trained for ploughing. It takes two men, or even three, to drive a single camel when ploughing. This compares with a country which has a strong tradition of animal traction, where one man can drive a pair of animals.

The fact that ploughing is only important in certain areas partly reflects the influence of cost. Water and browse to feed a camel are relatively abundant in the basement areas around Kas. It is, however, technique that makes camel-ploughing attractive and competitive with the traditional methods of the hand-hoe, despite the extra costs of maintaining the animal. In the previous chapter traditional techniques were described as 'minimum-tillage', in that the hoeing is done after planting the seed. It was explained that the farmers' preoccupation was not to prepare a good seedbed but to suppress the weeds. In essence, animal traction has found its niche in South Darfur where it has managed to achieve the same object for less effort.

On the grain crops, the animal traction technique is exactly the same as that used on the big mechanised farms of eastern Sudan. The ploughing is done after the first rains have germinated the weeds, so as to plough them in before the crop is sown. This reduces the weeding that has to be done later, when the crop has established itself. By putting the cultivation before the sowing this is a significant change to the standard minimum-tillage technique. The drawback is that sowing is delayed and a useful growing period is lost. If, moreover, the rains fail and the crop has to be resown then much of the benefits of the ploughing in suppressing weeds may be lost.

For groundnuts, the benefits of animal traction are far more straightforward, precisely because it requires almost no change to the existing technique. Unlike the grain crop the groundnut fields are normally hoed before they are sown. This means that ploughing is a straight substitute for that first hoeing. Because, moreover, groundnuts are sown close together, it is practical to sow them in the furrow behind the plough. The seed is then automatically covered over by the soil the plough throws over as it makes the next furrow. The labour saving this offers is considerable. It takes nearly 40 mandays to preweed and plant a hectare of groundnuts by hand. (WSDC, FS83) With three men and a camel plough it can take as little as six mandays. The importance of this 'plough and

sow' technique is shown in the fact that it was used by 70 per cent of the households using camels to plough in the WSDC survey. (WSDC, FS84)

Two other factors also make ploughing particularly suitable for groundnuts. One is that it is far easier to use animal traction on light soils and groundnuts are also suited to the sandier soils. The other is that groundnuts take only three months to maturity. The delay caused by waiting for rain and then for the weeds to germinate is not so important as it would be for the grain crops. By contrast, the weed suppressing benefits of ploughing for the grain crops would be most useful on the wetter, heavier soils and these are the most difficult to plough.

The benefits of animal traction in terms of both yield and the suppression of weeds have been well established in trials. Yield gains of up to 100 per cent have been measured and the weight of weeds removed at the time of first weeding was reduced by between 40 and 80 percent. (Harvey, 1986) Where farmers do use a plough, they manage to grow larger areas and those people who own a plough make extra earnings from ploughing for hire. (JMRDP, Annual Report 1982) What is clear, however, is that those benefits are insufficient to cover the cost except where a particular combination of the farming system provides a niche.

These techniques were introduced to southern Darfur before any research was done. The plough used is based on a design which some farmers call 'Sini' or Chinese. Wherever it came from, it is simple enough and local blacksmiths in Nyala and Kas have been making it since the early 1970s. The first four were made in 1972. (HTS, 1974)

What then was the aim of research, apart from building up a lot of evidence to explain why farmers were doing what they were already doing? One goal was to try and improve the efficiency of the existing method. Modern agricultural engineering, which reflects the influence of western mechanised farming, lays stress on correct adjustments to the plough to ensure that it enters the soil at the right angle and to the correct depth and so on. It was hoped that better design of the basic plough would allow farmers to make such adjustments. It was also hoped to encourage more standard manufacture, making it easier for broken or worn parts to be replaced cheaply, and to develop a seeder-weeder, in recognition of the fact that plough-sowing is the most important niche for animal traction.

A third goal has been to try to develop an animal drawn weeding tool. If a way could be found to do this more quickly then farmers would certainly be able to grow larger areas. The idea of a frame of some kind, a multi-purpose toolbar, that could carry both ploughs and weeding implements according to the farmer's need, has been pursued with virtually uniform failure throughout Africa. The attraction to outsiders, who perceive African farmers as desperately poor, is that it seems more economic. A multipurpose tool is, however, bound to be more heavy and cumbersome. The farmers, who have to carry and use such a machine and who have the tedious job of changing the plough for the weeding times or vice versa, take a different view. (An observer of European farmers, who also tend to prefer single purpose machines even if they cost more, might have predicted this.) With hindsight, the failure of the multipurpose toolbar was inevitable in Darfur because neither ploughing nor weeding with animals had been established independently. The current technique already combines the two purposes anyway.

Apart from all its other problems, animal traction research has been weighed down by the dream of linkage, the idea that true development sees a growing local industry servicing an expanding agricultural sector. To achieve this dream it is necessary to achieve two things simultaneously: to identify new designs suited to farming in the area and to stimulate local production of those designs. The attractions are obvious. After all, there is already an active blacksmith industry, in Nyala and Kas especially. There are several problems, however. First, material supply is a major bottleneck. Attempts to stimulate the production of ploughs in Nyala have, inevitably, drawn aid projects into the procurement of steel for the blacksmiths.

More importantly, however, the basic principles of mass production have not been observed. To produce a more standard design, which can be adjusted more easily and which allows for spare parts to be fitted off-the-shelf, simple mass production is essential. The ploughs must be built with standard jigs for example. If, moreover, the aim is to produce more ploughs and make them cheaper to farmers, then again a change in manufacturing technique is inevitable. The present approach, whereby the projects contract with the one larger blacksmith to produce a given quantity each year and that blacksmith then sub-contracts to all the other smiths in Nyala, is bound to result in variable quality and high cost. Even if the present monopoly held by the Nyala blacksmiths could be broken, and efforts to do so have not been successful, this would be unlikely to change that fact. This is a dilemma of policy; whether to concentrate on the short-term and on providing the best possible assistance to the farmers, which might be better done by contracting plough manufacture to the bigger engineering companies in Khartoum or even overseas, or to provide them with a rather poorer service in the hope of establishing a local plough manufacturing industry for the longer term.

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Because industrialisation policies in the early aid era were such a failure, it has become difficult to see the issue clearly. That failure was largely a result of attempts to build up export or import-substituting industries and led to an emphasis on appropriate technologies. By contrast, some of the most successful industries in third world countries have been in the production of the simpler agricultural equipment and supplies, which may not represent the most up-to-date western technology but which cannot, at the same time be described as 'intermediate'. The Indian diesel engine and irrigation pump industry, for example, may be simple but that does not mean that it does not use basic mass production techniques and equipment, such as power lathes, drills and grinders. To look at this from another angle, animal drawn ploughs are certainly an intermediate technology but that does not, in any way, constitute a sound argument for them being produced using basic smithing techniques which barely qualify as intermediate. In Europe it was the introduction of mass-produced animal drawn equipment that marked the first step towards integrated development of agriculture and industry, not the introduction of new designs for manufacture by craft blacksmiths.

WSDC did research the use of tractors. This was for ploughing on the hard nagaa soils of the southern alluvium. These soils are technically described as sandy-clay-loams. Although they are much more fertile than the qoz they are unuseable for traditional hoe agriculture because they are extremely hard. Even with a tractor they can be difficult to plough. Partly because they are so hard, they tend to become completely bare. Once the grass cover has been lost, usually because of sheet erosion compounded by grazing, the ground becomes so hard that the vegetation cannot reestablish itself naturally. Once this happens the nagaa is utterly useless.

As early as 1973 it was demonstrated that these soils can be ploughed with a standard, 90 horsepower tractor using heavy chisel ploughs. (HTS, 1976) Provided the ploughing is done to an adequate depth and providing there are no prolonged droughts, heavy crops of sorghum can be grown. These findings have been treated with great suspicion. Tractor ploughing is seen as "costly and difficult to sustain." ... "Although the methods are effective they do restrict the potential utilisation of naga'a to wealthier farmers. In the absence of any alternative practices this means that the majority of the farming population absolutely cannot utilise the naga'a lands." (Quin, 1989) Once again the potential consumer and employment benefits of increased sorghum production are arbitrarily ignored. More prosaically, the belief that tractor ploughing is outstandingly expensive is not really justified. WSDC analyses in 1984/85 indicated that a reasonable and affordable rate, comparable with hire rates for hand cultivation on the qoz, could be charged, provided that the hire service was managed efficiently.

Given current circumstances in Sudan the proviso about efficient management is a very big proviso. While almost all the imported goods needed to run a tractor are in such short supply, it is also difficult to make a realistic assessment of the true cost or to judge how profitable it might be. Nevertheless, it is worth emphasising that although the WSDC hire rates were subsidised in the early years, surveys in no way support the idea that nagaa ploughing is a wealthy man's prerogative. In 1984, the average nagaa plot size was only 1.77 feddans. Some plots were as little as half a feddan and less than 20 per cent used any hired labour at all. This is hardly comparable with the 1000 feddan blocks farmed in eastern Sudan. (WSDC Nagaa Survey, 1984)

None of the points made above are exclusive to Darfur. With minor differences they match Pingali's Africa-wide analysis, in which he showed that the change from hoe cultivation to animal-traction or to tractors depends on the level of intensity of the whole farming system, that the primary motivation is area expansion and labour saving and that "all the farmer wants to do is substitute one power source for another for a particular operation." (Pingali, 1987, my underline) Above all, the Darfur evidence supports his conclusion that changes in technique are farmer-led and that where they are profitable, farmers experience little difficulty in overcoming any constraints. Neither in the developed or the developing world have successful cases of mechanisation depended on special government interventions. They also support very strongly the wider Boserup prediction that technology, even apparently labour-saving technologies such as ploughing, follows a change in frequency of cropping and in the man:land ratio.

IRRIGATION

Research on irrigation illustrates two points: the way in which preconceptions about development strategies can obscure significant development possibilities and the way that pressures for efficiency are necessary for research to be useful.

The first studies carried out in Western District of South Darfur, the main centre of irrigation in the region, were sponsored by the Ministry of Mines and Irrigation in the hope of finding potential for large scale gravity-fed irrigation using dams. This was found to be uneconomic and the second approach during the 1960s and early 1970s, under the aegis of the Horticulture Department of the Ministry of Agriculture, was to drill large tubewells which would be used to irrigate Pilot Development Areas. There were to be three of these, each one of some

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hundreds of hectares. This approach was also dropped because adequate land could not be found and because there were difficulties with the whole concept of farmer organisation that was proposed. In the meantime, private companies became involved in the promotion of virginia tobacco production and this probably gave the biggest single boost to irrigation in the area. A number of large but shallow brick-lined wells were established by tobacco farmers and many are still in use, mainly for growing onions. The tobacco business has more or less disappeared.

In the public sector, however, the lack of progress on the larger irrigation schemes led to a complete change of strategy with the establishment of the Jebel Marra Rural Development Project. In keeping with the concerns of the 1970s, for help to the poorest of the poor, attention turned to the rainfed sector. Emphasis was laid on subsistence grain production and irrigation was dropped altogether. Although JMRDP has, subsequently, become involved in support to small scale irrigation it was against advice from both expatriate technical assistance staff and the preferences of the major donor, the European Development Fund. The Sudanese management had to overcome this in order to be allowed to do any work with irrigation. That work is now correctly focussed on providing services to farmers who want to irrigate: principally the sale of pumps and the construction of wells. To sum up, it has taken thirty years for public sector research on irrigation to escape from a series of preconceptions first on how it should be done and then on whether or not it should be done at all, before retreating to the more sensible role of support to farmers.

The benefits of irrigation can be twofold. The same piece of land may give more than one crop or labour, which might have little to do in the dry season after the rainfed harvest, can be profitably employed for longer. At the same time, irrigation costs are higher, compared to rainfed cropping. Water management is a critical factor. If water is applied wastefully costs are high and, more importantly, the area irrigated will be reduced because the wasted water could have been used to plant extra crops.

At the current stage of development, irrigation uses land rather extensively, like most other forms of agriculture in Darfur. By this it is meant that farmers do not use irrigation to grow another crop on the same piece of land so much as they do to grow a crop on a new piece of land that was not farmed during the rains. In 1987, 'only 41.3% of the irrigated plots had any rainy season crop on them at all. Of the ones that did only half had a grain crop'. (JMRDP IR88)

There are three reasons for this. First, much of the irrigated land near to the wadis is prone to heavy flooding: 39% 'always flooded' and 49% 'sometimes flooded' in the JMRDP survey. This means that it may not even be feasible to grow a rainy season crop on it. Second, the very hot season starts as early as February. There are few crops that can withstand the high temperatures after that and those that can need much more water, so most irrigated crops must be planted early enough to benefit from the cool season between the end of the rains and the start of the hot weather. The main exceptions are okra and watermelon. Thirdly, the watertable falls rapidly after the end of the rains which means that it becomes more expensive or even impossible to raise the water later in the dry season.

It is difficult to be sure of the effect of irrigation on employment. Certainly, farmers talk of declining opportunities for dry-season migration to central Sudan and of the need for alternative employment in years when rainfed production is poor. On the other hand there are many other dry season activities such as construction work and, perhaps most importantly, livestock herding which requires much more effort in the dry than it does in the rains. Most of these activities are difficult to measure. The degree to which irrigation offers employment to those who do not have work as opposed to competing for labour with other employments is impossible to assess. What little evidence there is does not show any reduction in wages rates during the irrigation season. (JMRDP, IR88)

Irrigated farming in Darfur costs more than rainfed. By international and even national standards, however, the quantities of inputs used are very small indeed. Only 15 per cent of onion plots had any fertiliser applied in 1987 and only 22 per cent had pesticides. (JMRDP IR88)

Water is the major constraint. No major sources of groundwater have been found at accessible depths. Irrigation depends therefore on the relatively narrow and shallow aquifers that run beside and under the larger wadis. Existing well construction technologies are still fairly simple. In many cases, the wells do not even exploit the existing aquifers to the full. (JMRDP, Hydrogeology Report 1988)

There are three ways in which research might look to raise production from irrigated crops: by increasing the amount of water available, by making more efficient use of the water or by raising the yield of the crops grown for a given amount of water applied. More water can be made available by improving well design and construction. This can be done fairly simply and JMRDP has demonstrated that both concrete ring wells and shallow tube-wells drilled with a simple percussion rig can be constructed in the area. (JMRDP, Hydrogeology Report 1988) Water management techniques to save water at every stage in the irrigation chain are have been extensively researched world-wide and simpler techniques have been demonstrated in Darfur. Raising yields would be somewhat more

complex, involving the combination of variety, fertiliser and pesticide use as well as cultivation techniques. Technically there is no reason to believe that considerable advances could not be made quite easily in all three areas.

Nevertheless, irrigated farming in Darfur appears to be rather inefficient. On farms with diesel pumps, the area irrigated per pump is very small: at 0.62 hectare per pump, far below the capacity of the pump. On average over the whole season, each pump was only operated for 19.7 hours per week; about 40 per cent of what might be considered full capacity on an eight-hour-day, six-day-week. (There are many countries where even that would be considered a low level of operation.) Many pumps are run at slow speeds and poor efficiencies, which reduces their performance still further below the optimum. Poor aquifers and poor well design are the main reasons for the low utilisation of the pumps' capacity. In addition, farmers do not seem to be making very efficient use of the water they do get. They do not vary the rate at which they apply the water to the crop, as they should do for the greatest efficiency, and the field channels and ridges are not constructed with any great care. (JMRDP, IR88) Fertiliser and pesticides are rarely used to raise yields and farmers do not normally apply manure.

Irrigation is a relatively new business in Darfur and this may be one reason for the low efficiencies. On the other hand, some farmers have been growing irrigated crops for twenty years or more and there is a wealth of irrigation experience to be gained from central Sudan. A more likely explanation for the failure to progress beyond the simplest techniques is to be found in the choking-off process. The lack of consumer goods and the high price of those that do reach the market mean that labour costs are high, a strong disincentive to more intensive methods. The direct impact of market fluctuations is even more important. On the input side that means fuel. There has been no reliable supply in western Darfur for many years. The acquisition of fuel almost always involves dealings either on the black market or with the bureaucracy. On the output side the market has been affected by changes in the rules over export to Chad and Central Africa, important markets, and by the fluctuation in competing supplies from central Sudan.

Farmer responses to surveys on irrigation provide a good example of the way the larger scale macro-economic constraints can mask the underlying resource pattern and deprive research of a market for its work. In early 1987 farmers reported that a lack of water was the biggest obstacle to increasing their irrigated area. In early 1988, despite the fact that the 1987 rainy season had been drier than 1986 water had dropped to fifth place. Fuel and cash, to buy that expensive fuel and to hire labour, were the main 1988 constraints. Farmer interest in techniques to save water or to get more water out of their wells or to raise yields was swamped by the need to keep their pumps operating at all. (JMRDP, IR88)

Constant change is part of the problem. If one constraint, be it water or labour or fuel, was dominant every year then it would be possible to adjust strategies to suit and research could focus on methods to enable such an adjustment. The inability to know which problem is going to be at the top of the list in any year means that farmers have to concentrate on simple techniques that avoid excess exposure to any one problem. Irrigation, which should be a more secure form of agriculture albeit more expensive, is actually just as risky as rainfed or even more so.

EXTENSION

The underlying lack of a market for new technologies under the present economic situation is most clearly seen in Extension, for it is the Extension Service which is supposed to 'sell' the new technologies to farmers and to inform researchers what it is that farmers want. Extension services which are in difficulty are characterised by two features: a lack of popular 'extension messages', ie technologies, to offer to farmers and inadequate contact with the farmers themselves. These are features that may be seen throughout Africa.

The standard diagnosis of these problems emphasises extension methods and organisation: "management and supervision are typically lax, links with research are weak and feedback from farmers is almost non-existent." Various cures are proposed for these ills. The most famous of them is the Training and Visit system whereby "supervisors check that fieldworkers are visiting farmers while regular training sessions and links with research allow extension workers to be continually upgraded and to feed results and farmers questions back to researchers." (World Bank, 1989) If, however, there is no effective demand for new technologies and there are no technologies available anyway this diagnosis is addressed more to symptoms than to causes. In particular, the lack of strong links with research and the poor feedback from farmers do not reflect any inadequacies in the Extension Service itself but are the result, instead, of a simple lack of demand for what it is offering.

In Darfur the national Extension Department of the Ministry of Agriculture has branches in Nyala and ElFasher, although they suffer from the same acute shortages as all government services and lack the capacity for any large-scale activity. It is only the JMRDP which has had a full extension service to offer its farmers for any length of time. In an area with approximately 90,000 farm households, JMRDP has around 60 Extension Agents or one for every 1,500 households. This may be compared with the national Extension Department which only

has around 200 agents for the whole of the rest of North Sudan. On the other hand, countries with well established extension services aim for a ratio of one agent per 800 farmers or lower.

This poses the first problem with Extension: the cost. Even at the density of coverage at the JMRDP's disposal, backed with an equally intense level of supervision - one supervisor for about ten agents, the project cannot, in a large area with very scattered population, reach every household even occasionally, let alone provide intensive support. In 1987, some 70 per cent of households knew of their Extension Agent and 45 per cent had been in touch with him in the last 12 months. (JMRDP, PH88) Given that each agent has to deal with as many as eight different villages, up to twelve kilometres away from his home, and given that he had only a donkey or a bicycle to visit his farmers with, this should be considered a good performance. Yet it is clearly not enough to allow him to give detailed help to more than a few farmers during the short peak of the farming season. Even so, the cost of a service at this level of intensity is almost certainly beyond the capacity of Government of Sudan to sustain without aid finance. It has to be doubtful, moreover, whether it will ever generate sufficient extra production and, hence, income to pay for itself and so enable government to afford it once aid finance ceases. Long-term sustainability is a serious problem for extension.

A simple calculation reveals the problem. In 1988 the total value of field crop production in the JMRDP area was some \pounds s 250 million, of which 220 million was in millet. That year the total project budget was \pounds s 30 million, which heavily undervalued the foreign exchange components. Even so, the project cost 12 per cent of the total, gross value of production in the area. This is a bit unfair as it makes no allowance for the contribution in other areas, transport and fruit production for example, but it helps to make the scale of the problem clear. Much of the methodology of extension has been developed in large, intensive production schemes. A major irrigation scheme growing an export crop is a typical example. Under those circumstances, farmers are being introduced to a complete package of new technologies that will generate a substantial increase in production. Under those circumstances extension may be both necessary and profitable. Under small-holder circumstances in poorer areas it is far more difficult to find a way between the twin perils of unsustainable cost, on the one hand, and an extension service that is spread so thin that it really serves no purpose, on the other.

The perceived complications of extension are many. Is it a good or a bad idea for extension workers to sell inputs, should they manage credit, how are male extension workers to contact women farmers and so on? All of these problems diminish in importance if the underlying situation is remembered: a lack of demand for what extension has to offer. Farmers are quite willing to put up with Extension Agents' involvement in credit if the equipment offered on credit is of interest to them. JMRDP has an admirable record on credit recovery for irrigation pumps which contrasts strongly with a history of failure with credit for animal traction implements. Similarly, women farmers find no obstacle in obtaining an input like Aldrex-T seed dressing from the Extension Agent if they want it. As far as the perceived clash between farmer training and advice and input supply is concerned, it is clear from surveys that inputs are the principal motor behind farmers' contact with the Extension Service. Attendance by farmers at extension meetings is not high and the agent's ability to reach the farmers individually, in the fields or at home, is limited by the sheer numbers and the distances involved. The biggest single way in which the agents meet their farmers is when they come to the agent's store to buy inputs. (JMRDP, PH88)

And this leads back to the central conclusion. If a wide range of effective technologies was available and if farmers were likely to be able to use them profitably, then a healthy and effective extension service would be easy to establish. Farmer demand would keep the Extension Agents busy without the need for the apparatus of Training and Visit. Clearly some supervision would be necessary to prevent abuses and it might be that the gender problem, for example, would turn out to be serious. At the moment, however, the extension service is tied to the promotion of some technologies for which it never has enough inputs, most notably crop protection, and others for which the demand is, at best, patchy like animal traction. Under these circumstances, it is impossible to judge which of the many suggested difficulties with extension are real and which are merely expressions of an underlying lack of effective demand for the service.

As far as theory is concerned, the above reveals the central problem with Schultz' argument that high social returns to extension justify government involvement where a private sector operator would not be interested. Which is that the costs are far higher than any likely return, social or private.

FARMING SYSTEMS RESEARCH

Farming Systems Research (FSR) developed as a reaction to the failures of earlier attempts at finding new agricultural technologies for Africa. It was felt that the earlier research was too much 'on-station', where the researchers confined themselves to carefully controlled trials on official research stations. As a result the techniques they developed were not adapted to farmers' actual circumstances. FSR therefore lays stress on

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farmers' participation, on 'on-farm trials', as opposed to 'on-station trials' and on the gathering of Rural Peoples' Knowledge. Vast advances in the understanding of African farmers problems and skills are due to Farming Systems Research. It represents the peak of attempts to overcome the supposed lack of 'amenability to transfer' of agricultural technologies.

In order to ensure that new techologies are appropriate, an area is divided up into 'recommendation domains' of homogenous groups of farmers, in the expectation that a different package of techniques will be required for each domain. Divisions between recommendation domains may be based on soils, rainfall or topography, or on social or economic factors such as sex or wealth. The considerable volume of research work done in South Darfur, starting from as long ago as the 1950s, means that there is plenty of material for Farming Systems analysis. Soils, vegetation and even land use maps are available. Several comprehensive farmer surveys have been carried out using a variety of approaches but in the later years almost all were influenced by FSR ideas.

The result is that differences in farming techniques in different parts of South Darfur can be clearly described and the reasons behind those differences can be understood. Although the reasons are not always so clear, it is possible to identify more complex differences between 'domains' where socio-economic factors interact with ecological ones. In Eastern District of South Darfur, for example, the Qoz Maaliya/Rizeiqat area differs in a number of ways from the rest of the WSDC area. The distinction is to be seen in the evidence of a more commercial form of qoz farming: larger areas, lower labour inputs and more hired labour used, without any difference in the basic hand-hoe techniques used. (WSDC, FS83) JMRDP surveys have even managed to show some distinctions between male-led and female-led households, in terms of area farmed, livestock owned and so on. The female household is smaller which means that although they own less livestock, for example, the difference in per capita terms is not great. (JMRDP, PH88)

Table 5.1 summarises some of the indicators that have proved most effective in showing a distinction between one 'domain' or another.

	- WSDC Area 1983 -		- JMRDP Are		ea 1988 -	
	Qoz	Central	Basement	Upper	Female	
	Maaliya	Area	Wadis	Jebel	H'holds	
Household Size	6.02	6.26	5.79	6.65	4.06	
Female Household Head %	2	12	21	4	100	
<u>Techniques</u>						
Precultivate millet	SOME	NO	NO	YES	na	
Prerain planting millet	23%	NO	NO	MOST	na	
Hoe type	Hashasha	Hashasha	Tawria	Julmai	na	
Ploughing %	0	16	30	22	na	
<u>Cropped Area - Ha</u>	8.5	3.7	2.7	3.2	1.7	
% Millet	70	56	50	67	51	
% Sorghum	8	20	20	3	14	
% Groundnuts	22	15	13	2	10	
% Other	0	9	17	28	25	
Hired Labour Used %	74	19	7	13	na	
Livestock Ownership						
Cattle % Owning	71	61	32	17	18	
Av Number Owned	29	30	6	4	4	
Goats % Owning	50	60	73	51	64	
Av Number Owned	9	11	8	3	5	

Table 5.1FARMING SYSTEMS INDICATORS

Sources: WSDC, FS83 & FS84, JMRDP, WS88 & 87

Some of the distinctions between the different 'domains' are very simple, perilously close to trivial. The differences are so manifest, and the reasons so clear, that they would probably have been obvious to the chance traveller, if he kept his eyes open. Examples of this are the different methods used by farmers on the qoz, on the

basement wadis and on the high jebel where clear and simple differences in technique and in cropping pattern tell almost the whole story and obvious differences in the environment explain that story. And if the traveller would not have spotted those differences, any researcher who works in the area would be able to spot them without the need for any complex surveys or the paraphernalia of FSR. One weakness, therefore, of FSR is a tendency to discover the obvious, at considerable expense.

Attempts, however, to deepen the analysis and to identify more subtle distinctions run, very rapidly into a morass of minor distinctions and subtle variations in degree that do not clarify anything. Prolonged surveys of labour inputs in the Jebel Marra area, for example, show no clear pattern and no improvement on the straightforward understanding gained in the first surveys. The degree of overlap, even between domains which the prime indicators show are clearly different, is considerable. "Within the large land system strata there is great variation especially between areas in the middle of each system and those on the margin with a neigbbouring system. Each village is by contrast relatively homogeneous. The villagers all face roughly the same environmental constraints and opportunities." (WSDC, FS83)

Nevertheless, farming systems analysis clearly works, in the sense that significant differences in technical and socio-economic patterns can be identified and 'domains' defined on that basis. Where, then, are the 'recommendations'? The answer is that they are few and far between and that they are rarely domain-specific. This might be because none of the workers in Darfur have yet got FSR right. A different answer is that identifying different domains is less useful than hoped for in the development of new technologies. This is because the differences between the domains do not imply any significant difference in the farmers' technical requirements. There may be variations in degree but the binding constraints in all domains are the same, peak weeding labour above all, and the technical potentials of all domains are very similar. The only exceptions to this are where the distinctions between major domains are over-poweringly obvious; that is to say where soils and topography are clearly different and where farming techniques are different as a result.

FSR appears to have found Darfur both too simple and too complex for it to handle. It is too simple because farming across the whole of the region is so homogeneous that it might almost all be considered one Farming System. After all, almost everyone grows millet with a little sorghum or groundnuts as well and everybody uses hand-hoes to do this. It is too complex because of the immense range of subtle variations in the the way that millet is grown from one place to the next and, especially, from one year to the next depending on the rains, the pests and a thousand other factors. "The definition of recommendation domains in the area is exceedingly complex ... in any one village several land types are represented from marginal upland soils through to various types of alluvial soil. A single farmer may have fields on several or even all of the land types, but the recommendations and by implication the research requirements for each differ considerably. Thus the domain either becomes a catch-all losing the focus for which it was intended, or many more domains must be created in which individual farmers of households are multiply represented." (Harvey, 1986)

CONCLUSION

The above does not do full justice to the research work done in South Darfur nor to Farming Systems Research, a concept that has developed a large literature. It is enough, however, to explain the case for a different approach, for a substantial change of emphasis.

First, a distinction may be drawn between two concepts: 'recommendation domains' and 'niches'. A domain is expected to be broadly homogeneous, so that there are major differences between the farming system on one domain and that on another. As a result, research is expected to form a package of different recommendations for each domain. By contrast, a niche exists where two broadly similar farming systems differ in only one respect. The use of camel ploughs only in some parts and only on some crops of the basement wadi farming system, is a good example of a technology occupying a niche. Some very different approaches to research depend on whether the aim is to develop technologies for whole domains or to concentrate on looking to fill niches.

The hazards of rainfed agriculture in western Sudan make the concept of 'frequency of superiority' important. Because it is unlikely that research will identify technologies that are unambiguously superior in all circumstances, it is necessary instead to seek out those that perform reasonably well, reasonably often. For the same reason, breadth of range is also critical. Where there is no one technology that is unambiguously better under all circumstances, it is vitally important that there should be as wide as possible a choice of 'frequently superior' but different technologies. That is the only way to have a good chance of there being at least one which does well, at any given time and in any given place.

There is a danger of excessive detail. TSP and nafaasha are both examples of this. For the former, a technology of some potential has become bogged down in a series of refinements. For the latter, the short-term significance

of nafaasha, which was most damaging during the drought years, may have diverted attention from other equally damaging pests that appear in better years. This leads to the crucial balance between risk and reward. In a hazardous environment, the ability to exploit good years is probably a more important way of minimising the overall risk than the ability to resist the damage in bad years. Once again, the pressing need is not for one technology but for a range that allows maximum rewards as well as minimum risks.

Goals should be kept as simple as possible. If the aim is to promote the most effective technique then it should not be constrained by attempts to develop local capabilities at the same time. If this means purchasing animal traction equipment from overseas rather than from local blacksmiths, then so be it. If this means using imported triple super phosphate instead of attempting to demonstrate the virtues of rock phosphate because there might be a source of it in Kordofan, then so be it. The importation of the Chinese plough was probably the biggest single boost the Darfur smithing industry ever received. It gave the smiths something to copy and created a market for them but it had to be imported first. Similarly, if TSP ever developed a demand for phosphate, then it would have prepared the market for Kordofani rock phosphate.

Researchers should be ruthless in support of their primary clients, the farmers. The goal is the best and cheapest technology for them. If government wishes to support local industries, then that should be a separate exercise. The fact that an intermediate technology is appropriate for farmers does not, in any way, indicate that the equipment supplied to them must be produced using intermediate techniques. Indeed, the most likely way for an intermediate farming technique to succeed will be if it is developed and produced using the most up-to-date manufacturing methods.

Equally to be avoided are attempts to guide research from social, economic or environmental first principles; especially where that means avoiding areas that are believed to be 'dangerous'. There is no such abundance of development possibilities in Darfur that any of them can be ignored. Mechanised farming almost certainly has social and environmental costs as well as production benefits but it is impossible to calculate the balance between them in advance. Not to research into mechanised farming will not stop the introduction of tractors. If the market favours them they will be irrestible. It will, however, ensure that a chance to find out how to use them efficiently will be lost, which will only make it less likely that the benefits will outweigh the costs. Similarly, statements that mechanised sunflower production on nagaa soils should not be promoted because of the "economic threat to the groundnut and sesame producers on qoz soils", represent no more than the wilful abandonment of a promising opportunity for wholly speculative reasons. (Quin, 1989)

The belief that agricultural technology is not amenable to transfer implies that traditional farmers will not adopt a new technique until is has been made absolutely perfect for their circumstances by research. The history of the few successful developments in Darfur seems much more akin to an evolutionary process, in which a new variant technique appears, more or less independently of any preliminary research, and is found, by selection, to fit into a particular niche within the overall farming system. The TSP story is, perhaps, the clearest example of this in that the fertiliser was distributed throughout the region in 1985/86 and found its niche on the Jebel Marra but the pattern has been similar for camel ploughing, for potatoes and oranges grown on Jebel Marra and for several other techniques.

Proliferation is just as important as selection in the evolutionary process and this has been more or less completely choked off in Sudan. Selection needs as large as possible a number of variants to choose from, if it is to have the best chance of finding a good one. In the Sudan, the supply of new variants is very, very small indeed: mainly because of the acute economic constraints and but also of the aid-financed research bureaucracy's insistence on thorough testing before new techniques are approved for release to farmers, As was said at the beginning of this chapter, the problem is not that 'off-the-shelf' technology does not work but that the shelf itself is bare.

Such an approach to technology transfer clearly implies that farmers are capable of selecting and adapting new technologies that are profitable without difficulty. It therefore means abandoning the Schultz case for research and extension which depends on the belief that adaptation is particularly difficult. The balance of cost between the two approaches is a key factor. The choice lies between the risk of losses and inefficiencies in a farmer-led evolutionary process and the cost of the research needed to avoid that risk and, most importantly of all, the time that would have to be lost while that research is carried out. If the experience of research in Darfur and, indeed, in Africa generally has anything to show it is that both the costs and the time losses involved in the search for a perfectly adapted technology are very high indeed. The scale of the costs on the other side are not so easily measurable but there is no obvious reason why they should be especially large, given that none of the technologies that are likely to be applicable in smallholder agriculture are especially expensive or capital intensive.

Risk is a central plank in the Schultzian argument. "Farmers in a poor community are less able, in terms of reserves and experience to cope with such additional riskiness" of new agricultural factors. (Schultz, 1964) If,

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furthermore, farmers are very short of capital then the cost of asking them to make even a small investment in trying out new technologies might well be high. If, on the other hand, as is argued in this book, capital is abundant and the farmers' principal problem is a lack of useful ways to use their savings then the cost of any investment in their own research will be low. Clearly, there are some very poor people in Darfur who cannot afford any kind of additional risk; additional because risk is such an overwhelming factor that no one, rich or poor, can avoid it. Equally clearly, however, there are plenty of people in Darfur who make small investments and some who make large ones. The risks faced in such investments are, by first world standards, enormous. If the Darfuri investor may be considered to have a portfolio, part of the reason it is risky is because it is very narrow. The range of options is very limited. For this reason, the chance to diversify into any new technology, however unproven, may actually reduce the risk of the overall portfolio.

Clearly research will always have a role which ever approach is adopted: in identifying and developing new technologies, in making sure that they fall within the range of likely requirements for the area and in providing farmers with an outline of their characteristics. Where this alternative evolutionary approach does suggest a major cut-back in research is in precisely those areas that have developed most recently: adaptive research, on-farm trials and the whole apparatus of FSR. All of these represent attempts to enhance the researcher's certainty in order to reduce the farmers' risk. In so doing, they substitute the slow and expensive processes of scientific technique for the rough and ready strengths of the farmers' own 'will to search'.

The fact remains, however, that effective research, whether it is set in an evolutionary framework or takes a more 'scientific' approach, cannot be carried out in a vacuum. It needs a market for its findings, a demand for its wares. This is not merely because without a use for its results research is reduced to an academic exercise but also because research itself desperately needs the feedback. It is only by testing them in that market that new technologies can be finally proven and adapted in the light of wide experience. The evolutionary approach will only work if the selective force of farmers buying one technology and refusing to buy another is allowed to function. Unfortunately, this market demand for research in Darfur and many other African countries has been stifled by the wider economic crisis. Inputs are not available, markets for product are unreliable, supplies of consumer goods to make the effort worthwhile are both expensive and unreliable.

The result has been that instead of being reactive to market demands and stimulated by them, research has become increasingly anticipatory. It is forced to focus on issues that may be useful in the future but which are not applicable now. One result is that the pressure to divert research into areas that are of concern to the first world organisations that finance it but not of any immediate interest of the farmers is difficult, if not impossible to resist. The very shift into the safety-first, all embracing style of research which has been, somewhat unfairly, summed up here as FSR, reflects the fact that research is operating in this kind of limbo. To put it another way, the fact that agricultural research in Africa has developed into what is the most sophisticated, sensitive and knowledgeable system ever while being the most expensive and least productive one at the same time, is the result of the green revolution, for example. In is not beyond the bounds of possibility that FSR before the green revolution would have predicted the negative effects, especially the social ones, and recommended that it should not happen. However great those negative effects, that would not really have been the right answer.

6. DROUGHT AND DESERTIFICATION

Darfur has seen extraordinary environmental change, especially so in the 1970s and 1980s. Big game, which was a pest right up to the second world war, is no longer seen. Vast areas of climax savanna woodland have been cleared. During the last two decades rainfall has rarely came close to the long-term average. In 1948, Darfur villagers were described as well off compared to many in Europe: "for the poorest people there is peace and security and sunshine: there is an ample food supply and a good variety of foods; milk and good water and fuel for cooking are available to all; ... " (Tothill Ed, 1948) While allowance must be made for colonial self-congratulation and for the impact of the second world war on Europe, this was not an unfair description. The starker contrast lies between Darfur as it was in 1948 and a modern Europe that has raced ahead to a position where famine is more or less unthinkable.

Which makes the modern concern with the environment seem entirely correct: the view that there is a vicious circle between population pressure and a poor natural resource. "The more people there are, the more they destroy the long-term potential of fragile environments and the poorer this makes them and their descendants." (Chambers, 1983) The Malthusian slant is clear. Some key difficulties are well recognised: the fact that "conservation will fail unless it appeals to the farmers' self-interest" (World Bank, 1989) and the poor quality of the 'long-term potential' itself. It may even be that the only option is to 'mine' what small potential there is for the maximum short-term production. "The environment exists for man, not man for the environment." (Chambers, 1983)

In the end the problem is technical: how great is the potential, how long can it last, what techniques can sustain it and so on? Yet measuring environmental change is difficult and explaining it can be close to impossible. Most prescriptions implicitly assume that these technical difficulties can be overcome, when they call, for example, for a "minimum framework that links a set of satellite (environmental) accounts to the conventional System of National Accounts"; something that is not done in any first world country. (World Bank, 1989) The South Darfur experience has shown that what is happening can be convincingly described, with some difficulty. Analysing why and how it happens is still more difficult.

In Darfur both crop land and range land for grazing are near enough open access resources. There is some concept of community or tribal ownership but it is weak. Livestock on the other hand are individually owned and farmers work as individuals. The theory of the 'Tragedy of the Commons' argues that this combination of an open resource and individual management is a primary cause of environmental degradation because it leads to overuse. (Hardin, 1968) If grazing land is open to all, "the communal grazing system gives no incentive to the individual pastoralist to reduce his herd in the hope that he will be able to feed them better, for there is no assurance that his action will improve grazing as long as others continue to increase their herds." (HTS, 1974) On crop land, farmers will not be able to maintain a rotation with fallow because other farmers can take over and crop the fallow land. At the extreme, it is even argued that farmers are forced to grow uneconomic crops merely to maintain their right to the land. The logical solution to this problem is to give the crop land to individual farmers or groups and to allow individual herders or groups to enclose grazing land. In other words, to replace open access either with much tighter communal ownership or with private ownership.

Many attempts have been made to do this but they have created more problems than they solve, especially where vulnerable groups lose customary rights in the process. This has at last been recognised. "The transition to land titling should be attempted only in response to demand by rural people." (World Bank, 1989) Nevertheless, the belief that social institutions are the root cause of the over-exploitation of the environment remains strong and the 'Tragedy of the Commons' thesis is still influential. One reason for the resilience of this belief is that it offers a way out of the difficulties of technical measurement and analysis. If the root cause of the problem lies in the social arena then it is far easier to justify developmental action on <u>a priori</u> grounds.

The Western Savannah Development Corporation was established in 1978 specifically to tackle issues of land use, by both farmers and herders, in South Darfur. It has commissioned research on many facets of the problem in an area where the issues are made particularly clear by the rapidity of the changes underway. This research has included intensive ground surveys of ecological change, socio-economic surveys, sociological studies and, in particular, detailed analyses of aerial photography and satellite imagery.

In this chapter, the aim is to develop a theoretical framework analysing the problem of common access resources and to set Darfur within that framework. Although the themes are the same the details are different for the livestock and crop sectors, so they are treated separately. Livestock is taken first. Because of its importance to many African nations, there have been many, largely unsuccessful, livestock programmes and the interaction of developmental and environmental change has received most attention of all in the context of common access range land.

Innovation, Technical Change & Open Access Resources

If institutions like land tenure are the cause of the problem it implies that they are permanent and immutable or at least slow to change. As discussed in Chapter Two, Boserup describes in detail how tenure forms adjust to changing resource endowments. More generally, Hayami and Kikuchi have modelled the mechanisms by which social institutions make these adjustments. The central questions considered here, therefore, are whether or not resource endowments have changed enough to justify a change in tenure and, if they have, whether or not the autonomous Boserup adjustment is taking place without undue difficulty. This is taken against a background in which it has been generally assumed that the answer to the first question is definitely positive and the answer to the second almost as definitely negative.

Climate is crucial. For Darfur there is really only one question: How much of the environmental change is the result of long term climatic changes and how much is caused by man, through over-cropping or over-stocking?

THE TRAGEDY OF THE COMMONS

The Tragedy of the Commons works through congestion. When too many people use a given resource, they get in each other's way. The classic Pigovian example is a narrow road which becomes congested when too many drivers use it. For grazing land, congestion occurs when the number of livestock becomes so great that each animal has less food than it needs and grows more slowly or produces less milk as a result. For crop land, congestion leads to pressure to reduce fallow rotations and hence yields. The problem with such common access resources, a road on which anyone can drive without charge, rangeland open to all herders and crop land without tenure, is that the individual is not charged for the cost his presence imposes on others, for the congestion he creates.

In Darfur the offtake rate for cattle is around 8 percent. (WSDC, 1985) A simple model would be for an area that is fully stocked when it carries 1000 head of cattle and produces 80 for sale. Then a herder, the 'Free Rider', who already has 100 head decides to buy ten more. Because there is no spare fodder this means that all the cattle have less to eat and the the offtake rate drops, let us say to 7.5 percent. The situation thus changes from the 'before' case shown below to the 'after'. (The third, 'Coase' situation is discussed later.)

	Before	After	'Coase'
Communal Herd	900	900	900
Communal Offtake	72.00	67.50	71.75
Free Rider's Herd	100	110	100
Free Rider's Offtake	8.00	8.25	8.25

The tragedy is that the other herders' only defence is to do the same, to buy more cattle and try to recapture some of what they have lost to the 'free rider'. In this way, the whole herd becomes far too large, production is actually reduced and, at the extreme, long term damage is done to the rangeland. (The model will be developed below.)

The logic of this is powerful and it has fitted outsiders' perceptions of what is happening on the African ranges so well that it has dominated the debate since long before the aid era. Only in the last decade or so has there been any serious attempt to break away from it, an attempt springing from the evident failure of programmes designed to tackle the 'Tragedy of the Commons'.

Modern analysis of externalities has revolved around the Coase theorem, which emphasises the reciprocal nature of externalities. On that basis it should always be possible for the loser from an externality to make a deal with the gainer. This is the third case in the model, where all the other herders pay the Free Rider not to buy his extra ten cows. He would get just as much but they would lose far less. (Coase, 1960)

Lipton has set the Coase theorem in opposition to the games theory model of the Prisoners' Dilemma whereby two accused men both confess because they cannot negotiate a common strategy. He argues that "a major task of governments is to convert PDs (Prisoners Dilemmas) into COs (Coase Outcomes)" and that there is a drift in the third world towards "PD non-cooperative outcomes". (Lipton in Matthews Ed, 1985) He gives four reasons:

- Population growth "increases the number of transactors" so raising the cost of negotiating a Coase deal, the so-called transactions cost. This is the exact opposite of Hayami and Kikuchi's view that 'tighter' social structures, reflecting higher populations, reduce social transactions costs. (Hayami & Kikuchi, 1981)
- Developmental change reduces the number of times that similar decisions have to be made and this makes it less likely that repeated plays of a PD game will reveal the costs of not cooperating.

- Risk aversion will lead actors to prefer the least bad, safe result over a better one that depends on others sticking to their word.
- Lastly, what he calls a 'transition of trust' is underway as the "old chiefly authorities and clan-like decisions are challenged by centralised governments and codified laws." Individuals are losing respect for traditional restraints but they are still unimpressed by the new authorities, so mutually beneficial deals are less easy to strike.

While it will not be considered in detail here, it is implicit in Lipton's argument that the process I have described as Social Boserup will fail. The 'political entrepreneurs' who in Hayami and Kikuchi's model should mediate the institutional changes required to accomodate changing resource endowments will not appear or appear too slowly. (Hayami and Kikuchi, 1981)

The Coase theorem explicitly excludes equity. It is clearly unfair that the Free Rider should be able to blackmail the rest of the community in the way he does. For this reason, Coase rules on compensation for externalities may not work. "Unless there is an all powerful autocrat, rules perceived as very inequitable will be widely broken." (Lipton in Matthews Ed, 1985) The free market approach to externalities offered by Coase still depends, therefore, on a social institution, call it government, to handle the equity aspects. The most likely way for government to do this would be by arranging an allocation of specific rights. In the example, if the Free Rider had a right to graze 100 cattle then he would have to buy the right to graze more from the others. If, on the other hand, he had a right to graze 110, then the other herders would do best by buying the right to the extra 10 off him. Total production would be the same either way, the difference would lie in the distribution of the output between the community and the Free Rider.

(It is possible to suggest ways in which the central tenet of the Coase theorem, that the allocation of rights does not affect production but only the distribution of that production, might fail. For example, there might be differences in the rate of time preference between "poor and non-poor agents" which would mean that "the pattern of resource allocation is greatly affected according to whether liability is for 'costs now and returns later' rests with rich or poor agents". Another possibility would be that the same allocation under different tenure systems, sharecropping or owner-occupation for example, will give different resource allocations. (Lipton in Matthews Ed, 1985) These depend, however, on special assumptions on matters outside the immediate range of the theorem itself. There is no reason to believe that any such special factors are relevant in Darfur and they are not considered further here.)

So far it has been implied that the Coase outcome can only be reached through cooperation or at least through a process of bargaining and negotiation. There is an alternative route: enclosure. This would mean abandoning cooperation, in favour of a minimal level of agreement to respect one another's fences. This route is particularly important because it was that taken in most developed countries and because it has, for a long time, formed a central plank in many development programmes. If it is less popular nowadays, it is mainly because government sponsored programmes to enclose the land and allocate formal rights to it have presented serious equity risks. The better-off are better equipped to get a formal land right registered, for example.

For this reason Lipton dismisses enclosure, on the grounds that its equity implications are unacceptable. But he is principally looking for policy prescriptions. Here the aim is to analyse whether or not the community is trapped in a Tragedy of the Commons and, if it is, why it has not found a way to escape from it. Of the two routes to escape, negotiation and enclosure, the latter is the more likely. Take the situation where "extra-economic power can lead one party to disregard, without penalty, promises to abide by a socially optimal solution." (Lipton in Matthews Ed, 1985) Such power might well stand in the way of a cooperative agreement to control stocking on the rangeland. On the other hand, 'extra-economic power' would be just what is needed to to enable the powerful to enclose and so capture all the benefits of destocking for themselves. The socially optimum level of production would be achieved despite the fact that the distribution of that production would be very far from optimum.

"Gains from trade characterise the Pareto relevant externality". (Buchanan & Stubblebine, 1962) In the Coase column of the example above, the gains from trade are the 4.25 head of offtake that the community saved by bribing the Free Rider not to increase his herd. The transactions cost of arranging the bribe might be so high as to eliminate the gains from trade and render the externality irrelevant. If, on the other hand, the externality is large then the incentive to negotiate will outweigh the transactions cost. As Lipton puts it, a socially optimum solution depends on the strength of the 'temptation of goodness'; the incentive for each Prisonner of the Dilemma to choose the optimum. When looking at ways to escape the Tragedy of the Commons, it could just as easily be the

strength of the 'temptation of badness'; the incentive for each herder to unilaterally enclose an area of range, in breach of customary law, and so capture the benefits of destocking for himself.

There are four phases to the Tragedy of the Commons. At first there is so much range land that the expansion of individual herds does not affect others at all. In the second phase, the gains to the individual who expands are greater than the communal losses he imposes on others. In the third phase, the communal losses are greater than the individual gains but the difference is not enough to cover the costs of a solution. At last, in the fourth phase, "losses exceed gains enough that the light-grazing solution, if enforced on all, produces so much more total herd output than the heavy grazing solution that the difference suffices to pay the cost of social institutions to ensure the light-grazing solution." (Lipton in Matthews Ed, 1985) Or the difference becomes large enough to pay what may be called the 'fencing cost' of the bad, enclosure route. In what follows, an attempt is made to identify into which phase the crop and livestock sectors of Darfur fall. It will be argued that the crop sector falls unambiguous-ly in the second, if not the second, while the livestock sector is clearly nowhere near the fourth and may still be in the second.

There is an important distinction to be made, between congestion and degradation. In Pigou's example of two roads, too many people will use the good one so that they get in each other's way. That is congestion, which might may be called an Annoyance of the Commons but is hardly a tragedy. Degradation, the Tragedy, would occur if the weight of traffic on the good road actually damages it. In poor pastoralist areas congestion itself might well reach tragic proportions, if it were to drive livelihoods down to poverty levels, but there is no doubt that most people consider that degradation is the true tragedy: "the destruction of the long term potential". The distinction is important for two reasons. First, because degradation can occur even on resources that are not free access. If mechanised farming in eastern Sudan is a 'mining' exercise, as is often said, it is not because of free access. Second, because the two are offsetting. By driving down current profits on on a free access resource, congestion may actually prevent the exploitation reaching a 'mining' level.

To put this another way, overexploitation of a free access resource may create two separate externalities: congestion which affects all the herders using the resource at the same time and degradation which affects future generations of herders.

The evidence from Darfur appears to give strong support to Lipton's model. The decay of law and order he describes seems all too evident in increasing tribal fighting. There has been extraordinarily rapid environmental change. Populations have grown rapidly. Both crop land and grazing land are, indeed, largely common access resources. Despite all this, a different conclusion will be reached.

First, the very existence of a significant overgrazing and overcultivation problem is questionable. Some twenty years of intensive research have still not produced a consensus on whether or not African ranges are 'overgrazed' although recent papers suggest that the balance is shifting towards the sceptics' "alternative theory of the functioning of savanna rangelands". (Behnke & Scoones, 1991) The evidence on the condition of the Darfur range is unclear, at best. On the crop land it will be shown below that the pressure on cultivated land has actually decreased. Second, there is evidence enough that farmers and herders are able to convert common land into more or less private tenure, where it is worthwhile.

It will be argued here that the correct conclusion is that it is not worthwhile. The problem is not one of population pressure, developmental change or transition of trust. Instead, it is the lack of any strong incentive or 'temptation' either way, partly because of the technical factors controlling returns to farmers and to livestock owners but more importantly because of the overall stifling and economic compression of the Darfur economy.

RANGE AND LIVESTOCK

There are two questions. Is pastoralism and, by association, free access to rangeland economically inefficient? and Does it cause degradation? Initially, evidence was deemed almost unnecessary. "So many documents, officials and even scientists repeat the assertion of pastoral responsibility for environmental degradation that the accusation has achieved the status of a fundamental truth, so self-evident a case that marshalling evidence on its behalf is superfluous if not in fact absurd, like trying to satisfy a skeptic that the earth is round ... " (Horowitz quoted in Anderson & Grove, 1987) Well into the 1980s this remained largely true and there are still many who will argue in support of the basic premise that African herders keep too many cattle, too many for maximum economic returns and so many that the range is damaged.

The first effect of overgrazing is a reduction in range quality. Some plants are more attractive to grazing animals than others. On overgrazed range these good species are eliminated. The next stage comes when the vegetation as a whole is reduced. This bares the soil to wind and water erosion, which means that plants cannot re-establish themselves. A threshold of irreversibility has been passed. This rapid summary conceals a complex range of

possibilities between a change in plant species composition, that may have no serious consequences, and an irreversible deterioration in the natural resource. Traditional range science held that it was possible to estimate a safe, sustainable carrying capacity. More recent studies have concluded that "the Carrying Capacity concept is of questionable validity in livestock production systems in Africa, that it is virtually impossible to accurately estimate CC, and that the concept cannot be meaningfully applied in pastoral systems." (Bartels et al, 1990)

The concept of degradation on the rangeland has proved almost as difficult to apply. "Direct examination of rangeland vegetation does not, on the whole, provide an unequivocal answer. ... Rates of soils loss and other deleterious changes in the soil may prove to be more reliable than vegetation change as an indicator of irreversible rangeland degradation." (Behnke & Scoones, 1991) But even when soil loss can be shown, as in Botswana studies, it is slow giving a 'residual soil life of 400 years' and the lost production from cutting cattle numbers to try to stop it would be considerable. "Put simply, the immediate costs to producers of destocking would be heavy. The long-term gains in terms of reduced range degradation would be slight. In eastern Botswana, destocking is not worth it." (Behnke & Scoones, 1991) This does not mean that economically significant degradation does not ever occur. But it is worth remembering that Botswana is one country that has seen decades of attempts to halt perceived degradation.

Some studies have suggested that the African savannahs are "highly resilient with a strong tendency to return to a central equilibrium despite disturbance." (Homewood & Rogers in Anderson & Grove Eds, 1987) This resilience depends on the vegetation's ability to reproduce rapidly, even under stress, the heterogeneity of that vegetation, the fact that animals cannot graze under the ground so root systems survive and many other factors. Furthermore, "Attempts to protect savanna against disturbance may reduce this resilience." If, for example, the range is sown with one fodder species then it is wholly dependent on that one species' ability to survive instead of on a range of species.

Ambiguous evidence has not hindered the debate on the causes of overstocking. Once the axiom that African herders keep too many animals is accepted the scope for discussion becomes infinite. A supposed difference between western and African pastoralist 'management goals' has been a frequent feature. In its early form, the idea was that there was an 'East African cattle complex', whereby African herders put social values on cattle ownership over and above the financial return. Latterly, there has been a shift towards more 'rational' explanations. For example, that Western ranchers prefer low stocking rates that give maximum growth rates for young animals because they want rapid production of high quality meat. "The (African) subsistence pastoralist is more likely to see as optimal a stocking rate which supports a larger number of animals (with) a higher output in terms of the much wider range of desired products - milk, calves, subsistence and security for a large number of people." (Homewood & Rogers in Anderson & Grove Eds, 1987) Although superficially logical, these ideas are irrelevant to the problems of congestion and degradation. Inadequate fodder will have just as great an impact on a milk cow's production as on a heifer's weight gain and would almost certainly raise the risk of losses. There is no <u>a priori</u> reason why degradation should not affect both western beef herders' and pastoralists' future returns from the same resource equally.

The evidence points to more straightforward explanations. "African pastoral systems, with high labour but low capital and fossil fuel inputs, have a higher output per unit area of land than extensive Western ranching enterprises." (Grandin, 1987) In other words, differences between African and western systems reflect straightforward economic factors, principally massive differences in the returns to labour. One implication of this should be underlined: that a shift from African to western systems will result in a reduction in output and hence in incomes. Even if the African way is not sustainable, such a change cannot really be advocated.

Another 'rational' explanation of African overstocking is risk. It is suggested that subsistence pastoralists have to keep large herds to ensure their minimum needs in a risky environment. It is even suggested that cattle become a 'store of value' and monetarist analyses of cattle stocks have been attempted. It is more revealing to look at the balance between risk and reward: "a conservative stocking rate always carries a cost - the forage which cannot be consumed and the livestock production which is thereby foregone in good years because livestock numbers are insufficient to consume all available feed. As Sandford has shown, this cost increases as the variability of rainfall increases ..." (Behnke & Scoones, 1991) Less conservative stocking is more efficient because it captures the benefits of good years but it does lead to inevitable die-offs in bad years. It is these die-offs that give observers trained in western livestock management the constant impression that African herds are on the point of disaster and that the African range is grossly overstocked.

To argue that there is no 'cattle complex' does not invalidate the basic mechanism of the Tragedy of the Commons, which explicitly assumes rational economic behaviour. What it does do is remove some of the extraneous explanations for the failure to reach a Coasean solution. Similarly, the growing recognition that the perception of universal overgrazing may be false does not explain why institutions to control stocking, be they

social controls or enclosure, have not developed naturally, nor why they have been such abject failures when introduced. Even where common access does not lead to a tragic crash in the quality of the resource it may still act as a barrier to investment and prevent the introduction of more intensive and profitable techniques. It can also lead to misallocation of resources. Because no economic rent is paid for the range, too much labour and capital may be employed in livestock management. (Gould, 1972)

To sum up, there have been three approaches to the question of overstocking. One is to attempt to measure directly the balance between the number of animals and the capacity of the range to support them. The second has been to try to demonstrate that African herders will have too many cattle by <u>a priori</u> reasoning, because of the assumed special conditions they live in. Those conditions may be social, such that they suffer from a 'cattle complex', or socio-economic where they are risk-averse, subsistence pastoralists. The third is the 'Tragedy of the Commons', another *a priori* argument but a more general one. The evidence from Darfur does not support any of them.

LIVESTOCK MANAGEMENT IN DARFUR

Western Sudan is one of the most important livestock producing areas in the whole of Africa and Darfur is the most important in Sudan. In the 1977 census, the region held 23 percent of all cattle in the nation, 16 percent of sheep, 21 percent of goats and 15 percent of camels. The Darfur cattle herd was nearly twice the size of any other province. (VRA/RMR, 1977) Survey results have fluctuated but it is clear that well over 40 percent of Darfur households own cattle and as many as 60 percent own goats. Some 20 percent own camels and 10 percent sheep, both of which are more important in the northern province. (WSDC, 1985)

The majority of Darfur livestock is owned by farmers, to whom cropping is at least as important as herding. Even among the most famous cattle keeping tribe of all, the Rizeiqat of southeastern Darfur, only half were identifiably nomadic in 1976; nomadic in the sense that they were living in 'nomadic dwellings', the famous Bayt al Arab tent of woven mats. (Adams, 1982) The fact that most owners are settled farmers does not mean, however, that the livestock is also settled. Because of the climate, mobility is critical. In the south/east section of South Darfur, the most important cattle producing area, over fifty percent of farmers who owned cattle trekked their herds a significant distance away from their cultivation for at least part of the year. (WSDC, FS83)

The herders' strategy is to take maximum benefit of the wet season and to survive the dry season. In South Darfur this means taking the herds onto the higher basement areas during the rains. The majority of calves are born in the late dry and early wet season: 77 per cent between March and June in 1973. (HTS, 1974) The herds' peak production period follows. Milk is plentiful and the animals gain weight as they make the most of the good rainy season grazing on the basement. Much of this becomes inaccessible later on, after the pools of standing water dry up. Even if it were accessible, the quality of grazing falls off fairly rapidly once the rains stop. The sheer volume of fodder remains the same but the grasses lose protein value rapidly as they dry. (HTS, 1974) Western experts bent on conservation suggest that herders should reduce the pressure on the wet season range and save some of it for the dry season when it will be short. Even at this seasonal level, however, Sandford's point stands; that it is better to 'track environmental variation', grazing as much as possible during the rains and aiming to do no more than survive the dry, rather than struggle to find some optimum, steady level of production through the year.

During the wet season, the low lying alluvial areas are avoided. They flood, movement becomes difficult and flies become a major pest. The farm land is also closed to all livestock during the rains, once the crops are established. It is opened again after the harvest is over, a moment called the <u>Talaqa</u>. During the dry season, it is essential to get to an area with enough grazing in reach of reliable water before it is too late. Once the herds reach one dry season area it may become impossible for them to move again because there is no grazing or water on the way to another.

"Rainy season migration is a lot more flexible than was previously thought. Migrations can no more be described in terms of lines of movement but more in terms of a diffuse kaleidoscopic pattern." (HTS,1974) The movement can be divided into three levels. Some herds do not move far, grazing just outside the cultivated area during the rains and moving back into it after the <u>Talaqa</u>. Then there are herds which move greater distances during the rains but which also return to a base in the area of settled farming during the summer. Lastly, there are the herds which travel away from the cultivated area in the dry season as well as the wet. Many of these go considerable distances to find good reserves of dry season grazing and water. The movement of the Rizeiqat herds south of the Bahr al Arab and of the Fellata and Taaisha south and west into the Central African Republic are the most well known. As might be expected, it is the larger herds that are most frequently trekked, often with hired herders.

The sandy goz lands of the south/east, which are so important for cropping, are poor grazing. In the dry season there is no water to be had, except expensively at boreholes. During the wet, the basement offers better grazing. In the western world, agricultural development has sprung from the integration of livestock and crop farming, allowing manuring, fodder rotations and all the other yield enhancing improvements of the agricultural revolution. The Tragedy of the Commons, if there was such a thing, was solved almost incidentally by the enclosure movement that accompanied the agricultural revolution. The special nature of the goz - profitable crop land but poor and waterless grazing - is only one of many factors that make it unlikely that the western experience can be repeated in Darfur.

Many of the boreholes drilled in the eastern half of the region were intended for livestock use, with the aim of easing pressure on the rangeland, long believed to be overstocked. Nevertheless, herders avoid the boreholes because of the cost. For three out of the four seasons, they depend almost entirely on standing water in pools. In the hot summer months the majority use hand dug wells. In 1984, 70 per cent of nomadic herders used wells during the dry season and 60 per cent of stock owning farmers. Although the wells are cheaper than water bought at a wateryard, it still costs money to get the wells dug and it is very hard work to raise enough water for a large herd from an average depth of five metres. At the height of the dry season some wells may be in use twenty four hours a day. (WSDC, NS84)

As in much of Africa, discussions of livestock in Darfur have focussed on nomadism and on groups perceived to be nomads. An ethnic dimension is added by virtue of the fact that the majority of the Arab tribes of Darfur call themselves 'Baggara', meaning cow people, or 'Jammala' meaning camel people. The reality is, however, that the majority of the herd is in the hands of farmers, that is to say those whose interest in cropping is significant and in most cases greater than their interest in livestock. In 1970 and in 1971 the largest number of cattle sold in Nyala, by far the greatest market in South Darfur and one of the largest in Sudan, came from the Fur tribe, who are neither Arab nor Baggara. (HTS, 1974) The truth is that it is impossible to draw a clear dividing line between nomad and settled management of livestock. There is a continuous spectrum between the wholly sedentary herder whose cattle do not move at all during the seasons and the wholly nomadic one who never stops moving. Individuals shift position along that spectrum according to their own circumstances, more or less regardless of tribe.

One reason the distinction between 'nomadic' and 'sedentary' was believed to be important was the fact that comparisons appeared to show that nomads are better managers of livestock. Nomadic herds had higher calving rates, 65 per cent against 40, and lower mortality. As a result, production was nearly twice as high: 0.057 kg of meat per breeding female compared to 0.023. (Adams, 1982) The evidence that nomadic herds do better is not beyond question. The figures quoted were taken in 1973, a dry year when sedentary herds might have been expected to suffer. They ignore milk production, when milk for the household is proportionately more important for the smaller sedentary herd. Surveys from a later period showed exactly opposite results: higher calving rates among sedentary herds than among transhumant ones. (WSDC, 1985)

Nevertheless, it seems probable that on average herds that move further will produce more. They will be able to reach better grazing during the rains and will be less likely to come under stress during the dry season. To conclude, however, that nomads are better managers of livestock is to misunderstand the meaning of efficiency; which is not properly measured by the calving rate or by mortality. The true measure is the total return a household gets from the effort it puts into managing not merely its livestock but all its enterprises. A farming family is sensible concentrate on its crops at the expense of its livestock. And the argument is reversible. It would be equally wrong to accuse the nomads of being bad farmers because their yields are lower. They too would merely be making the decision to concentrate their effort on their animals without abandoning crops altogether.

The nomad-sedentary divide was given further emphasis by the belief that disputes between herders and farmers indicated serious tensions. "Cultivated areas often represent an obstruction out of proportion to their size and yield, both because of their location across migration routes and because graziers are obliged to give them a wide berth." The result was that at one stage it was intended to rationalise land use by resettling cultivators out of the nomad herds' way and so "polarize the rural economy into a predominantly transhumant livestock sector and a crop sector with supplementary livestock enterprises." (HTS, 1976)

The 1970s surveys in South Darfur did show very clearly, beyond any possible doubt, was that the 'East African Cattle Complex' was dead and buried. Livestock herders are as aggressive profit maximisers as any Wyoming rancher. This is true throughout the region. In the far north-west just as much as in the central cattle keeping areas of South Darfur. "The predominant interest that the Zaghawa have in their livestock is as economic assets; there are no indications of the kind of relationship associated with the East African 'cattle complex'" (Tubiana & Tubiana, 1977)

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Earlier studies in Sudan emphasised social aspects of stock-keeping, especially among the most famous cattle people, the Baggara Arabs. "In kinship, in marriage, and in politics, cattle serve a common purpose in that by investing in them a man is investing in social relationships; he is attaching followers to him. In short, cattle are power." (Cunnison, 1966) A better understanding came from the realisation that even groups with a supposedly strong 'baggara ideology' frequently made investments in agriculture even to the extent of putting their major efforts in that direction and that, conversely, cultivators were major stockholders and sometimes even took up a strongly nomadic pattern of life as a result. Ideology is secondary to economic motives. (Adams, 1982)

This went considerably further than a mere acknowledgement that pastoralists had a rational approach to maintaining their subsistence. Herders were found to be deeply involved in the market. It is usually argued that the pastoral family has a minimum subsistence requirement of milk and meat which only a certain size of herd can meet. As a result, "it is rational for a herder to accumulate a large herd to produce milk for his family as well as to provide an insurance fund and portable bank." (Dahl & Hjort quoted in Eicher & Baker, 1982) The Darfur cattle owner is not of this class at all. Not even the most nomadic herders subsist merely on meat and milk. They buy grain by selling their cattle. Cattle are rarely slaughtered for domestic consumption, outside of ceremonial occasions, and the strongly seasonal pattern of calving and the lack of grazing in the dry season mean that a year-round milk diet is impossible. Many herders will admit that a milk only diet is boring anyway. In 1983, even among households towards the 'nomad' end of the spectrum, grain consumption was as high as among settled farmers. On average they purchased 12.8 sacks of grain per household and they grew 5.9 sacks themselves, giving a per capita consumption of over 200 kilogrammes, when the average for Darfur is usually estimated at around 150 kilo. (WSDC, NS84)

Once market exchange is involved it becomes impossible to calculate a 'subsistence' herd size because it will depend on the relative price of grain and cattle, which is highly variable. (Eicher & Baker, 1982) Darfuris are well aware of this and some can recount in detail how they built up their herds by growing grain when it was expensive to buy in stock and then ran them down again when cattle became the more valuable. The extraordinary increases in offtake during both world wars are extreme examples of that process.

Herd management is clearly intended to achieve the maximum sales earnings. "Herd structures are generally well adapted to the physical environment and to the marketing constraints." (Adams, 1982) Those who believe that the range is overstocked almost always suggest that herders keep their animals too long. If they were to sell them younger, then the same or even a higher production might be achieved with fewer animals on the degraded range. Many livestock development projects in East Africa have tried to bring about greater 'stratification' of livestock management, whereby herders are persuaded to sell their animals to specialist fatteners at a younger age, thereby reducing the size of the herd on the range. (Bennett, 1984) In Sudan the Livestock and Meat Marketing Corporation was established partly with this objective, with World Bank money. The price structure of the Darfur market gives no incentive for stratification. The market for young stock is restricted because it is only when a bull reaches maturity and is in good condition that it can make the long trek to Omdurman, to be slaughtered for the Khartoum market or even to be exported. These were prices cattle owners actually received for the various classes of cattle in 1984:

Average Sale Price Per Head

		£s		
Madmun	(12 - 18 Mths)	83		
Jad'	(18 - 24 Mths)	103		
Tani	(2 - 3 Years)	215		
Raba'	(3 - 4 Years)	232		
Adult	(> 4 Years)	212		
			2	

Source: WSDC-Unpublished Data

Selling an animal under two years meant passing up \pm s100. Keeping it for an extra year to four still earnt \pm s15. Drought and rinderpest in 1983/84 meant that herders were keen to sell and the price gradient is probably steeper in better times.

While the return from keeping an animal until it is older is high, the extra cost of doing so is negligible. Grazing is free and cattle taxation is low, when it is collected. Other running costs include watering, herding and animal health but these did not exceed \pounds s4 a head in 1983/84. (WSDC, NS84) As would be predicted from these figures, less than 30 per cent of cattle sales are of animals less than two years old. Over 50 per cent are over three. (WSDC, 1985) Also entirely in keeping with hard commercial sense, males are sold first. The proportion of adult males in the herd is small, around 7 percent, and adult females for breeding form the core of the herd, over 40 per cent.

There is, however, one important potential cost to keeping animals for longer: the risk of losses. If that risk is high, it might well be sensible, for example, to sell a three year old, Tani bull. To hang on for an extra year would mean risking the loss of over f_s s200 worth of bull instead of gaining an extra f_s s15.

It is often argued that risk is a major reason for keeping large livestock herds, as an 'insurance fund and portable bank.' Here too, the argument only holds for the subsistence case, when the pastoralist is presumed to be out of the market. If, for example, a household has to guarantee itself ten cows in milk to survive and if mortality is high and calving percentages are low, then it will have to keep a large breeding herd to ensure that its needs are met. By contrast, where the household is producing cattle or milk for sale, a larger herd merely becomes a bigger gamble on a risky proposition than a small one. If the owner could find a safer home for his money, then he would do better to sell a portion of the herd and so lessen his exposure to the risks of drought, disease and poor markets.

Darfuri cattle owners are very much in the exchange economy. If, therefore, their cattle are an 'insurance fund', then the risks being insured against are outside the livestock sector. That is to say that they may be balancing the risk of a poor crop harvest against the separate risk of poor livestock performance, in the hope that the two do not coincide. Livestock have one advantage in this respect and that is that they can be moved. Even if the rains fail on the farm and the crop is lost there is some chance of reaching grazing elsewhere before all the herds are lost.

The conclusion is that Darfuri livestock owners are entirely rational and that they keep the numbers of animals they do for the good reason that it is profitable. If they do treat them as a store of wealth it is because there is no alternative investment which provides any better combination of security and return. If the Darfur range is overstocked the reason does not lie in any 'cattle complex' or in the special strategies of subsistence or risk-avoidance.

LIVESTOCK POPULATION AND CARRYING CAPACITY

The difficulties with the concept of carrying capacity have been described and Darfur is no exception. To demonstrate overstocking it is necessary to know what the livestock population is and to compare it with what the rangeland can safely and sustainably carry. It has proved extremely difficult to measure either the population or the carrying capacity.

The only comprehensive estimates of total livestock numbers in Darfur date from the 1970s and earlier. Clearly, there may have been considerable changes since then, above all as a result of the 1984 drought, when there must have been some reduction in the numbers, especially in North Darfur. It is impossible to assess how great the reduction was or how rapid the recovery has been. It has to be emphasised, moreover, that all estimates of livestock numbers are hugely imprecise. Several attempts were made to count livestock in South Darfur. Two used similar aerial census techniques and others the completely different approach of sampling numbers at waterpoints. The results were all hopelessly inconsistent, summed up in the despairing comment that "No useful purpose is likely to be served by any further direct counts of livestock in the project area in the foreseeable future." (HTS,1981) The most comprehensive and recent survey was the aerial census of 1977. The figures at least give some indication of the scale of what is being discussed:

	Livestock Numbers in Darfur	
	1976	
Cattle	3,600,000	
Goats	2,300,000	
Sheep	2,600,000	
Camels	370,000	

Source: VRA/RMR, 1977

A central plank of the 'overgrazing' argument has been that the livestock population has seen explosive growth in the 20th century. It is argued that the Africa-wide rinderpest epidemic of the late 19th century, combined with smallpox and the wars and movements of people during the period of the Mahdia reduced both population and livestock numbers to very low levels at the start of the Condominium era, in 1899. The extent to which this represents colonial propaganda against the Mahdist regime is impossible to assess. Under the Condominium, the situation was very different. "By the end of the 1930s, the increased use of motor transport by veterinarians anad the discovery of certain vaccines, together with political stability, enabled the livestock population to expand. About 1945, livestock numbers were probably on a par with carrying capacity; in 1955 Harrison reported that the Baggara territory was 20 per cent overstocked. Between 1953 and 1976, the cattle population more than trebled."

(Adams, 1982) The pan African JP55 Rinderpest vaccination campaign of the early 1970s may be seen as the last step in the expansion of livestock populations assisted by security and veterinary advances.

Similar statements may be found about many other parts of Africa. "From 1930 on Baringo (in Kenya) is repeatedly identified as having a major land-use problem, with erosion surveys rating it among the worst in the Colony." (Homewood & Rogers in Anderson & Grove, 1987) However, few of them show quite so clearly as the Sudan reports, the inconsistency between a report of 20 per cent overstocking and a subsequent continued massive growth in numbers. What, after all, can 'overstocking' possibly mean if numbers can still be trebled without reaching a catastrophe?

On the figures given to back up this argument, the period between 1953 and 1976 saw cattle populations increase at 5.8 percent per annum. Over roughly the same period human population was growing at only 2.7 per cent. Although it is possible that the rate of human population growth is underestimated, it is unlikely that it was much over 3.0 per cent, which still leaves a considerable gap. Such a wide divergence is difficult to believe. Pastoral herding is relatively labour intense and an individual household can only manage a certain number of animals. The twentieth century has also seen a rapid expansion in crop farming inside Darfur and vastly improved opportunities for labour elsewhere in Sudan or abroad. The proportion of labour devoted to herding must have decreased as a result. On the other hand, it seems probable that there was a shift from dairy production to beef. Ghee (Ar Samn) used to be a major Darfur product and a significant Sudanese export up until the late 1940s. With rising demand for meat and the introduction of cheap vegetable oils, ghee is now an insignificant luxury item. Reduced milk and ghee production must have released some labour but not such as to outweigh the other factors drawing labour away from the livestock sector.

The only reasonable conclusion is the rate of increase in livestock populations is unlikely to have exceeded the rate of population growth. It is more likely that the average herd owned by each family is smaller than it used to be, that is to say that livestock has expanded less rapidly that the human population.

This does not mean that the pressure on the range was not considerably increased. If, for example, livestock populations grew at 2.5 percent between 1953 and 1976, then the Darfur herd would have been 76 per cent larger at the end of the period. Such a large increase makes it difficult to accept the 1955 reports that the range resource was already 20 per cent overstocked. Indeed overstocking had already become an issue twenty years before that, in 1935. (Gillespie, 1965) Vaccination, which was supposed to be the major factor causing increased herds, was actually restricted for fear of overstocking as early as 1944. (Fisher quoted in Adams, 1982)

In the 1970's intensive attempts were made to estimate carrying capacities in terms of standard livestock units (lsu) equivalent to 300 kilogrammes of herbivore biomass. In 1976/77, the National Livestock Census showed stocking densities of 11.8 lsu per km² in South Darfur and 3.3 for North Darfur. (VRA/RMR,1977) As averages these conceal the fact that the better areas are more heavily stocked while others are of little use for grazing. Nevertheless, range surveys at the same time estimated that a stocking rate of 10 lsu per km² in the better areas of South Darfur would prevent further range degradation. That is to say that the 'safe rate' on the better areas was less than the average rate for all areas, good and bad. It was estimated that on the two most important zones for livestock, the basement and the baggara alluvium, the stocking rate was about twice the safe level. (HTS, 1974,1976) This is not quite as "embarrassing" as a report from Somalia of "rangelands chronically overstocked at rates 8 times in excess of their capacity" but it is still quite implausible. (Behnke & Scoones, 1991)

The conclusion was, nevertheless, that the region was massively overstocked and that the hardier and more prolific classes of stock, above all goats, were expanding at the expense of cattle. Survey results appeared to show such a shift, with the implication that livestock production was in long term decline. Expansion in the first part of the century had put excessive pressure on the range. Increasing population was diverting range land to cropping. The drought of the late 1960s and early 1970s was only accelerating an existing downward trend. Furthermore, the ever decreasing performance of cattle herds would force more owners to turn to cropping so the process was actually self-reinforcing. Disputes over cattle movements, crop encroachment on stock routes and so on were all seen as evidence of this same trend.

The premise that the Darfur ranges are overstocked is still widely accepted, as it was in most of Africa until very recently. All development plans since the 1970s have been based on the belief that there was serious pressure on the land resource. "The decline follows the familiar pattern: de-vegetation, soil erosion, falling crop yields and herd productivity, coupled with an increase in migratory labour. The major factors are pressure of population and stagnant technology, wasteful of natural resources." (Adams, 1982)

Given the difficulties of measurement it is unlikely that a definitive answer will ever be possible. Indirectly, however, overstocking is looking increasingly implausible, simply because all attempts to tackle the problem meet with indifference from those who are supposed to be suffering from it and because the cry of overstocking has been raised so often and for so long, while stock numbers just keep on growing.

THE 'TEMPTATION'

To be certain that Darfuris are aggressive, market oriented keepers of livestock does not conflict with the Tragedy of the Commons, which predicts that overstocking will occur even when economic agents behave entirely rationally in the search of maximum profit. Nor do doubts about extent of environmental degradation disprove the contention that communal range land leads to significant economic losses from congestion or a combination of congestion and degradation. Despite advances in range science, it still seems unlikely that it will ever be possible to answer these questions by direct measurement. An indirect approach may be taken by returning to Lipton's twin parables of the Prisoners' Dilemma and the Coase Outcome, in particular to see if the value of the temptation to shift to the 'light grazing solution' can be estimated.

In the example set out above, there was a community of herders using a common range one of whose members was a Free Rider, who would always increase his herd at the expense of his neighbours if given the chance. By reversing the before and after situations the example can represent what was believed to be the situation in Darfur. The Free Rider has increased his herd, negotiations have failed, the range is overstocked and the offtake rate has been reduced from 8 per cent to 7.5 per cent. The community wants to destock and to restore the productivity of their herds and they are willing to share the reduction proportionately between themselves and the Free Rider. The table then reads as follows:

	Before	After
Communal Herd	900	891
Communal Offtake	67.50	71.28
Free Rider's Herd	110	109
Free Rider's Offtake	8.25	8.72

The shift from 'before' to 'after' here represents the outcome of a successful attempt to raise range productivity by destocking. It should be noted that the 'before' column and the 'Coase' column in the first example and the 'after' column in this second example all have the same total herd and the same total output. However, the distribution of that output between the community and the Free Rider is different in every one. They are, in effect, all Coase Outcomes, illustrating the point that differing allocations of rights and differing distributions of income do not affect the total product in the Coase model.

Once again, the example shows that it should be possible to do a deal. Both parties are better off if they all destock. A failure to do so presumes that neither of the two possible routes to escape from the Prisoners' Dilemma of non-cooperative misery can be taken:

- for either or both sides to unilaterally fence off their share of the common area and so break out of their dilemma by going their separate ways. This might happen amicably or by force. One of the two parties might, for example, be able to make an investment in 'aggressive overstocking', so as to drive the other off the range. Once he had done that he could capture all the gains of destocking for himself. Perhaps more likely would be for one side to use simple force majeure to achieve the same thing.
- 2. for all parties to negotiate a rational arrangement for stocking control.

Two arguments could be put forward to explain the failure to take one or other route in Darfur. One is that the traditional consensus in favour of open access to rangeland remains too strong to allow enclosure. Another is that political and economic changes had destroyed earlier arrangements under which the larger tribal groupings controlled movements between their respective areas of rangeland by agreement. Post colonial biasses against the nomads and the relatively intensive efforts made by the Condominium authorities to manage tribal relations counted against those arrangements. "Any policy which tolerated nomadism was dismissed as colonial." (Adams, 1982) This is a reversal of an argument put forward to explain similar problems in East Africa, especially Kenya, where it is argued that it was colonial penetration that first destroyed the 'adaptive' tribal institutions that prevented abuse of the rangeland. (Bennett, 1984)

There remains, however, a more fundamental problem. The cattle owners of Darfur do not appear to regard the range as being overstocked, at least not so much as to wish to tackle the problem. They certainly appear to take a more relaxed attitude to range quality than most outsiders. Under the WSDC programme single villages were encouraged to enclose relatively large grazing reserves and given considerable support in so doing. This

included all the necessary administrative measures to ensure their legal rights to enclose. This did not lead to any obvious measure of destocking. More importantly, the people of the community allowed outsiders to bring their cattle inside the enclosure, more or less destroying the point of the exercise. Again this parallels experience elsewhere. "The Samburu voted out all grazing schemes when given the opportunity to do so in the late 1960's." (Bennett, 1984)

The customary position on rangeland is summed up in the saying that three things are free: "<u>Al Hawa wa Al Ma'</u> <u>wa Al Kala</u>''' - air, water and pasture. "It is customary for any member of a tribe to have the right to graze his animals at will over the tribal land of his tribe providing that they cause no damage to cultivation or to gum gardens. The responsibility of keeping animals out of cultivation and gardens is on the herdsman. Grazing boundaries exist between tribes where ill-feeling has made them necessary. Similar boundaries may exist between sub-sections of a tribe or adjoining villages but they are an exception to the common practice. Strangers are required to gain permission to graze their herds." (Tothill Ed, 1948)

Contrary to later views on Sudanese developments and, more generally, to Lipton's argument that change has undermined "old chiefly authorities and clan-like decisions", the situation at the end of the colonial era was very loose. This was at a time when the tribal leaders' authority, which had been supported by the Condominium, was at its height. Despite this the only restrictions on the movement of livestock were those required to avoid damage to crops, except where there were special reasons for tribal tension. The situation has not changed. Livestock herders are still required to avoid cropped areas during the season and farmers should not crop on acknowledged livestock routes. The principal routes (ar Murhal) are defined by custom and latterly enshrined in local government orders. They are supposed to be 40 ropes, or 120 metres, wide. Each main route has many subsidiaries branching off it and even running parallel. Stock usually travel quickly along the major routes running between cultivated areas in order to reach the more open range where the herds can spread out and settle to graze. Farmer herder clashes are mostly the result of a herder loosing control of his stock in transit, not because of direct competition over grazing land. (This is not to say that the 'loss of control' is always innocent.) For the same reason, herders resent cultivation because it blocks access to grazing or, especially, to water, not because of the loss of pasture. In normal times, there are acknowledged procedures for negotiating compensation for damage done to crops by livestock. A few hours inadvertence by a herder can result in him having to sell two or three head of cattle to pay compensation.

To sum up, the customary procedures mediating between herder and farmer were designed to facilitate movement, not to control stocking. It is not irrelevant that one of Coase's examples of how the market can handle externalities is precisely that of cattle trampling crops and Darfuri customary arrangements that are still in place prove his point; that given clear rules compensation arrangements can and do work. (Coase, 1960)

On the other hand, the well defined customary position, that rangeland is free, is being breached quite widely. Both communities and individuals are establishing enclosures of which the purpose is clearly rather more than just the protection of crops. These enclosures are known in the local phrase as Zara'ib al hawa, or 'enclosures of air', a sarcastic reference to the traditional wisdom that three things are free: air, water and range land. In the mid-1970s at the village of Diri, west of Nyala, "about 30 people worked for 10 days constructing a communal enclosure for the village herd." There were also individual attempts to "enclose pasture by Zeribas." (Haaland Ed, 1980)

Behnke, working in the same area in 1984, developed this to show that the degree to which range land was being enclosed and crop land acquiring more individual tenure depended on the distance from the major urban centre of Nyala, an important market for fodder. (Behnke, 1985) In the JMRDP area, a relatively recent trend is the gradual extension of a plot cleared from virgin bush, year by year, until it includes an area of fallow. The cropped area is then rotated within the fenced area and the fallow produces a crop of natural grass which may be cut and stored. (JMRDP/HTS, 1985) In yet another part of the WSDC area, the alluvium of southern district, transhumant herders reported that they had bought the right to graze over enclosed land, in most cases pure grassland not just crop land left to fallow. (WSDC, NS84) All of the above instances indicate a move towards the enclosure of rangeland by groups or individuals to conserve fodder, in many cases for sale rather than for the household's own livestock.

To sum up, neither traditional structures nor Lipton's four factors of population growth, development change, risk aversion and 'transition of trust', adequately explain why the Darfur herders have failed to escape the Tragedy of the Commons. Where it is worthwhile, Darfuris are perfectly capable of finding both escape routes from the Prisoners' Dilemma: negotiation and enclosure. Negotiation forms probably the biggest single part of Darfuri social action and there is no solid reason to believe that the proportion of failed negotiations is any greater in Darfur than it is in the developed world. Where the need for rules to organise negotiations over externalities are needed, to control transit damage by livestock, they exist and usually work. (Alternative explanations for the

undoubted increase in tribal disputes and tensions are discussed later) Similarly, where enclosure is likely to be worthwhile, Darfuris are happy to do it, regardless of the overt consensus against it. It should be stressed, moreover, that there is no evidence of attempts to resist these enclosures. Given the ample evidence that Darfuris are willing to fight and kill in defence of their interests and given the lack of customary or legal support for enclosure, this is a strong indicator of the weakness of that consensus.

There is only one conclusion really left, that the incentives to tackle overgrazing are too weak: that the benefit to be gained from controlling stocking is too small to justify the effort of enclosure or of negotiation.

A return to the Prisoners' Dilemma helps to illustrate the possibilities:

The Community

			NO CHANGE	DESTOCK
e	Herd	NGE	100 : 900	190 : 810
S id	Output	CHA	<mark>8</mark> : 72	15.2 : 64.8
С С	Total Output	NO	80	80
9	Herd	сK		90 : 810
Ð	Output	STO	Nul Case	9:81
Ч Н	Total Output	D		90

Note: for simplicity, output is assumed to be an adequate indicator of returns net of costs.

The columns show the choice taken by the Community, to keep stocks high or destock. The rows show the Free Rider's choice. (It is assumed that the Free Rider will certainly not destock if the Community does not so the bottom left box is empty.) In each box, the situation that results from the combined choice of both parties is shown, the Free Rider's herd size and output on the left and the Community's n the right. The current offtake rate if neither party destocks is eight per cent. If the total herd could be cut by a tenth, that would rise to 10 per cent. If the Free Rider decides not to cooperate, he will increase his herd to take up the slack created by the Community's destocking and total output will not change. Instead the Free Rider's share of the total, overstocked, output increases.

What would happen if the Community offered the Free Rider a trade. To do this they might have to offer him as good a deal as he would get from increasing his herd to 190 and capturing all the gains of their destocking. Can they do it and would it be worth it? The answer is yes:

Community's cooperative gain:	81 - 72	=	9
Free Rider's non-cooperative gain:	15.2 - 8	=	7.2
Free Rider's cooperative gain:	9 - 8	=	1
Community bribe to Free Rider:	7.2 - 1	=	6.2
Community gain minus bribe:	9 - 6. 2	=	2.8

How implausible is this? In some ways very. The Community's net gain is small, only four per cent of their original offtake. In the real world, moreover, the transactions costs between a community of thousands and potentially hundreds of free riders would be very high. However the real point of the model is to emphasise the very narrow range within which the Tragedy of the Commons can be operative; the narrow range in which the externality is relevant. A relatively small change in the assumed improvement in the offtake rate can shift the numbers either downward, to where it is not worth anybody's while destocking, or upward to a position where even the Free Rider unambiguously gains from cooperation.

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In the example it is assumed that a ten per cent reduction in the size of the herd will generate a 25 per cent improvement in the herd's performance: from eight per cent to ten per cent offtake. If herd performance improves only 11 per cent it is not enough to compensate for the reduction in numbers and offtake does not increase at all. On the other hand, if the performance is doubled by destocking then the Free Rider gains just as much from cooperating as he does from stealing the Community's reduction in numbers:

Offtake	Community's	<	Free Rider's Gain	>
Rate - %	Cooperative Gain	Coop.	Non-Coop.	"Bribe"
8.9	0.0	0.0	7.2	-
10.0	9.0	1.0	7.2	6.2
11.0	17.1	1.9	7.2	5.3
15.0	49.5	5.5	7.2	1.7
20.0	90.0	10.0	7.2	0.0

Clearly, well before the position is reached at which the Free Rider is unambiguously better off, the amount needed to bribe him to cooperate becomes diminishingly small compared to the Community's gains.

As noted, the 'offtake rate' shown in the example should be taken to be net of costs. An important part of the benefits from destocking might be expected to come in the form of costs saved when the herd is smaller. That does not, however, affect the basic point which is that the Tragedy of the Commons position is essentially unstable; changes in costs, returns and technical productivity are all likely to push it down, to a position where there are no relevant gains to be made from the establishment of institutions to control over exploitation of the free access resource, or up to a position where the gains are so great that the incentive for all parties is towards resolving the problem.

In economic terms, a free access resource is overexploited in the sense that more of variable factor of production (typically labour) is employed in exploiting that resource than is optimal. Where more than one factor is used, one of them may create a greater externality than the other and the result will be that the combination of factors used will also be distorted. Because this will be inefficient, there will not only be overproduction off the free access resource. That production will be unnecessarily expensive as well. (Gould, 1972) As far as the Darfur range is concerned, the two factors are labour and the capital value of the herd. Clearly, it is the herd size that creates the twin externalities of congestion and degradation, meaning that the problem lies in excessive application of capital.

Using data from Darfur and Gould's model, it is possible to make some estimates of the current level of the incentive to control overstocking. The model is as follows:

The production function is such that::

X = X(K,L,M)

and it has constant returns when all factors are variable, diminishing returns when M is fixed.

By Euler's theorem, the total output X is divided amongst the three factors according to their marginal products as follows:

$$K.mpK + L.mpL + M.mpM = X$$

On standard assumptions, the marginal product of capital (mpK) equals the market return on capital (R), and the marginal product of labour (mpL) equals the wage rate (W). Since rangeland is a free resource the marginal product of rangeland (mpM) equals the market price, zero, so that::

$$K.R + L.W = X$$

Using data from a WSDC survey of the larger tranhumant herds in Eastern District of South Darfur, the most important cattle producing area of all, the following estimates can be made:

Cattle herd:	100 head
Sheep:	50
Goats:	20
Total capital value:	£s 13640
Family Labour Herding:	1095 mandays (3 x 365)
Daily Wage:	£s 1 per day
Total Revenue:	£s 2035 (stock sales plus small amount of ghee)
Running costs:	£s 396 (Veterinary, water etc)
	Source: WSDC, NS84

From these figures the return on capital may be estimated as follows:

13640.R + 1095.1 = 2035 - 396

$$R = 3.99$$
 percent

The subsistence value of livestock products can be left out of the equation because they form part of the wage and would, therefore appear on both sides of the equation and cancel out. The wage rate shown is low compared to contemporary surveys of the farm sector, which show a return on family labour of around fs2. This partly reflects the missing subsistence value of livestock products, but also the fact that farming does not offer the same 365 day employment as herding. Wages paid to labourers raising water for the cattle in the survey were paid between fs 30 and fs 50 per month plus food, supporting a 'family wage' of around fs1. One major cost has been excluded, mortality. Losses recorded during the survey were high because of poor rainfall and rinderpest but it is assumed for analysis of the longer-term situation that losses on average balance out. Drought and disease may also have driven down prices at the time of the survey. However, this should have been balanced out to some extent by the fact that both the revenue and the capital value of the herd were calculated using the same market prices.

The purpose of this calculation is to get back to the question of the incentive to deal with the problem of overstocking. This may be done by looking again at the original equation:

$$K.mpK + L.mpL + M.mpM = X$$

Given all the normal economic assumptions, the optimal level of production off the rangeland should be reached when the marginal product of that rangeland (mpM) is equal to the rent that is paid. It is because free access means that the rent is zero that the rangeland is overused, or overstocked. On that basis, therefore, Lipton's "temptation to good" (or the alternative "temptation to bad") is measured by the rent that would be generated if the overstocking were cut back. If the potential rent that might be gained is high then it will more than cover the transactions cost of negotiating a socially optimum Coase deal to trade off externalities or the cost of individual enclosure.

It is a striking feature of all the work on African rangeland that there are no estimates of what the potential production gains from destocking might be. All that can be done, therefore, is to calculate the level of rents that might be generated at various levels of destocking and of production improvement. Transforming the equation above gives:

$$mpM = \frac{X - K.mpK - L.mpL}{M}$$

Taking the estimate of a safe sustainable stocking level of 10 hectares per 300 kg Livestock Unit, the example herd from the calculations above, which is about 87 LSU, would need approximately 900 hectares, which becomes the value for M. Two opposite assumptions may be made about the effect of destocking, giving the outer

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boundaries on the value of mpM, ie the rent in Sudanese pounds per hectare. Those bounds are graphed in Figure 6.1.

Figure 6.1



On one assumption destocking raises the herd's performance substantially, such that total offtake actually increases as the herd gets smaller. (Labelled Improving Offtake in the figure) The opposite assumption is that the herds performance only improves by just enough to hold the total offtake steady. (Steady Offtake) In other words, the benefits of destocking come solely from the cost savings that result from a smaller herd. It is further assumed that both capital and labour requirements are in fixed proportion to the size of the herd.

As the figure shows, even on the more optimistic assumption, the 'rent' only reaches f_{s2} per hectare when the herd has been reduced by nearly 40 per cent: from a capital value of $f_{s14,000}$ to $f_{s8,750}$. This would imply that the owner would have around $f_{s1,800}$ a year with which to maintain the fences around the 900 hectares he would need or alternatively that he could spend this much on negotiating with his competitors to keep them out of his rangeland. $f_{s1,800}$ at 1984 prices would be worth considerably more in 1990. Cattle prices have risen, for example, from f_{s200} to $f_{s3,000}$. Nevertheless, it is quite unlikely that it would be enough to maintain a fence around what is an extremely large area. It is easy to build a temporary thorn zariba in the early years, merely by felling the thorn trees along the line of the fence required. Once the termites have destroyed that, as they do very quickly, trees will have to be dragged from beside the fence line. A zariba needs renewal every two or three years and it can be seen that very shortly trees have to be brought from a considerable distance merely to maintain the fence. Even a good fence has to be patrolled.

The alternative approach is to herd the animals more closely and develop more detailed rules about when they are allowed onto different sections of the range and how many of them are. Once again, the likely costs will be high. Whichever method is used, nothing can prevent a loss of the mobility and flexibility that is a key advantage of the existing system.

One of the classic solutions to the problems of free access resources is taxation. Theoretically, it would be difficult to calculate the correct level of tax and the tax would have to be applied to the correct factor of production. Taxes on output do not have the right effect. Despite these difficulties "quite crude approximations may be rewarded by significant efficiency gains." (Gould, 1972) It is worth noting that the colonial system of taxing livestock numbers was the best theoretical option. The decay of that system in more recent years is correspondingly regrettable. Because it is easier, government now focusses its livestock taxation on sales, that is to say on output.

The conclusion is that there is nothing to support the belief that development in the livestock sector can be brought about by better management within the existing resources. Despite the logical power of the Tragedy of the Commons thesis, the evidence is that the livestock owners of Darfur do not perceive adequate benefit from attempts to control stocking and that they are almost certainly right. One last piece of indirect evidence that they see little value in extra rangeland is the fact that attempts to extend it by providing extra water supplies from hafirs (tanks) or from boreholes have almost always failed because the herders are not interested in maintaining the hafir or the borehole. This contrasts with farmers who make strenuous efforts to keep their water supplies going. (Adams, 1982) Herders also make every effort to avoid paying for water for their herds regardless of the fact that to do so might gain access to better grazing.

The conclusions of a report from Mali in the early 1980s seem entirely supported in Darfur: "The suggestion that a smaller herd will produce more in an absolute sense is not true for rangelands such as the Sahel that are dominated by annual plant species whose production is mainly determined by the availability of nitrogen. Nitrogen losses from the vegetation are already high without grazing. When more cattle are kept less nitrogen is lost by volatilisation and fire so that animal production is almost proportional to herd size. Experience with perennial pastures on soils with reasonable fertility may also have led to the idea that better pastures are those with higher biomass. Applied to the Sahel where nutrients limit the production of annual grasses this is a mistaken idea that leads to overestimation of the value of wells, boreholes, fire control, fodder conservation, rangeland regeneration and other important management ideas." (Breman & De Wit, 1983)

This conclusion is also exactly parallel to that from agricultural research, that no gains can be made from "the improvement of range and herd management alone <u>without external inputs</u>". (Breman & De Wit, 1983, my underline) Whether or not there is overstocking and whether or not the range is in danger of serious degradation, the way out of the problem depends on the development of new techniques using imported inputs and almost certainly linked to new market opportunities. There is every reason to believe that if those do become available, the herders and farmers of Darfur are capable of making all the necessary adjustments to both their techniques and to their social arrangements. (Justice and administration are important exceptions here as discussed later) Sadly, it must be concluded that most of the work done in this area represents no more than an attempt to tackle the wrong problem in the wrong way, possibly a wholly non-existent problem. Why this has gone on for so long is discussed at the end of this chapter.

SAVING THE SAVANNAHS

With some exceptions, crop land is a free access resource in Darfur just as much as rangeland. In areas that are not already occupied anyone can settle and clear a farm without any formalities at all. Even where a pioneer group has already established a claim, by virtue of prior occupancy, newcomers are usually allowed to take over land that has been abandoned or to clear new land with a minimum of negotiation. The mechanism of the tragedy of the commons should, therefore, be just as destructive on crop land as on the range; more so in fact, because the act of cropping changes the vegetation and the soil far more radically than even the heaviest grazing. Concerns about exhaustion, degradation and exhaustion of the crop lands have a history almost as long as that of overstocking on the range.

The strongest concern has been about the goz savannahs of the eastern parts of Darfur. This has been partly because the goz is the poorest soil and vulnerable to wind erosion, partly because the effects of drought are most obvious on the goz farming areas of North Darfur and partly because the impact of new borehole water supplies has been mainly confined to the goz. That impact has been rapid and highly visible. The discussion that follows concentrates on the the goz, where the issues are most obvious and where the most research has been done.

The pessimistic belief is that before population pressure built up, the goz savannahs supported shifting cultivation in which relatively short periods of cropping were followed by long fallow periods during which the vegetation recovered to its original climax condition of relatively dense savannah woodland. This long fallow restored fertility. Then, as population pressure built up, farmers were forced to shorten the fallow period. An individual farmer could not prevent this because the right of free access meant that some other farmer could take over and crop his fallow. This is why land tenure, or rather the lack of it, is so important to this argument. "When fertility is exhausted and the land abandoned to bush fallow, the cultivator has no easy way of ensuring that others will not reclear the land before the planned period of bush fallow expires. As population pressure increases, especially within easy access of watering points, this problem becomes acute and soil erosion and exhaustion sets in." (HTS,1974)

In a closed system, where population has no escape through migration for example, this becomes a vicious Malthusian circle. "Population increase led to excessive cultivation, which in turn led to enhanced soil erosion and

soil impoverishment. To make amends for this the population which is increasing at an annual rate of 2.5 per cent had to increase the area cultivated with millet. This meant a fresh wave of desertification." (Ibrahim, 1984) That description came from North Darfur and the flow of people driven out of the north increased the pressure on the the wetter south, which might not see desertification, in the sense of a total loss of vegetation but 'abandonment' as a result of soil exhaustion would have the same effect. Vegetation was seen as a critical indicator of this kind of exhaustion. Farmers stated and observation confirmed, to some degree, that apparently exhausted areas of goz carried a high proportion of the species Guiera Senegalensis (ar ghubeish). (HTS, 1976)

On the other hand, it seemed that farmers could use the gum arabic tree, Acacia Senegalensis (ar Hashab), to counter the whole process of decline. In the colonial era it was reported from Kordofan that "The (hashab) trees are cut down, when they become too old to produce gum, to make way for grain cultivation. Five years later the land becomes too exhausted to produce grain and is left fallow. After an interval the acacias begin to reappear, without human effort, and in five years or so are big enough to be tapped for gum." (Davies, 1957) It came to be accepted that "Ideally the land is cultivated on a rough 4 year cultivation - 12 year bush fallow (gum) rotation". As early as 1950, however, it was reported from Kordofan that "population increase and the tendency of well fields to dry up has resulted in concentrations of population round permanent water supplies, where, consequently, the fallow period has largely disappeared." (Jewitt & Manton, 1951)

The earliest experiment to test these ideas was in 1948 when the presence of a gum forest that had been protected since 1920 next to land that had been cropped for 30 years allowed a comparison. "The comparison is an extreme one, between land cultivated for 30 years and land under Acacia forest for a similar period." As always with trials in western Sudan, the most important aspect was lost to the everyday hazards of agriculture in the area, the "two grain crops being destroyed by pests and birds." Nevertheless, the experiment did show clear differences in yield for sesame and groundnuts and responses to fertiliser on the exhausted land, although the "experiment was not replicated and it is unsafe to draw firm conclusions from the yields". (Jewitt & Manton, 1951)

Those words of caution were to be forgotten in the eagerness to find a sustainable cultivation system. Besides, hashab appeared to have all the fashionable virtues. It formed part of a traditional rotation sanctioned by Rural Peoples' Knowledge and technically it has all the characteristics of an ideal rotation crop. It produces a commodity of value and it is by nature a legume. Leguminous crops have the capacity to fix nitrogen in the soil, although not all of them do so, and hashab should, therefore, have a beneficial effect on fertility. (As with measurements of livestock carrying capacity, the debate on how, when, where and how much leguminous trees contribute to fertility is enormously complex and hedged with scientific qualifications. (Vetaas, 1992)

No experimental work in the subsequent four decades has made it possible to make any firmer statement about the effect of a hashab fallow on yields. And therein lies the fundamental problem. It may be possible to recognise 'exhaustion' from the vegetation and from the tendency of the soil to wind erosion but it has proved impossible to put any significant economic value on it. If, after all, it is possible to crop these soils profitably for 30 years then the rate of yield decline must be very small indeed. Why then was there any traditional rotation between hashab and grain? A possible answer is that during boom times in the gum markets it was hashab that was the principal crop and grain that was the rotation crop. It was not soil exhaustion that encouraged rotation at all, merely the fact that the hashab trees periodically became "too old to produce gum".

Whatever its contribution to fertility, Hashab did play an important role in land tenure. Because gum arabic had such a high value, the ownership of the trees was important and British district officers in Kordofan spent a considerable amount of their time adjudicating on disputes over hashab gardens and many of them were formally registered. (Davies, 1957) To this day, there are many areas where hashab is the only registered form of tenure.

The 1970s saw a massive acceleration in the rate of bush clearance in South Darfur as new borehole wateryards made new areas accessible. The impact of the wateryards was extremely visible. On aerial photographs and later on satellite images the radiating rings of clearance, cropped land and abandoned land were more eyecatching than even the largest of the natural topographical features. Driving overland, the traveller crossed from the enclosed world of mature savanna woodland, where the view is confined to the patterns of shade and light cast by the tall broadleaved trees on the scanty grasses underneath, over a frontier into another country, the bare plains of the cleared land. There the view over the mix of crops and dense grasses and low shrubs on the fallow had no limit except the dark line of the next block of uncleared land on the horizon.

In 1975, a study of some 150 wateryards in the eastern half of South Darfur revealed that so much land had been cleared, since they were opened in the late 1960s and early 1970s, that in some areas, "at the present rates of exploitation it is likely that this small amount (of reserve land) will be exhausted by 1981 and by 1986 the vast majority of cultivation will have been abandoned." (HTS, 1976) In the western half of the province, on the Goz Dango, the frontier of the cleared land advanced at the rate of one kilometre a year up until 1984. By 1987 it was estimated that 61 square kilometres of natural climax vegetation were being cleared every year. (WSDC/HTS,

1989) Even in 1987 there were still large reserves of uncleared land on Goz Dango, over 9,000 square kilometres. There are also uncleared reserves on the southern half of Goz Maaliya/Rizeiqat in the east. Despite this it was easy to see the situation as being similar, in its smaller way, to the wholesale destruction of the tropical rainforests of the Amazon basin, for example.

In one sense, the 1976 prediction that the reserves on the sandy athmur dunes of the Baggara Alluvium and in the northern half of Goz Maaliya would be 'exhausted' by the 1980s was more or less borne out by the 1987 study. By then, less than twelve per cent of uncleared climax woodland remained on the area of goz studied and just over 15 per cent on the Baggara athmur. At many individual wateryard sites there was no climax woodland left.

To sum up, there seemed to be compelling evidence of a Tragedy of the Commons in process and development strategies of the late 1970s were founded on that belief. These included a programme of 'controlled settlement' on uncleared goz savannah areas of South Darfur carried out by the Western Savannah Development Corporation. Although the first phase of the work was considered to be a pilot programme, it involved \$20 million expenditure over three years and represented a very major attempt to tackle the perceived problems of development on the goz. Four settlements were established, each based around a newly opened borehole water supply. Farmers were allocated 30 hectares of land each. This was rented to them on condition that they did not crop more than 6 hectare at any time. It was expected that a rotation with hashab would develop and that research would identify an increasing number of more intensive techniques to enable incomes to increase without encroaching on sustainable cropping intensities. The key feature was that the secure leasehold tenure would ensure that there was no obstacle to farmers taking up those more intensive techniques and making the necessary investments to support them.

As discussed in Chapter 5, research to identify the more intensive techniques required was not a success but the settlement model proposed was not wholly dependent on new techniques. The benefits of land tenure on its own were expected to be substantial.

The strength of the belief that population pressure on a free access resource was leading to soil exhaustion through declining rotations diverted attention from some important technical facts about cultivation on savanna soils:

- Shifting Cultivation: "The attitude of the shifting cultivator to the soil is quite different from that of a farmer in a less spacious environment. The system is not designed to preserve the land for posterity - that is an attitude which evolves when there is no more room to expand. Nor do farmers attempt to achieve maximum yields on a given patch regardless of effort."
- "There is no doubt that the increasing effort of keeping land free of weeds is often the primary reason for a patch of land being abandoned." If land is abundant, clearing can be easier than weeding. Especially as it can be done in the off season which weeding cannot.
- "In the savanna there are many examples of 3 years cropping being followed by only three years fallow for many years, though fertility declines to a very low level at this intensity."
- "For any form of intensified production in the savanna, whether by shifting cultivation or by permanent cropping, fertilisers, especially nitrogen and phosphate, are essential. Without them the vicious cycle of poor fallows leading to poor crops cannot be broken."
- "In high-grass savanna soils very low in nitrate, nitrogen content is low for leguminous species generally, and recent work in Australia indicates that the growth of Rhizobia may be severely restricted by periods of water shortage." (Rhizobia are the bacteria which fix nitrogen in the roots of leguminous plants.)
- "It seems likely that one of the main functions of the fallow on phosphorous deficient soils is to mix the phosphorous availability chiefly through the ash added when the fallow is cleared." (Nye & Greenland, 1960)

All this implies three things: that fallows on savannah soils are of small value, that they are not necessary to sustainable agriculture, since farming can continue profitably at very low yield levels, and that the driving force behind shifting cultivation is not soil exhaustion so much as weed infestation. The prolonged and painful research experience described in Chapter Five confirms this description in almost all respects, notably in the fact that the
only clearly established research result was a yield response to phosphate. The whole concept of 'soil exhaustion' was probably a misinterpretation. Dense stands of bushes like Guiera on abandoned land do not mean that the land is 'exhausted'. Instead, it is the density of the infestation itself that forces farmers to move on; the bushes become so thick that it is pointless to continue planting a crop.

The very act of farming creates weeds. "Many weeds are plants that under natural conditions would not be able to survive competition with the natural flora. Under cultivation, however, where the natural flora is kept in check and competition is reduced to a minimum, they are able to thrive." (Tothill Ed, 1948) Small shrubs like Guiera are too tough to pull up by hand so the farmers have to farm around them. Even the animals do not graze Guiera and an infestation is encouraged to build up almost unopposed.

If it were not that the concept of increased pressure on shifting cultivation systems was so central to the aid analysis of environmental problems, this discussion would almost be irrelevant. Shifting cultivation may not be any indication of soil exhaustion but true shifting cultivation, with a short crop period followed by a move of residence, is uncommon in Darfur anyway. In 1983, "At least 25% of the population have never moved their residence. Almost all the movement can be attributed to the pressure of population growth and cropped area expansion. Even in the goz areas significant numbers have never moved." Even for those who did move the periods of residence were long and "It seems unlikely that many have moved more than once in their life." The conclusion was that "In the absence of population growth stable cultivations systems would be the rule (on the goz) too." (WSDC, FS83) In other words, as communities expand they inevitably outgrow their immediate environment and some proportion has to move regardless of whether the cultivation itself is shifting or not and regardless of whether the soil is 'exhausted' and yields declining. A 1976/77 survey showed that 99.4 percent of South Darfur households had always lived at their present site and 89.7 percent of North Darfur Households. (VRA/RMR, 1977)

The ratio of cropped land to fallow, called here the cultivation intensity but analogous to Boserup's frequency of cropping, is an indicator of the extent to which heavier cropping may be leading to soil exhaustion. As Boserup emphasises, increases in intensity may occur in settled agriculture just as much as under shifting cultivation and they may be the result of increasing population pressure or of greater cash cropping. Whatever the farming system and whatever the cause, the trend should be clearly evident in a declining ratio of fallow to cropped land: in an increased cultivation intensity.

In most of the areas opened up for farmers by the provision of borehole water supplies the pattern of development was similar. Initially population built up very rapidly and the land closest to the water source, the focal point, was cleared to absorb it. At this stage most of the cleared land was cropped, meaning that the ratio of fallow to cropped was low. The cultivation intensity was high. New areas were constantly being cleared. There was usually a belt of land under clearance, where the trees had been cut but the farmers were waiting for the wood to dry out. Then they could burn it and start cropping the new land. As the first cropped land was abandoned the farms moved onto the ring of newly cleared areas surrounding it. The belt of clearance itself moved still further out. Cultivation intensities started to decline as more and more land was abandoned to fallow.

While this process was going on the site could continue to absorb more population; as the radius increased so did the area available. However, once the circle reached its limits, dictated by the distance water could reasonably be carried, no more population could be absorbed. If there was exhaustion and if yields did start to decline because farmers were forced to start reusing fallow before it had fully recovered, the village might even have begun to need to shed population. Nevertheless, at some level of population, an equilibrium would be reached at which fallows were long enough to ensure yields adequate to support the community. It appeared that the cycle from zero cultivation through to a stage at which population levelled off or even started to decline took about 25 years in the Goz Maaliya in the circumstances of the 1980s. (Scott-Villiers, 1984)





In effect, the pessimistic analysis of what is happening on the goz depends on the belief that no stable equilibrium between population, fallow and yields can be reached. Because the community cannot shed population it will be forced to crop more than is sustainable and to reduce fallows below the necessary level. Without denying that this might happen in the long-term, the evidence is that it has not happened so far. A detailed study in 1987 compared land use in 1971, 1975 and 1987. (Using aerial photography from 1971, ground survey in 1975 and satellite images for 1987) Figure 6.2 graphs the cultivation intensity in three separate areas of South Darfur using the data for the three measured years and interpolating for the intervening periods. Although the interpolation makes it appear smoother than it really was, the trend was the same in all three areas: an unambiguous decline in cultivation intensity. In other words, the quantity of fallow land relative to the cultivated area increased very substantially. The vast areas of woodland that were cleared during the 1970s were not cropped ever more intensively until exhaustion set in. Instead, they have been cropped extremely extensively. On average, the land that was newly cleared does not seem to have been cropped for more than two or three years.

What this means is that right at the end of a period of spectacular expansion in cultivated areas and of serious drought and famine, which drove population down from North Darfur into these relatively better-off parts of South Darfur, the ratio of fallow to cropped land was substantially higher in areas of uncontrolled clearance than it had been in the past. It was also higher than the various strategies aimed at preventing a Tragedy of the Commons were recommending. The WSDC controlled settlements required tenants to maintain a cultivation intensity of 20 per cent: six hectares cropped out of 30 hectares. The traditional 'ideal' grain to gum arabic fallow rotation of 4:12 implies a cultivation intensity of 25 per cent. In two of the 1987 study areas of uncontrolled settlement, the Goz Maaliya and the Baggara Alluvium, the cultivation intensity was only 11 per cent and 13 per cent respectively. Even on the Goz Dango, which was the most newly developed area and still under active clearance, the density was only 27 per cent. It should not be forgotten, moreover, that these areas had absorbed population from the north thus lowering cultivation intensities there. In 1987 there remained reserves of uncleared land so there was no particular reason to believe that the decline in intensities would be reversed in the near future.

Here, in more extreme form than anywhere else, we once again have a situation in which the development strategy proposed was addressed to a problem that might or might not occur in the future but which was not in any way a matter for concern at the time the strategy was being put into effect. To repeat, that strategy was based on the idea that population pressure under a situation of free access to crop land would mean that farmers could not fallow their land for long enough and would not be able to invest in land saving technologies that would allow more productive agriculture to develop. Instead, they were trapped in a vicious circle of reducing fallows and

declining yields. With hindsight, it can be seen that this analysis, which appeared to have ample circumstantial evidence to support it in the shape of an extraordinarily rapid rate of land clearance, lacked firm evidence on four critical points:

- It was not demonstrated that exhaustion was a problem in the economic sense that yields were driven below the level at which it was profitable to crop. Evidence that agriculture could be sustained at low yields for long periods was ignored.
- The fact that farmers could and did fight to maintain tenure when it was important, as over gum arabic gardens, was ignored in the general presumption that tenure was a problem.
- At a time when the provision of borehole water supplies had radically changed the quantity of land that was easily accessible to cultivation, it was not clearly demonstrated that population pressure had reached a level that was driving cultivation intensities upwards,
- Economic factors behind the explosive growth in cropping were not considered, notably the profitability of groundnut and gum arabic production.

Despite this there remains to this day a belief, backed by substantial development efforts, that the establishment of secure title to land will bring about more intensive agriculture on the goz single-handed. A report written by retired World Bank staff of the very division that had been responsible for the whole programme acknowledged in 1988 that the WSDC land management programmes were probably in a "blind alley". Despite this Pauline conversion, or perhaps because of it, the advice was rejected.

LAND TENURE AND THE VALUE OF LAND

As discussed in relation to range land, the value of land is the crucial link between the Prisoners' Dilemma of the free access resource and the paradise of the Coase Outcome. The value of land in Darfur is low and the lack of negotiations over reductions in livestock numbers and the relative weakness of most forms of land tenure are a direct result of that fact. Tenure or the lack of it is a symptom not a cause.

Land may have a low value because it is productive but abundant or it may just be non-productive. For Darfur, it would seem that both are true. With poor soils, low rainfall and restricted links to markets, farming in Darfur is generally unproductive. At the same time there remain large areas of relatively unused land, so supply is abundant.

Traditional land tenure is summed up as follows: "Within the village lands each villager has the right to cultivate. If he leaves the village the land occupied by him is allotted to someone else. There is no inheritance according to Mohammedan law. Land in excess of the requirements of the village may be allotted to strangers. The area allotted to a man is supposed to be no more than he can work (ar Kifayat Yad)." "Gum gardens fall into two classes, those within the village boundaries and those outside them. A villager has the right to tap the trees which spring up on the plot of ground which he has abandoned. A short absence does not deprive him of the right to tap these trees. It is not unknown for a villager to pay a due to a shaykh for the privilege of tapping but a stranger is required to do so. Gum gardens outside the boundaries of the village are regarded by custom to be at the disposal of the tribal chief who as the agent of the government is entitled to collect these dues from tappers." (Tothill Ed, 1948)

As already mentioned, the ability to maintain a right to gum arabic meant that there was at least one way that farmers could retain control of their fallows despite the principle that tenure was communal. Added to that, once a sheikh had allocated land he had no right to withdraw the allocation later. Only if the land was clearly abandoned did it return to the common pool. Ownership of baobab trees, the crucial source of water, also conferred a form of ownership of the land and according to some reports the sheikhs allocated a complete package to each household, including baobabs, a gum garden and a site to build a house as well as crop land. Under the Condominium a register of the baobabs was kept in Kordofan. (Davies, 1957)

Under the Fur Sultans a system developed called Hakura. This was the system of land allocation under the Sultans, which paralleled European feudalism in that high officials of the Fur state were allocated estates (hakura) not to farm themselves but to administer. The Sultan rewarded his men by allotting them the right to levy taxes, legal fees and labour dues on the estate. The Lord of the Hakura (ar sid al hakura) usually delegated most of his powers in turn to agents who became in effect the land sheikhs (ar shaykh al ard) The latter allocated the right to cultivate to the farmers whose title Lord of the Axe (ar sid al fas) illustrated how their tenure was established by

the act of marking the trees for cutting and clearing. Once a farmer had laid claim to his land in this way he could subdivide it among his family or even sublet to others. What he could not do was transfer his rights to others. (Hamza, 1979)

The hakura were granted to the great lords of Darfur in written documents. Many of these have been preserved and are still presented in the courts when disputes over land arise. (O'Fahey & Abu Salim, 1983) The result is that "contemporary systems of land tenure in Darfur and Kordofan are deeply rooted in the Hakura system" "By the nineteenth century much of the most desirable land west of Jebel Marra and around El Fasher had been parcelled into Hawakir." Further south, among the Baggara arabs, a different form, the Hakura al `Urban or Arab Hakura, was supposed to be in force. Under this the tribal chiefs were supposed to collect the dues but because the Sultan was never able to establish great control over the Baggara and because their wealth lay in livestock rather than cultivation, this did not result in the same formal land tenure system taking root. (Hamza, 1979)

With the overthrow of the Fur sultanate, zakat and the other traditional forms of taxation were abolished, at least as far as government was concerned. This took away the feudal elements of the hakura system and many hakura owners and their land sheikhs slipped back to being merely village leaders, although they retained their role in the allocation of land rights and their power to do this was generally respected. During the 1960s and 1970s, however, various attacks were made on the system of Native Administration which had been built up under the Condominium. The land sheikhs formed a part of this and their position was correspondingly weakened.

Among the Fur, two classes of land were identified: 'ard al `aysh or millet land and the terraced 'ard al qamih or wheat land of Jebel Marra. The latter was in all practical respects owned and it could be abandoned for quite long periods without losing a claim to it. A 1966 case saw the owner's right enforced after eight years. It could also be inherited. (Hamza, 1979)

In principle, the farmer's right to rainfed land, 'ard al `aysh, lapsed after three years' absence. In fact there were elements of ownership even here. It was common, for example, to make gifts and it could even be 'sold' under the guise of compensation payments for clearing or planting hashab. It could be maintained in fallow by continuing to mark the trees or by weeding. "Strong evidence is needed to rebut a presumption that the holder intends to return." An illustration of the ways in which a right could be maintained was a case of a woman whose husband had given her half their land when they divorced. She did not cultivate it but she had hashab growing in it and she informed the sheikh of her intention to return. She even offered to continue to pay him dues in her absence. When she did return to tap the hashab and her husband tried to stop her he was overruled. (Hamza, 1979)

In the modern era much of the old communal tenure system has become irrelevant. Gum arabic gardens have become private property and tebeldi trees have been replaced by boreholes. While the concept that land is allocated through the sheikh and that he may reallocate it after three years absence is still acknowledged, it is admitted that even crop land has become 'shibh wurathiah', that is to say 'more or less heritable'. Many farmers in the old established goz farming areas are able to hold onto extensive blocks of fallow in one or even two neighbouring village areas for as much as seven or ten years. Provided that they do not leave the area for good they run no risk of losing that land. An indication of the move towards retaining fallow is that many of the cases now coming before the courts in the area relate to attempts to return to land. (The speed of modern communications is an important factor that has greatly increased the ability of farmers who travel to make sure that they do not lose their rights to land in their home village.) These changes almost exactly match those described by Boserup as part of the process of increasing frequency of cropping. (Boserup, 1965)

The relative abundance of land is shown most clearly in surveys of tenure which have shown that the largest single class of land was acquired by uncontrolled clearance from virgin bush. This was true in the both the wider regions of the WSDC area, where 46 per cent of fields where 'cleared from bush without permission', and the more intensive basement wadis of the JMRDP area. Even there, where agriculture is much longer established, 34 per cent was described as 'Free gift/cleared from bush'. Inheritance is the next most important class in most areas followed by free gifts or loans. Only in one part of South Darfur, the Goz Maaliya, is formal allocation by the sheikh still important. Perhaps it is significant that this is the heartland of commercial groundnut production. With the exception of land under dry season irrigation and the small amount of land rented on government mechanised schemes, rental is rare, no more than five per cent of all land, while purchase of rainfed crop land is even rarer. (WSDC, 1985)

CONCLUSION

The evidence suggests that the emphasis on population growth and environmental decline was mistaken in almost every respect. There was ample circumstantial evidence of increasing pressure on both the crop land and

the range land of Darfur but this was misleading and it diverted attention from the need to establish three facts. The first was that an absence of formal land tenure was an obstacle to better farming practice and that the traditional support for communal access to rangeland prevented destocking. The second was that the crop land actually was over-cultivated and the rangeland over-stocked. The third was that more careful management of either crop land or rangeland would result in higher production.

As far as the first is concerned, farmers can and do win tenure, if it is worth it, and they can even enclose rangeland, if it is worth it. For the second, enormous efforts to count cattle numbers and estimate carrying capacities have failed to show that the range is overstocked, in any practical sense that production is lower than it would be if numbers were reduced. Nor has it been shown that the range is in in terminal decline. Equally great efforts to measure overcultivation in South Darfur have merely established that cultivation intensity has actually gone down. The introduction of boreholes has effectively reduced the pressure on land, even if only temporarily. For the third, agricultural research has relatively little to offer while livestock research has barely got off the ground.

Low productivity has universally been confused with declining productivity. Even if it is declining, no viable technical defence has been identified. Given the limited opportunities available to the people of Darfur, there would be no equitable alternative to allowing them to continue to 'mine' the region until such a defence were identified. It has been suggested, for example, that cultivation cannot be sustained in areas with rainfall below an 'agronomic dry limit' of at least 500 millimetres of rainfall without causing desertification. Even if that were correct, a ban on cultivation beyond that limit cannot be justified; a ban which "would deprive the inhabitants of that zone of the basis of their existence. It would be unthinkable as long as no real alternatives can be offered." (Ibrahim, 1984) Although it is not central to the argument, it would be beyond the capacity of the Sudanese state to implement such a rule in any case.

There is no firm evidence that the expansion of either livestock herds or cropping in Darfur has gone significantly beyond the first of Lipton's four phases in the Tragedy of the Commons, in which expansion by any one individual does not affect the rest of the community at all. It may even be that the individual's expansion actually helps the community in some cases. Extending the cropped area has strong positive externalities, for example, in that it drives back the frontier of pests and diseases harboured in uncleared land. It seems highly unlikely that the third phase, in which communal losses are greater than individual gains but not by enough to cover the transactions costs of social management, will be reached in the near future. Which means that all the aid-financed development strategies to deal with overstocking and overcropping are 'anticipatory', attempting to tackle tomorrow's problems, not today's.

The impact of trade on the resource endowment must be underlined. Export demand for gum arabic led to tenure in hashab trees and tenure in crop land is clearly related to quality. Irrigable land is clearly owned and customary ownership of rainfed land is most formally expressed in the major groundnut growing area. For this reason, the economic compression that has stifled development over recent years will also stifle developments in tenure.

7. STATE WITHOUT ROOTS

In the preceding chapters it has been argued that the mechanisms of agrarian change and development in Darfur can be distinguished but that in recent decades they have been stifled by the forces of economic compression that spring almost entirely from the weaknesses of the Sudanese macro-economy. In this chapter the development of those weaknesses is described and some attempt is also made to discuss why they have come about. Economic failure has been matched by and linked to a failure of public administration. That is also described in the latter part of the chapter.

In 1983, Sudan was receiving US \$35 per capita in aid, compared with \$19 for the whole of Sub-Saharan Africa. By 1989, Sudan's arrears in debt repayments to the IMF alone were over US\$1billion. Total debt was many times greater. The civil war between the north and south of the country flared up again in 1983 and eight years later, in 1991, there seemed little or no hope of a settlement. Even within the muslim north of the country, political change seemed always to mean no change. Whatever the regime the state appeared to lack all capacity to deal with any one of the problems facing it. A series of natural disasters such as drought and flood only highlighted this incapacity. There was a stark contrast with the high hopes at independence in 1956, when the Sudan's political problems were obvious but the economy was strong and government revenues were both high and more broadly based than most other African countries. "Few who had witnessed the Sudan's independence had predicted an easy future, but few too had foreseen such a grim one." (Daly, 1991)

The evidence of economic mis-management in Sudan is overwhelming. At least the first premise of Structural Adjustment, that there is a clear failure of policy, has to be accepted. On the other hand a series of adjustment programmes sponsored by the IMF have failed abjectly.

There were many continuities between the colonial and independence eras but there were three important differences. The first was sovereignty, not in the common modern sense of freedom from outside interference but in the older Hobbesian sense of a state power with the ability to offer security and relatively even-handed justice in return for the citizen's surrender of part of his freedom. However little they were entitled to it, the colonial administration did establish a position of sovereignty sufficient to allow it to offer a measure of justice, or at least security. The second is financial discipline. The colonial government was almost always dependent on foreign subventions but it was also under constant and intense pressure to reduce them. It had its own strong incentives to do so, as the only way to win independence from interference from the twin colonial powers: Egypt and Britain. As a result, the colonial Financial Secretaries were, without exception, bywords for parsimony; men who would 'count the knives and forks'. In addition, the modern tricks of deficit finance had yet to be invented. The contrast with the independence era is acute. It should be emphasised, however, that if the colonial state had survived into the 1960s, it might well have taken up the cheap capital that was offered and the respectable advice of the economists of that time - to increase investment and diversify away from export crops - just as avidly as the independent Sudanese government did. As early as the 1930s there was a significant minority in the Sudan Political Service, the elite of British colonial administrators, advocating very similar policies. (Daly, 1991)

It is around the last and most fundamental discontinuity, however, that all else revolves and that is performance. For all its failings and despite a number of spectacular setbacks, the colonial state did preside over a degree of development in Sudan. It may have been inequitable, it may have been slower than it should have been but the overall trend was upwards: in health, in wealth and in education. The contrast with all except the very earliest years of the independence era is marked. This is not to disguise the many faults of colonialism nor to deny that its successes may have had little to do with merit. Luck had a big part to play. The fact, for example, that independence fell just after the Korean war boom in markets for cotton meant that the British left on an economic high-point. "Ironically and significantly, the post-war boom had already run its course on the eve of Sudanese self-government in 1953, and a legacy of rising expectations was left to the post-independence regime." (Daly, 1991)

Even the rainfall seems to have been on the side of the Condominium. Out of 35 years since independence, total rainfall was above average in only ten, compared with 33 out of 53 in the colonial period; the ratio of good to bad years was almost exactly reversed. (Figure 1.3) The Sudanese blamed the 1984 drought on the Numeiri regime and similar thoughts were being voiced about Omar ElBashir in 1991. If rainfall is truly the measure of political legitimacy then it seems clear who are God's chosen rulers for the Sudan; and it is neither Structural Adjustment nor the Islamic Front.

SPENDING THE RESERVES

The relationship embodied in the Anglo-Egyptian Condominium of Sudan was so extraordinary that it was bound to collapse as soon as Britain's control over Egypt was weakened or there was serious opposition within the Sudan; an opposition which would find it easy to exploit the divisions between the Co-Domini. By the end of the 1940s, events were moving rapidly on both these fronts and Sudan became the first colonial African state to win independence on Flag Day, 1 January 1956. (Daly, 1991)

The second world war had already seen a recovery in the Sudanese economy, stimulated by the needs of the British armies in Egypt. The post war boom was even greater. "A regular but none the less paradoxical feature of Gezira economics was that production seemed always to vary with price. Both withered in 1931; both shot up in 1951." Between 1946 and 1951 cotton yields doubled: from 3.4 Kantars per feddan to 6.8. (Henderson, 1965) The result was that government revenue in 1951/52 was ten times that of the pre-war period and three times that of only three years before. After the long years of economy during the depression, the government's surplus was \pounds S3 million greater than its total expenditure. The political pressures to unleash the economy were only increased by the knowledge that Government had built up large reserves during the bad years. Once the Gezira debts were paid off, as they soon were, the pressure to spend this "embarassment of riches" was impossible to resist. (Daly, 1991) As a result, a more liberal approach to development was already underway some years before independence. More ominously, several newly powerful interest groups proved able to force government to give in over pay and taxation during the same period.

The first five year development programme was set in progress in 1946. The second, starting in 1951 was considerably more ambitious, reflecting the rapid increase in revenues. Expenditure on the two programmes together totalled £S50 million: between a fifth and a quarter of total government expenditure annually. Rehabilitation was necessary to make up for repair and maintenance that had been postponed during the war. Nevertheless, the major part of this expenditure was on new developments. Much was concentrated on the towns and the more developed areas of riverain Sudan and on productive 'sure bets', such as further expansion of cotton and the railways. To some this is evidence of a missed opportunity: "not enough (was spent) on experimentation. Almost no attention was paid to developing an industrial sector." (Daly, 1991) Indeed, almost all the themes of later development debates are evident in this, the most early period in which a planned development effort was undertaken: exports versus import substitution, saving versus consumption, urban versus rural, modern versus traditional and so on.

But in fact the Government had little choice. The balance of expenditure was already being determined by political considerations, by the need to buy off powerful groups: the provision of better than average social services to the Gezira in order to ensure a 'satisfied tenantry', for example. And satisfied the tenant certainly should have been. In 1951, the profit per tenancy was $\pounds 800$ and a British satirist wrote:

"Half-starved tenant in his Standard Vanguard Mowing down a passing herd of tick-thick goats, With a cargo of scent bottles, tooth sticks, prayer-mats, Petitions to the Governor and Ten Pound Notes" (Masefield in the Gezira, quoted in Henderson, 1965)

Government attempts to maintain saving, through increased import and export duties and staggered payments to Gezira tenants, failed in the face of this pressure to consume. Private savings were equally deficient and signs of impending economic problems made a rapid appearance. The Cost of Living Index, from a base of 100 in 1938, reached 307 in 1949 - an inflation of 11 per cent per annum. In 1951 the index for low-paid Sudanese rose by 29 per cent in that one year alone. Between 1946 and 1955, imports rose from \pounds S11.4 million to \pounds S548.8 million: 17.5 per cent per annum. Much of this increase went on consumer goods. Sugar acccounted for up to 9 per cent of the import bill. Coffee, tea and tobacco were also important but the largest item of all was textiles. All these commodities were, in theory at least, capable of being produced in Sudan, possibly marking a missed opportunity for import substitution when "demand was incessant and the government was awash with money to invest." (Daly, 1991)

Government was not awash with money for long. Its hard-won position of financial ease was rapidly eroded. One particularly ominous sign was the consolidation of Cost of Living allowances for government employees into their basic pay and, hence, into their pensions in 1950. Inflation was so rapid that an adjustment was inevitable but the close interaction between government service pay and nationalist politics set a pattern that was to be repeated many times in the future. Heavy development expenditure was another factor. From 1955 onwards, the development schemes planned "depended not only on large anticipated (revenue) surpluses but on £E45 million in foreign loans or grants." Government foreign exchange reserves fell in every year after 1951 and "by 1955 the Sudanese public were living on credit." The last factor was the end of the post-war boom itself. The value of cotton exports peaked in 1951 and did not reach the same level until 1968. (Daly, 1991)

Also significant was the first of many futile attempts to fight international markets in defence of those expectations. By 1956, the Sudan Gezira Board was already in difficulties over marketing the cotton crop. By abandoning its traditional UK buyer in favour of auctioning the crop and by setting unrealistic reserve prices, it failed to sell an increasing proportion of the crop. By 1958, it had the equivalent of the whole season's crop unsold and this was in a year when production had not been especially high. (Henderson, 1965)

Two important private sector activities expanded shortly after independence: irrigated pump schemes and mechanised farms. Pump schemes rose from 244 in 1939 to 1,331 in 1954. (Barnett & Abdelkarim Ed, 1988) As a result, 27 per cent of the national cotton acreage in 1956 was on private schemes, which held this share up until the late 1960's, keeping pace with a considerable expansion of the public sector acreage after independence. (Beshai, 1976) Government introduced tractors to grow sorghum on the rainlands at the end of the second world war and it expanded very rapidly. By 1956 388,000 feddan were under cultivation and this expansion has continued ever since. The area in 1973/74 was 3,186,000 feddans: a growth rate of about 14 per cent per annum for nearly two decades. (Lees & Brooks, 1977). By 1985, it had reached around 9 million. (ILO, 1987)

State patronage was an important element in both activities, echoing Muscat's Bureaucratic Capitalism. Land rents were low and credit was offered. After the cotton boom, the foreign commercial banks became relatively reluctant to finance pump schemes and the Agricultural Bank was established to fill the gap. Government did the land clearance for the mechanised farms and here too finance was provided through the Agricultural Bank. (Mahmoud, 1984)





BREADBASKET TO BASKET CASE

If the pattern of the problems to come was set immediately after independence or even somewhat before, the major acceleration came in the mid-1960s. Figure 7.1 shows the budgetary position from 1961 onwards. At no stage was government out of deficit, although it briefly came close in the early 1970s. The deficit, which initially was linked to development expenditure, rose to a peak in relation to GDP surprisingly early, in the 1960s. It did not reach the same level again for another fifteen years. At this early stage, current expenditure was mostly kept well within the bounds of revenue. The turning point came in 1978/79 when current expenditure exploded. Spending on development, however inefficient, did at least offer a hope of a return in the future. From 1978 even the hope was gone. Development expenditure relative to GDP never returned to the level of 1963/64.

The first serious fiscal and balance of payments problems came after the October Revolution of 1964. The Sudan government had to resort to the IMF three times between 1966 and 1969. There was an increasing

dependence on foreign finance for public sector investment. Between 1955 and 1960, overseas borrowing was only nine per cent of gross public sector capital formation. In the next five years it was 30 per cent and in the five years after that it was 50 per cent. This was not only because of an increase in development spending. Public sector saving declined as well, especially after 1964/65: "attributable to the expansion of recurrent expenditures by the (new) civilian government". (Brown, 1990)

There were also significant shifts in Government revenue. After independence the contribution from export taxation fell steadily, from 18 per cent in 1955/56 to only 7 per cent in the mid-1960s and as little as 5 per cent in the early 1970s. Non-tax sources, that is to say the revenues from the irrigation schemes, the railways and so on, which had been so important under the Condominium, were also declining. These reductions were more than offset by increasing revenues from import duties and other consumption taxes; so much so that government revenue as a proportion of GDP rose sharply through most of the 1960's. (see Figure 7.1) Nevertheless, what had been a relatively broad revenue base under the Condominium, spread between export duties, direct non-tax revenues and import duties, was becoming more narrowly dependent on consumption taxes alone.

The state's share of the economy was growing. There had been considerable public investment in new irrigation schemes and many other sectors; investments which should have at least maintained government's non-tax revenues. Instead, an "increasing share of the surpluses generated on the new as well as the existing schemes drifted away from the control of the state sector." (Brown, 1990) To some extent this reflected Bureaucratic Capitalism. The elite, the "indigenous agricultural entrepreneurs", were major beneficiaries but other powerful groups also gained: notably the tenants on the irrigation schemes and organised labour in the government services.

The May revolution of 1969 brought Ja'afar Numeiri to power. Initially there was a fairly determined effort to raise government revenue. There were widespread nationalisations, including the entire banking system. Other measures included dual exchange rates, in effect an indirect tax on cotton and other exports, substantial extra import levies and excise duties and increased direct taxes. (ILO, 1976) It was significant that the solution was to raise revenue when the budgetary problem had arisen from a rapid expansion in expenditure. The fiscal deficit did fall but the larger part of the revenue increase was absorbed by higher current expenditure. (Figure 7.1)

And even that minor fiscal improvement was not maintained, being "politically unsustainable". The IMF had to be called in for the fourth time in 1972. Shortly afterwards, the rise of OPEC set off a surge of petrodollar investment in Sudan, to turn its supposedly limitless natural resources into the breadbasket of the Arab world. Its true effect was to postpone the day of reckoning. The "breadbasket' funds perhaps offered only temporary respite to the regime, from the impending fiscal crisis and balance of payments crisis that was futher exacerbated by the external shock of the 1973/74 oil price hike." Both the beginning and the end of this breadbasket era were astonishingly rapid. The peak came in 1974, when actual disbursements of foreign borrowings rose to US\$460 million: an increase of over 300 per cent over the previous year. Only three years later, it was all over. Between 1974 and 1977, when disbursments declined again, nearly US\$2.5 billion had been borrowed. The proportion of private lenders was larger and the terms of the loans were harder than either before or since. (Brown, 1990)

The short life of the breadbasket reflected the lenders' rapid realisation that the projects were turning out far more expensive and slow to implement than had been hoped. A shortage of complementary local resources and heavy cost overruns led to a mounting backlog of unfinished and non-operational projects. Direct corruption also took its toll of both the money and the lenders' patience. The effect on government's own finances was disastrous. It had devoted most of its own investment resources to the breadbasket schemes, at the expense of its principal revenue base: the older agricultural schemes and other established sectors of the economy. Unlike the previous decade, import duties and other consumption taxes did not make up for the decline in revenues from export producing schemes and from export duties.

The reasons for the decline in export revenues, especially from cotton, were much the same as in the 1960s; both areas and yields fell, not because of any change in world markets but because of increasing disincentives inside Sudan. Internationally, the terms of trade for Sudan's long-staple cotton remained relatively steady till after 1978. Domestically, on the other hand, the tenant's share of the cotton profit, raised to 50 per cent in the 1960s, was reduced to 40 per cent again. The multiple exchange rate system imposed a further implicit tax on cotton. The fact that all of the irrigation schemes' costs were charged to the cotton crop alone acted not only as a disincentive but as an increasing one; the less of the crop that was grown, the greater the costs to be borne by the cotton area that was left, making the disincentive even greater. By 1978, these pressures had reduced cotton to only 30 per cent of the cropped area on the Gezira, down from 40 per cent a decade earlier and nearly 60 per cent at independence. (Brown, 1990)

As early as 1976, Sudan had begun to default on debt service payments and by late 1979 the country was US\$1.2 billion in arrears: 150 per cent of total export earnings. The breadbasket funds inevitably dried up and government

was forced to borrow more and more from the Sudan's own banking system to meet its deficit. Government financing from the Central Bank leapt from $f_s 4$ million in 1972/73 to $f_s 173$ million in 1977/78. Money supply grew through the 1970s at around 30 per cent per annum and inflation followed at 20 per cent. Exports were down from 16 per cent of GDP in 1970/71 to 8 per cent in 1977/78. (Brown, 1990)

In the real economy, the list of depressing statistics is endless. Between 1967 and 1978, real household expenditure in Greater Khartoum declined by a third. For cotton, "In international markets the view is of a disorganised and unreliable Sudanese cotton marketing policy." In 1971, Sudan had half the world's trade in sesame. By 1983, it only had a quarter. For gum arabic, where Sudan had 80 per cent of world trade, it "took years to recapture markets lost (to substitutes) when a high export price was set for the 1974-75 crop." In 1972, three million tons of goods were moved on the railways. In the 1980s it was one million tons per year. Rising oil prices should have given the railways a cost advantage but road transport's share of freight traffic rose from one third in 1969 to two thirds in the 1980s. (ILO, 1987) "The one major new cotton scheme of the 1970s, the Rahad scheme on the Blue Nile financed with World Bank support, proved in need of rehabilitation virtually as soon as it was completed." (Woodward, 1990)

ADJUSTMENT?

By 1978 the Sudan was, on every possible measure, a classic case for the Structural Adjustment treatment. High foreign debt, declining government revenue, ballooning government expenditure and a whole range of previously successful export crops in rapid decline. Shifts in the terms of trade, notably the second oil shock of 1978, must have had some effect but it was impossible not to conclude that Sudan's problems sprang from bad domestic policy and outright bad management.

The distinction between policy and management is important. Foreign debt was a good example. As a matter of policy, the volume of debt taken on by the Sudan is incredible enough but it is the lack of control that is truly shocking. Virtually any government agency was entitled to organise a foreign loan and so commit the Sudan to repayment without consultation. The result was that the Sudan was "unable to provide the organizations monitoring its external debt with an adequate list of its creditors, let alone with reliable information on the magnitudes and terms of its borrowings." (Khalid quoted in Brown, 1990) A debt that was estimated to be US\$2 billion in 1978 was revised upwards, after investigation by foreign consultants, to US\$7 billion in 1982. (Brown, 1990) That it took four years for this fact to even emerge says something about the utter lack of management.

From 1978 to 1984, the Sudan, the IMF and the Sudan's creditors represented in the Paris Club were almost never out of negotiation over debt rescheduling. Five separate agreements were reached. Five separate agreements were suspended, terminated or superseded by the one that came after. A sixth was under negotiation in 1984 but the Sudan was by that time not even able to meet its obligations to the IMF. The failure of these agreements was matched by continued deterioration in the Sudanese economy. In 1978, the current account balance of payments deficit was 7 per cent of GDP and the nominal debt service ratio was 14 per cent. By 1982 an 'imbalance' had turned into bankruptcy. The current account deficit had more than doubled, to 17 per cent of GDP, and the debt service ratio was over 150 per cent. For the people of Sudan, the adjustment years saw per capita income drop from US \$ 526 in 1978 to US \$ 330 in 1987. (Brown, 1990)

There are two possible interpretations of the dismal performance of the reforms laid down in the IMF agreements; either the adjustment policies were wrong, presumably because the analysis of the problem was also wrong, or they were not applied. On all counts, the evidence points to the second conclusion. The relatively limited devaluations were undermined by the multiple exchange rate system, which was not abolished despite it being a condition of the IMF agreements. By 1984, the exchange rate regime had "if anything, become more discriminatory and administratively cumbersome and offered those in privileged positions with enormous scope for financial gain through illegal dealings in this complicated market." (Brown, 1990)

Most important of all, however, was the fact that the domestic policy changes required to to match the devaluations were never implemented, with the result that "nominal depreciations of the Sudanese pound barely kept pace with the domestic rate of inflation." By 1984, the real value of the Sudanese pound at official rates was back to, or even above the 1978 level. The cause of this was not hard to find. Without exception, the fiscal and monetary statistics did not just miss their adjustment targets, they went in the opposite direction. The budget deficit was supposed to be eliminated by 1984. It increased. Money supply was supposed to grow at 16 per cent per annum. It was closer to 30 per cent. Central Government's domestic bank borrowing rose at 38 per cent per annum. Even this was not enough to cover the budget deficit. The gap was filled from overseas. "Effectively, there had been a movement away from domestic borrowing to foreign financing of the government's budgetary

deficit, associated with the IMF Extended Fund Facility and increased foreign lending that this unleashed." (Brown, 1990)

As figure 7.1 shows, this failure did not even reflect a determination on the part of the Sudanese government to maintain a higher level of investment than was compatible with adjustment. Instead it was the result of a huge loss of control over recurrent expenditure, which rose above revenue for the first time since independence, although it had been close to doing so for a long time. A major factor had been the Job Employment and Classification Scheme, implemented at IMF/World Bank instigation in 1978. Far from any rationalisation of public sector employment, this led to a large increase in public sector pay. (Brown, 1990) Numbers in public service also increased as fast, if not faster than ever. Between 1978 and 1985, central government employees alone rose from 274,941 to 338,354: an increase of over one fifth for a government supposedly in dire financial difficulties. (ILO, 1987)

Nor did the expansion of recurrent expenditure meet valid social needs that might have justified government's failure to take the adjustment medicine. The service government offered deteriorated almost as fast as the numbers employed increased. This combination, of swelling numbers providing a worsening service, can be termed bureaucratic stagflation. One reason was a growing imbalance between clerical and productive staff. The number of classified staff, that is to say white-collar, pensionable employees, grew fastest most of all in the parastatal corporations and institutions. Nearly one third of employees in these supposedly productive organisations was in a classified post. A UNIDO survey of 1981/82 "indicated that average value added per worker may be four times higher in private companies than in public sector establishments." (ILO, 1987)

The second factor behind the stagflation, was a gross imbalance between expenditure on staff and expenditure on complementary costs: materials, fuel, maintenance, depreciation and so on. By 1985, even a relatively sympathetic observer such as the International Labour Organisation could only conclude that the "Deterioration had reached the point that there are serious doubts about the capacity of large areas of government administration to implement necessary policies." This deterioration was leading to a process of "creeping privatization" as user fees and contributions to running costs, not to mention outright bribes, became the norm for consumers of government services. (ILO, 1987)

The impact of these developments in the public service only become obvious in the macroeconomic variables, such as the budget deficit, in the adjustment period. The process of stagflation in government service had started much earlier. "While the Sudan Government was consistently increasing its employment during the 1960s, it was simultaneously reducing the availability of goods and services to accompany them." (ILO, 1976)

Defence expenditure and debt repayments are often seen as the primary causes of African governments' failure to control their budgets. Between 1964 and 1974 in Sudan, this was true to a degree. The civil war in the south inevitably raised defence expenditure and debt service was rising well before the breadbasket period. Administration expenditures were also increasing. (ILO, 1976) (Figure 7.2) There was a sharp contrast in the Structural Adjustment period when the defence/administration share of government expenditure actually fell sharply, despite the rekindling civil war in southern Sudan. Debt repayment also remained a relatively unimportant item while expenditure on social services was steady. This time it was economic services that saw a big expansion, reflecting the impact of the World Bank inspired Three Year Public Investment and Agricultural Rehabilitation Programmes designed to reinvigorate the export production sectors of the economy and government's revenues from those sectors.

In other words, the investment funds provided under the Structural Adjustment programmes were spent exactly as intended, in the productive sectors. The continued miserable performance of exports and government revenues forces the further conclusion that those additional investments completely failed to achieve what was expected of them. As a result the decline in revenue, which had begun in the early 1970s, continued steadily throughout the adjustment years. By 1985/86, current revenues were down to 8 per cent of GDP, only half of government's current expenditure and "far lower than in most other low income countries." (ILO, 1987)

All these factors were reflected in a major shift in the real economy. "The general impression is of an economy failing to perform in its key agricultural sector while moving strongly into services where, however, the growth has been of a nature and composition hardly conducive to continued development and least of all to the well-being of those most in need." The service sector of the economy, which had been slightly less important than primary production in 1973, was 55 per cent larger in 1986. (ILO, 1987)

Figure 7.2



To sum up, both halves of the Structural Adjustment programme for Sudan were abject failures. On the IMF side, the disciplines of exchange rate, monetary and fiscal reforms were utterly ineffective. On the World Bank side, the investments designed to restore the productive momentum of the economy had only one significant effect. They further undermined government's control over its budget. For the Sudanese economy, the outcome was wholly at odds with the rhetoric of both sides of the debate on Structural Adjustment. Far from it being a major turning point - towards reform and a return to growth for its proponents or towards misery and inequity according to its critics - Structural Adjustment was little more than a rearrangement of trends that had been underway since before independence: growing but increasingly ineffective public investment, repeated failures to control staff and other recurrent costs, a steady reduction in the quality of government services, only partly offset by a wider coverage, and a steady decline in government revenues.

The only difference between the three post-independence periods is in the way in which these trends were financed. Between 1956 and 1970, expanding investment and consumption were financed partly out of overseas lending but principally by reducing the surpluses of the last decade of the Condominium; surpluses which included Government reserves and the profits of the productive economy. Taxation did not keep up with increasingly ambitious government services. Prices for commercial operations fell behind costs. The labour force or, on the irrigation schemes the tenants, were able to force larger and larger distributions in their favour. The elite inevitably sought and gained compensation for their losses from these redistributions. In 1973, just as the scope for squeezing any more out of these surpluses was exhausted, the influx of breadbasket funds allowed the process to be prolonged. Finally, in 1978 when the more commercially minded investors of the breadbasket lost patience, concessional funds provided under Structural Adjustment programmes took their place and so prolonged the process once again.

It has been suggested that the IMF, the World Bank and the rest of the aid community are, by their very nature, bound to be Paper Tigers, unable ever to actually wield the stick of leverage that they purport to carry. This seems all too evident in the Sudanese case. The very word 'adjustment' carries the idea that the both the problem to be tackled and the solutions required are temporary and this is the weak point in the donor agencies' armour. Just as adjustment is temporary, so is the leverage. The Sudanese government, once it recognises that fact, takes little risk in accepting loans, ostensibly to cover the costs of adjustment but in fact as the price of policy reform, and in failing to maintain reform afterwards. "A temporary reward is a recipe for temporary liberalisation." (Collier, 1991)

The international agencies also have no defence against a government that claims adjustment reforms are 'politically unsustainable'. By presenting the 1982 sugar price riots in Khartoum as more disastrous than they really

were, the Sudan government was able to persuade the IMF to renegotiate yet again "having only shortly before suspended the Extended Fund Facility." (Brown, 1990) By the standards of more violent societies the damage done was slight, just as the rise in the price of sugar was slight compared to what was to happen later without provoking a riot. In short, the Sudanese government had, if anything, more leverage over the IMF, the World Bank and the rest of the aid agencies than vice versa.

If Government held the whip hand in its dealings with the aid community, it was increasingly unable to control its own people in order to regain budgetary and economic control. Many of the central features have already been described: the failure to resist the demands of tenants on the irrigation schemes, the loss of control over civil service pay, diminishing returns from state enterprises reflecting a similar inability to resist the demands of the workforce and subsidies to the mechanised farm sector are just some examples. Many others could be added.

Ironically, the colonial state had paved the way for much of this because the machinery of that state was turned inside out. A system that had developed out of the need to raise government revenue was converted into a mechanism for distributing government benefits. The government sugar monopoly, established as a means of taxation, became a system for the provision of subsidised sugar rations. As time went by, more and more commodities were added to the ration list. By 1989, even the one consumer good that the Sudanese private sector had proved more than capable of producing in abundance, edible oil, became a rationed good for a while. Condominium civil servants were given subsidised housing or cheap loans to build their own. This, combined with the government control over the distribution of land also inherited from the colonial state, led naturally into civil servants' participation in real estate speculation after independence. "Civil servants in government housing found it easy to raise loans and join in." Education under the Condominium was concentrated on the needs of the government services. This led to events like the "distribution of jobs to hundreds of graduates before the 1968 elections in an effort to boost the Unionist vote." (Woodward, 1990)

All of the above may be grouped under the heading of policy-based patronage. Although the driving force was to buy political acquiescence through the distribution of benefits, those benefits were distributed within legitimate channels and through the implementation of policies that may have been mistaken but which were neither illegal nor dishonest. This can be distinguished from management-based patronage. The latter, which was just as widespread, ranged from legal 'inefficiencies', such as the appeasement of employees by lax discipline and overmanning, through to outright corruption. The latter took many forms. Here, too, the colonial institutions of economic control provided much of the machinery, especially licences. In commerce, "The acquisition of licences has been the top entrepreneurial concern." There was widespread "pseudo-investment" to qualify for licences. (ILO, 1987) The supply of subsidised commodities also created shortages and wide scope for patronage and speculation. There has rarely been a time in Sudan when there have not been rumours of vast warehouses full of basic comsumer commodities such as tomato paste and sugar.

It has been suggested that what would be considered corruption in the modern world is more leniently viewed at all levels of Sudanese society. Within the tribes of Western Sudan, respect for government does not depend on its honesty but on its power. The word <u>Haramy</u>, which is derived from the religious term for sin and is used for all forms of dishonesty, sums up the attitude. "It is not a bad thing to be <u>Haramy</u> and to use what power you have to try to effect transfers of wealth to your own person." "Nazirs are <u>Haramy</u>, the (colonial) Government is too." At the same time, accusations of dishonesty are legitimate weapons in political struggles over tribal leadership. Under the Condominium, accusations of corruption against members of the Native Administration, especially over the distribution of rationed sugar, were a favourite weapon by those intriguing for posts in the same administration. (Cunnison, 1966) In national politics the pattern was almost exactly the same. Frequent resort to accusations of corruption as a political weapon only served to obscure what seemed to be a widespread, albeit covert, consensus that it is not particularly dishonest. Some have even argued that corruption has almost become an institution, the 'Fifth Factor of Production'. (Kameir & Kursany, 198?)

Apparent political differences between the elite were misleading. Under the military regime, both the "son of the spiritual leader of the National Unionist Party" and three members of the Islamic Charter Front, the Muslim Brothers' political party, were on the board of the same corporation. (Kameir & Kursany, 198?) In the democratic coalition government formed in May 1988, there were eighteen ministers who "had served as national or regional ministers under Numeiri." There were only twenty-five ministers altogether. "Northern Sudan's healing social relations at the elite level once more assured that there was little by way of a purge in most ministries, and it soon became clear (after the 1985 coup) that a general return to the old corrupt ways was taking place." (Woodward, 1990)

To explain these patterns, some argue that the colonial legacy has irrevocably distorted Sudanese society. Divide and rule has created a pattern of meaningless competition over the spoils of the state. Others lay the blame on the "hurried transformation of the state into a series of service-orientated ministries" at independence, which

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gave rise to "the symptoms of an 'overdeveloped' and 'soft' Third World state." An alternative view might emphasise the Numeiri era, "that transformed an inert party system into one of Africa's longer running personal, clientilistic regimes. ... ultimately, in seeking to deconstruct what had been central to political life hitherto, it created little of lasting substance as a replacement. Whereas the liberal-democratic system had rested on relatively stable, if selective social bases in northern Sudan, in moving away from those, Numeiri had turned towards new ideological and institutional forms, and in doing so he showed up the grave problems inherent in such attempts." (Woodward, 1990)

One feature is evident throughout. Patronage in Sudan is not the prerogative of a small, all-powerful elite who are exploiting a position of unchallenged political power to their own benefit. On the contrary, patronage is the only way of maintaining a very weak form of political power. The management of patronage is the fundamental skill of politics, a skill practised by everyone from the tribal sheikh to the President. Even before independence, "the loyalty of southern MPs depended on subsidies." (Daly, 1991) It was for this reason that the impact of outside intervention, whether it was the commercial lending of the breadbasket or the Structural Adjustment package, was very different from that planned. "The importance of the Gulf Arab states' money in the end lay less in its contribution to Sudan's economic development than in the resources it provided for the exercise of clientilist politics." (Woodward, 1990) "Access to these (breadbasket) funds and the lucrative contracts associated with them was enjoyed by a relatively wide group of well-placed senior civil servants, politicians and others who the Nimeiry government depended on for its support." (Brown, 1990) And if government appeased the elite through the allocation of commodity aid, import licenses and the like, it appeased its workforce through continued wage drift and it appeased the general public, albeit less generously, through subsidies.

If the state depended on patronage for its survival then it depended on foreign money to finance that patronage. As early as 1976 it was stated that "The state, although not the subsistence sector of the economy, is dependent on outside support for survival." (J. Waterbury quoted in Woodward, 1990) By 1983/84, 79 per cent of the deficit was funded externally. (Brown, 1990) Commodity aid was particularly important. In the 1985/86 budget, it was planned that commodity aid would finance half the total deficit. (ILO, 1987) The Sudan had moved full circle from the early years of the Condominium, when the state was equally dependent on external finance, from Egypt, for its survival.

If, however, the state was dependent on foreign money to finance its patronage, it was quite unable to accept the reforming conditions that were supposed to be attached to that money. To do so would destroy the very same patronage. The fact, for example, that the exchange rate was so critical to the system of patronage played a major part in the government's unwillingness, inability even, to implement the central policy of the whole adjustment programme: "maintaining a multiple exchange rate system plays an important role in deciding who is to enjoy privileged access to such resources." (Brown, 1990) This exactly matches Muscat's description of Thai Bureaucratic Capitalism, unable to accept advice that was in conflict with its own political imperatives however urgent the need for reform.

BRAIN DRAIN AND CAPITAL FLIGHT

In 1986, the real value of the minimum wage in Sudan was only 16 per cent of what it had been in 1970. (ILO,1987) Driven by the growing poverty of Sudan and drawn by the wealth of OPEC, every Sudanese now dreams of migration. And, because they are hard-working, skilled, pleasant, Arabic-speaking Muslims, the Sudanese are in demand. In 1986 it was estimated that two thirds of Sudan's professional and skilled workforce was overseas: predominantly in the oil exporting states of the Arabian peninsula. (ILO, 1987) There have been various estimates of the numbers of Sudanese Nationals Working Abroad: 45,000 in 1979 up to 200,000 or even 500,000 by 1983. In the mid-1980s, 350,000 was a conservative estimate. and the result was that "Sudan's recorded and unrecorded remittances together would have been sufficient to support three times the value of officially recorded imports." (Brown, 1990)

These estimates, raise a whole flock of questions about what is happening in the Sudanese economy. Why, if those vast sums are remitted, can Sudan not pay for its imports and why is the supply of imports so restricted? Why is the real value of the Sudanese pound under constant pressure? Why does inflation continue to run at high levels? Why do government revenues continue to decline? According to Brown, the answer lies in grossly distorted markets that allow the extraction of rents which are then lost in capital flight. Sudan's balance of payment problems therefore spring not from excess demand for imports, reflected in the current account, but in excess demand for foreign assets on the capital account. After the coup in 1985, it was estimated that some US\$15 billion of capital had been exported from Sudan between 1978 and 1986: as much as a quarter or even a half of all capital exports from Sub-Saharan Africa. "The estimated unrecorded export of capital from Sudan in 1983/84

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comes to \$2.6 billion, or more than twice the level of the country's net foreign borrowing in that year." ... "In reality Sudan is a net exporter of capital" and "Sudan ceases to be a net debtor in that the estimated value of its privately held foreign assets far exceeds the recorded value of its publicly held foreign debts." (Brown, 1990) The extraordinary nature of this conclusion bears underlining; it is that the biggest debtor of the international community in Africa, the country with the largest single outstanding debt to the IMF, is in fact a net exporter of capital.

A detailed analysis of this is outside the scope of this thesis but the impact on the real economy and the Darfur producer in particular is not. A review of macro-economic policy and trade policy allows some interpretation of the mechanisms of what has been described earlier as 'economic compression'.

In 1976, the ILO completed a comprehensive study of the Incentives for Resource Allocation in the Sudanese economy. At that time the position was as follows:

- Exchange rate: $f_{s1}=US$ but a tax/subsidy rate of US\$2.5 allowed since 1972 on all transactions except the export of cotton and gum arabic.
- Export duties between 5 and 9%, except meat on which 20% (ie eliminating the exchange 'subsidy')
- Sudanese Nationals Working Abroad (SNWA) allowed an exchange premium on remittances of 60% (plus the 15% general subsidy.)
- Import duties at 26 different rates from 5% to 600%. Overall, in 1970/1 = 43% CIF value, in 1973/4 = 34%. It was difficult to identify any clear policy distinction between the rates for raw materials and equipment and for consumer goods.
- All imports licensed by both the Bank of Sudan and the Ministry of Finance and Economic Planning with a tendency to give priority to investment goods, thus choking existing capacity. No clear appraisal mechanism so that "firms making chronic losses may receive allocations at the expense of efficient firms."
- A Nil-Value licensing scheme for imports by SNWA had been suspended in 1976 because of 'abuse' (although it was to return).
- Three major export crops, cotton, gum arabic and oilseeds, controlled by monopoly marketing corporations.
- Domestic prices of manufactures controlled ex-factory by the Ministry of Industry on a cost-plus basis. As the cost figures were supplied by the producers this was a procedure with 'serious limitations' but ex-factory price control was relatively effective.
- Crop minimum prices set by the Ministry of Finance, also into-mill prices for import substitutes: wheat and sugarcane.
- Retail prices for 20 odd consumer items controlled, 'generally ineffective' except where government also controlled supply eg sugar.
- Trade profits also controlled, ineffectively, at rates between 2% and 25%.
- At end 1973, 36 industrial products protected by outright import bans and six by quota.
- Industrial enterprises eligible for tax holidays, cheap utilities and infrastructure and duty free imports of machinery, spares and raw material. On the other hand, subject to license from the Advisory Committee for Industrial Development where "decisions are of an ad-hoc nature and the process does not act as a screen based on considerations of social profitability." (ILO, 1976)

It was estimated that the tax/subsidy regime gave a pronounced anti-export bias, in effect an anti-agriculture bias, of between 35 and 40 percent, without taking any account of the effect of quantity restrictions. Inflation and

consequent over-valuation of the exchange rate would have further increased the anti-export bias but comparison of Sudanese and international inflation for the early 1970s showed relatively little divergence.

Anti-export bias was not, however, the critical dimension. Sudanese industry was performing little better than agriculture, if at all. The tendency to allocate foreign exchange to yet more investment, persistent utility and infrastructure breakdowns, ex-factory price controls and licensing restrictions all eroded the apparent incentives. Instead it was the commercial sector that benefitted. "Weak control of wholesale and retail prices has not only left the commercial sector with excessive profits but by fostering the illusion of control distracted attention away from the rich premia being earned in trade." (ILO, 1976)

One conclusion was, therefore, that devaluation would not reduce the anti-export bias and that it would be "no substitute for fiscal reform." The other key conclusion concerned management. The policy structure was not so much incorrect of itself as ineptly run. To be successful the existing system required "a well elaborated plan, a pervasive and rapid information-monitoring system and a co-ordinated decision-making process. None of these conditions is met to any significant degree by the present administrative structure in the Sudan." (ILO, 1976) The primary case for market liberalisation rested, therefore, on the need to find policies that were within the state's administrative capacity.

The ILO's perceptive analysis does not appear to have been noted in the debate, two years later, on the IMF package of adjustment reforms. Nevertheless, Sudanese academics resisting the IMF package took a very similar view. "The Sudanese economy, despite the distortions that characterise it, is not suffering from a fundamental disequilibrium as the IMF/IBRD proposals purport to show. The Sudanese economy, we believe, is rather suffering from a crisis of economic management." (Ali Ed, 1985) For this reason, Government's own Consultative Panel to the Minister of Finance, Planning and National Economy recommended that cotton taxes should be reduced, and that Government expenditure, especially wages and salaries in parastatals, should be cut. Instead of devaluation, import duties should be raised, which would allow a measure of selectivity. Lastly and most surprisingly of all, development expenditure should be cut as "there are already clear signs that the rate of at which new development projects are contracted and executed is by far greater than the economy can absorb." (Quoted in Ali Ed, 1985)

It is difficult to see anything in this rather harsh self-analysis with which the IMF could disagree, apart from the rejection of devaluation. Perhaps for that reason, the subsequent debate revolved almost entirely around that one topic, in particular what came to be called the Supply Framework for Exchange Rate Determination. This explicitly set out to justify devaluation on broader grounds than the standard IMF monetarist analysis. It was argued that the principal Sudanese export crops were not competitive internationally because the currency was over-valued. This was measured in terms of International Value Added (V) as follows:

$$V = (PxX - PmT)$$

where X = Exportable Output Px = World Price of Output in £s T = Imported Inputs Pm = Imported Input prices in £s

From this a coefficient of competitiveness (C) can be calculated as:

$$C = V.r/Pd.D$$

where r = the exchange rate D = Domestic Inputs Pd = Domestic Input Prices

The results were as follows:

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		1972/73	1976/77
		С	С
IRRIGA	TED		
Cotton	Long Staple	3.25	2.69
	Medium Staple	2.75	2.22
Sugar		3.95	2.57
RAINFE	ED		
Groundnut		-	3.22
Sesame		-	2.68
Sorghum		-	2.08

The IMF argued that a devaluation from 2.5/fs1 to 2.0/fs was needed in 1978 to put the exchange rate "at the margin of competitiveness of medium staple cotton and rainfed sorghum." (Nashishibi quoted in Ali Ed, 1985)

This analysis attracted substantial and effective criticism. Firstly it was pointed out that the drop in the coefficient of competitiveness between 1972 and 1976 was the result of falling productivity, not any change in the relative value of the Sudanese pound. At 1972 productivities, C was little changed in 1976. Second, the coefficient is a relative indicator. If the figure for rainfed sorghum is low that may merely show that resources should switch out of that crop, not that the exchange rate should be adjusted to match it. (Ali Ed, 1985) There was nothing to indicate moreover that rainfed sorghum was the truly marginal enterprise. A much larger devaluation might have made even the industrial sector competitive. Would that have been justified? Despite this the IMF prevailed and the exchange rate was duly cut in May 1979.

A further criticism was that the impact of devaluation on C was not unambiguous. It would depend on three key factors: the price elasticity of supply of exportables, the extent to which the devaluation would be 'passed through' to producer prices and the inflationary effect on domestic prices (Pd). Econometric analysis of four major export crops between 1969 and 1980 showed that "a combination of a low elasticity of supply and a high elasticity of foreign and domestic prices to exchange rate devaluation leads to a loss of foreign exchange earnings per unit of domestic input." (Hussain & Thirlwall, 1984)

Hussain and Thirlwall's analysis is open to criticism. They use quarterly data when the crops concerned are all annual. Quarterly movements can have no relevant meaning in this context. Using Nashishibi's figures, they show levels of imported inputs for groundnuts and sesame that are higher than for cotton, which is quite unrealistic for what are almost entirely rainfed crops. The elasticities of supply that the model estimates are low: 0.5 or less and in one case negative. This may be compared with the real price elasticities estimated in Chapter Four: 0.64 for groundnuts and 3.22 for gum arabic. These were estimated more crudely but from data that is much closer to that on which producer's decisions are made and the results are intuitively more consistent.

This analysis of elasticities appeared to indicate that Sudan was a typical 'rigid country', dependent on agricultural exports and on imported intermediate inputs and correspondingly unresponsive to devaluation. Other authors have suggested that for smallholder producers markets and poor transport infrastructure are particular factors in this rigidity and evidence has been presented that traders, processors and exporters margins in the oilseed sector increased over the period 1962 to 1979. (Saad & Simpson, 1990) Once again the data is not without its weaknesses. It could be argued, for example, that 1979 was too early to assess the impact of the major devaluation and no account is taken of possible increases in the costs faced by the traders.

Despite the very different style of analysis, the rigidity argument has many elements in common with the Myint and Schultz descriptions of a smallholder agricultural sector, which is efficient but slow to change. There is a clear conflict, therefore, with the conclusions of this thesis: that smallholder producers in Darfur are capable of rapid and effective change, whenever it is justified and that the rural marketing system is active and efficient.

The IMF inspired devaluations clearly failed to stimulate Sudanese exports but rigidity is only one of the possible reasons. It might have been, more simply, that weak fiscal control meant that the devaluation was eroded by inflation resulting from Government borrowing from the banking system. As already mentioned, fiscal control was certainly very weak indeed. (Brown, 1990) Critics of the IMF package on this flank argued that devaluation would feed directly into the Government deficit and thence into inflation. Government would find it impossible to reduce its commitments in real terms and its tax revenue was both lagged in time and relatively inelastic to income. The patterns of revenue and expenditure in Figure 7.1 support this argument very strongly.

There is, however, one outstanding characteristic of the Sudanese economy which received little attention in the debate: labour migration. It was certainly expected that devaluation would bring the large underground flows of remittances to the surface and that migrants would be encouraged to repatriate their earnings rather than hold

them overseas. What was not considered was the impact devaluation would have on the 'migrant wage', the incentive to migrate, and hence on the numbers of migrants and on domestic wage levels. Indirectly, the increase in the migrant wage would also have a substantial impact on incomes and hence on demand: adding further inflationary pressure in the non-tradable sector.

If there was any export commodity for which devaluation was likely to increase competitiveness, it was labour, if only because the cost of imported inputs is nil. At the same time higher domestic wages would clearly damage the export crops. Statistics on migration are scarce and it is impossible to analyse these effects but the probability must be that they were substantial.

A TENTATIVE MODEL OF EVENTS

Neither space nor data allow a complete analysis. What follows is a tentative interpretation of what happened. A simple model of a structural adjustment package that is compatible in money-supply terms has two elements:

- Trade Liberalisation lowers the domestic price of importables and reduces the demand for money,
- Devaluation increases the demand for money to offset and prevents liberalisation leading to an increase in the trade deficit.

Devaluation without liberalisation is only justified where the Balance of Trade is already in deficit. This appeared to be the case in Sudan and, for all the debate over the supply side, this was the essential argument in favour of devaluation. However, the devaluation was not in fact justified. Migrant earnings and aid flows on the capital account meant that the trade deficit was supportable, (provided, that is, that the migrants repatriated those earnings as discussed below). In theory, aid was a temporary phenomenon and should not be included in the calculation of the appropriate exchange rate and level of imports. In reality, all previous experience could only lead Government and, indeed the nation as a whole, to conclude that large aid flows would continue.

If devaluation was not justified, then the deflationary money-supply effect would have to be sterilised, preferably by trade liberalisation: the removal of tariffs and quotas. There was, however, an easier and much more politically acceptable solution: to increase the money supply by borrowing from the banking system.

It is not clear why the IMF felt obliged to present the Supply Framework in support of their recommendations for adjustment in Sudan instead of the simpler money-supply model. Possibly it reflected the influence of the World Bank, which holds the brief for the supply side. Whatever the reason, by opening up the debate on supply elasticities etc, the Fund may have allowed the key monetary message to be obscured: that devaluation must be accompanied by trade liberalisation and fiscal reform if the overall package was to be compatible. Since Government's own advisors laid more emphasis on the latter two aspects, this was unfortunate to say the least. The rather sterile debate on the supply effect of devaluation allowed Government to avoid facing up to more fundamental issues.

At first sight, the active black and grey markets for hard currency and the premia on foreign exchange, which were sometimes substantial, make it seem difficult to accept the suggestion that the trade deficit was supportable and devaluation unjustified. There are two reasons why this is not so. The first is that the black markets in foreign currency were not necessarily that large in volume terms and they were certainly imperfect. For Sudanese residents without family overseas it was extremely difficult to obtain foreign exchange at the official exchange rate. There is a story that even Numeiri himself, before one trip to the United States, sent the Ministry of Finance out into the then legal parallel market to buy his 'pocket money' (some millions of dollars). To an extent, at least, the black market premium did not reflect the overall balance of payments situation, merely the barriers to legal access to foreign exchange.

The second more substantial reason was that the premium did not reflect unsatisfied demand for imports but rather for foreign assets; capital flight in other words. There were two factors at work. One is that capital flight was to some extent an investment in emigration. If the Sudan has a comparative advantage in the export of labour services then it is entirely sensible to invest in the provision of those services. The other factor concerned the compatibility and credibility of government policy. Collier and Gunning have modelled the impact of expectations on a structural adjustment programme, suggesting that if a programme is either economically or politically unsustainable and widely known to be so, then the private sector will defer all investment switching into liquidity instead. In an economy with almost non-existent financial markets this demand can only be met through capital flight. (Collier & Gunning, 1992) A devaluation that was not justified on balance of trade grounds was likely to

be incompatible. Given the growing weakness of the Numeiri regime at this period it was almost certainly not politically credible.

Large gains in foreign exchange that use few domestic resources cause what is known as 'Dutch Disease': a consumer boom that raises demand and output in the non-tradable sector, most notably services such as commerce and construction. If Sudan's remittance earnings were anything like the scale estimated by Brown, the Dutch Disease effects on an economy already subject to a substantial bias against exports and towards commerce must have been substantial. Devaluation, through a substantial one-off increase to the value of remittances, can only have increased that pressure.

In recent years, attention has been drawn to the the potential Dutch Disease effects of aid. An analysis of Sri Lankan experience between 1977 and 1988 showed very similar characteristics to Sudan. A 'sweeping' liberalisation programme combined with a steady nominal depreciation with the result that the real exchange rate (RER) held steady or even appreciated. Aid financed investment in major projects, which created demand for non-tradables, was a significant factor behind the real appreciation. Econometric analysis showed that "transfers have had a dramatic impact in creating a tendency for the RER to appreciate, thus confirming our suspicion that aid may induce Dutch Disease, and so undermine donors' concerns that recipients improve their export competitiveness." (White & Wignaraja, 1992)

The Sudanese version of Dutch Disease combined high net aid flows with remittances. It had, moreover, the unique feature that the domestic labour supply was reduced, adding a supply side twist to the demand-led inflation. To this there has to be added the inbuilt anti-tradable bias of the Sudanese state identified by the ILO: a regime that purported to offer protection to import-substituting industries at the expense of exports was in fact most effective at protecting the service sector.

REGIONAL GOVERNMENT

The patterns of bureaucratic stagflation were matched at the regional and lower levels. Devolution policies made the situation worse rather than better. "The Peoples Local Government act of 1971 vested responsibility for administering all central government services except the judiciary, defence, communications, foreign affairs and banking in the Peoples Executive Councils at provincial level." (Davey Ed, 1976) This was not accompanied by recognition of the extra cost. The number of rural councils was increased from 86 to 500 but the Ministry of Local Government explicitly instructed that the new system of People's Local Government should not involve the Government in any increased financial burden. In 1981, there was once again "no radical reappraisal of National/Sub-National financial distribution with the implementation of regionalism." (Shepherd et al, 1987)

The result was that while it was burdened with ever increasing responsibilities, local government's share of total government expenditure actually decreased. In 1955, local government spent one third of all government expenditure. By 1967, that share had been halved, to only 17 percent. On the revenue side of the account, local government was more or less self-sufficient in 1955. By 1966/67, it received nearly 80 percent of its resources as a grant from the centre. (Howell Ed, 1974) Both in share of expenditure and the degree of dependence on central government grants, the pattern set in the mid-1960s continued at into the 1980s, when even the Gezira, the most productive province of all, drew 72 per cent of its budget from the centre. (Shepherd et al, 1987) Figure 7.3, shows the total budget for Darfur between 1982/83 and 1989/90 and the deficit over local revenue, that is to say the sum that would have to be financed out of central government funds if the budgets were to be covered. It shows local revenue reduced from 17 per cent of the budget to only 6 per cent.

Financial dependence inevitably undermined the whole concept of devolution. Local budgets were increasingly liable to savage cuts as a result of the national Government's own financial difficulties. (Davey Ed, 1976) In the end, the whole budgetary process became nearly meaningless. By the mid-1980s, financial control had collapsed to such an extent that national Ministry of Finance officials had no information on Darfur Regional expenditure except the amount paid as central government grant each year. Regional accounts had not been audited for some eight years. In Kordofan it was concluded that "The concept of the finance of an operating Department or Agency being the means of its achieving some programmed objectives (was), to say the least, obscured." (Shepherd et al, 1987)

Figure 7.3

Local councils also failed to live up to their new responsibilities. It made political sense to avoid raising local taxes by pressing central government for increased aid and "For many of the councillors, 'participation' involved, above all, the opportunity to make demands on the Government, as well as the higher councils." (Howell Ed, 1974)

Government budgets in Sudan are divided into three chapters. Chapter One is for wages and salaries, Chapter Two for running costs and Chapter Three (a) for repair and maintenance. Chapter Three (b) is for 'development' funds. The latter is the channel for foreign aid money for regional projects and



for matching central government funds. However, large projects like the two integrated development projects in South Darfur are financed directly from Khartoum and outside regional government's responsibility; a particularly fruitful source of jealousy and non-cooperation.

Figure 7.4 graphs the four budget headings for the period 1982/83 to 1989/90. The acceleration of Chapter One after 1985/86 is most striking but the desperate inadequacy of Chapter Three (a), for repair and maintenance, tells the most important part of the story. It should be emphasised that these are budget figures. Actual expenditures are not known. Any shortfall in receipts or overspends on staff had to be met by raiding Chapters Two and Three. In 1985, Regional Government was in the process trying to bring the payroll back under control. At the time it appeared that the number of staff was as much as 7.5 per cent over budget in 1985 and that a further 12 per cent were being paid at grades higher than those shown in the budget, which explains the jump in Chapter One for 1986/87. Unfortunately, any improvement in control was temporary as the continued acceleration of Chapter One shows.





These figures do not mean that staff were overpaid. By the early 1980s government pay rates were deeply unattractive. They do not even necessarily mean that the regional government was overstaffed relative to its ambitious responsibilities, although the ratio of one state employee for well under 200 people seems very high in an area where very many inhabitants neither receive anything from nor give anything to the state. Above all, it must be stressed, these budget figures are no indication that the Regional Government actually received anything like the sums planned, "money frequently being unavailable despite its formal authorisation." (Shepherd et al, 1987)

Although they are not supposed to be, the expenditure chapters are closedly linked to the revenue sources. The size of the central government grant to the region is almost entirely determined by the Chapter One requirement. "In view of the inflexible character of salary payments this is not surprising. Scales are set down nationally, and the reduction of staff to any radical extent is politically and socially inadmissible, offering little room for manoeuvre." (Shepherd et al, 1987) Chapters Two and Three(a) are left dependent on local revenue and they are the first to suffer when central government is looking for economies. Chapter Three(b), on the other hand, is protected by the fact that if central government reduces its contribution the matching foreign aid funds may also be reduced. Because these development expenditures are intended for the creation of new capital assets they automatically create yet more burdens on Chapters Two and Three(a) in future years. At least they do if they are spent as intended, on capital works. Where possible they are often diverted either to running costs or to maintenance. Given the "admitted value of development expenditures from which recurrent activities can discreetly withdraw resources"... "any project is desirable, however poorly conceived and whatever the scepticism of the Sudanese counterparts." (Shepherd et al, 1987)

The shortage of operating finance means that departments become obsessed with any possible form of revenue raising activity. Schools, hospitals and veterinary services make more or less explicit charges for their services, on the often valid pretext that they cannot operate without them. The National Water Authority undertakes private contracts for drilling boreholes, the Range and Pasture Administration grows fodder, the Veterinary department organises cheese making and chicken farms. These operations are almost never profitable. No allowance is made for depreciation and wear and tear on the equipment used. The labour is drawn from underemployed staff already on the payroll. Fuel and other inputs are diverted from other purposes. Vets making cheese, for example, buy milk for cheese-making with an official allocation of scarce sugar. In effect this converts the sugar to its the black market value and realises that value for the department.

The charitable interpretation is that these activities raise revenue for the department's other operations. In many cases, however, they serve instead to convert what little is left for Chapter Two expenditure into additional staff benefits. Government departments sell each other the produce from their various farms and other activities at much below the market price. The staff employed in those activities are paid overtime and extra 'incentives' out of the revenue and so on. Once again it should be emphasised that this reflects the absolute inadequacy of government pay at every level. It would be easy to interpret all this in terms of Krueger's Rent Seeking behaviour but it probably more valid to see it as the mechanism by which inadequate government salaries are bought somewhat closer to the market rate.

It seems senseless to consider increasing revenue after a decade in which Darfur faced famine twice. Nor are the figures available to make confident estimates of regional income and the potential for increased taxation. Nevertheless, some approximations give surprising results. For example, a JMRDP survey for 1988 recorded an average household cash income of over £s3,000. (JMRDP, WS88) This did not include the important contribution of subsistence production. This income was matched by annual cash expenditures of very much the same. The Jebel Marra area is undoubtedly better off than many other parts of the region but it would be reasonable to assume that the average household income for the whole region is around £s1,500 except in drought years. There were 639,000 households in Darfur at the 1983 Census, which would indicate some 740,000 in 1988. Taking these very broad estimates cash income for the region as a whole would be £s1,110 million. If regional government could raise only 5 per cent of that it would receive £s55 million, nearly four times its budgetted revenue for 1988/89 and 27 per cent of its budgetted expenditure for that year.

When attempts are made to raise tax revenues they do have an effect. Levels of collection by the area councils in Kordofan in 1981/82 were 102 per cent of budget. "In contrast the recorded collection of income from projects and services by Departments was grossly below target, only fs 988,628 being realised of fs 4,796,650 (budgetted)." (Shepherd et al, 1987) The reason behind this nonsensical over-estimation of their revenue potential is the Department's knowledge that it might strengthen their case for larger allocations of fuel and so on.

It is difficult for anyone who has not attempted to find out something about local administration in rural Sudan to comprehend the extent of the collapse in management, especially in financial management. "Bad as (the

approved budget record) might seem, reconstruction of actual expenditures is far more difficult. Records are very poor if not totally missing. Discrepancies between disbursement requests and actual payments abound and the intended use of disbursed funds is usually difficult to ascertain. Finally, it is all but impossible to examine actual uses of funds once they are disbursed to the line ministries and operating departments." This collapse does not reflect any concentrated effort to divert funds or to cover up abuse. Instead, it springs from a total breakdown of basic management disciplines, partly because of poor pay but more importantly because there is no political interest whatsoever in maintaining it. There is an "apparent absence of politicial influence and intervention in the recurrent budget preparation, a process confined to routine public service action and interaction." (Shepherd et al, 1987) This points to a very important conclusion: that the modern Sudanese political entrepreneur has next to no interest in the day to day business of government.

ADMINISTRATION

The role of the Sudanese political entrepreneur in Darfur can best be examined through the history of local administration. Since the early colonial period, administrative developments in Sudan have run on two tracks. One employed traditional groupings - the religious sects and the tribes - as agents of the administration. The other created a bureaucratic machinery dealing with the members of society directly, as individuals not as members of any particular group. This machinery was supposed to be subordinate to a matching democratic framework of elected councils. The dilemma of the state, in the post-colonial as much as in the colonial era, has been how to strike a balance between the two.

The colonial government was perceived, not altogether fairly as having overemphasised the first track. Partly in reaction, post-colonial regimes have regarded the traditional leadership with suspicion and attempted to reduce their role. Despite this, the traditional groupings have survived and retained their political force. The more modern elements of bureaucratic administration and participatory representation have repeatedly failed to escape the influence of the traditional or to deliver the improved services that they were supposed to offer.

The traditional system cannot, however, stand on its own. Tribal leaders can only function if their powers are clearly delegated from a higher, independent and dominant authority. The colonial state was able to harness the traditional groupings because it stood above them and controlled them from a neutral position. In this way it created what was known as the Native Administration from the tribal leadership of northern Sudan. When, however, the Condominium government attempted to create a Sudanese force to replace it as the controller and arbiter of the Native Administration, most especially under the doctrine of Indirect Rule through the most dominant traditional leaders, it failed. (Daly, 1986)

Elected councils were the next alternative to Indirect Rule as the governing force controlling the Native Administration. In 1948, Dr Marshall, City Treasurer of Coventry in England, was commissioned to draw up recommendations for future development of local government in Sudan. Marshall was looking for a system that would not "confuse administration of local services with the 'cross currents of national politics." (Daly, 1991) It took only two years after independence for this dream to collapse with the end of the first democratic government. By that time it had become all too clear that national and local politics are inextricably entwined in Sudan. After the 1958 coup, "The absence of 'sound democratic institutions' at provincial level had been blamed by the President for the failure of parliamentary institutions." (Henderson, 1965) Two attempts were made after independence to tackle the issue of local government, under the military governments of Abboud and Numeiri. The latter tried a socialist/one-party approach through the Sudan Socialist Union. Neither had any greater success. (Woodward, 1990)

In this sense, both the colonial and post-colonial states failed at the same hurdle: the creation of a sovereign and independent power that could oversee, direct and discipline the lower levels of social organisation. Just like the majority of Indirect Rulers, neither a modern bureaucracy nor democratically elected councils nor a monopoly ruling party have been able to achieve any effective degree of independence from the religious sects and from the tribes. And the failure to build up a successful modern sector administration has led to a collapse in the traditional sector as well. Without an arbitrator, the sects and the tribes cannot escape the tendency to pursue their particular interests at the expense of the greater good. Far from being unrepresentative, the Government of Sudan has been all too representative in this sense, even under military regimes. "The Sudan army, like the bureaucracy, has been not so much a detached institution as something of a mirror of Sudanese society." (Woodward, 1990)

In the terms of Hayami and Kikuchi's model, the 'political entrepreneurs or leaders', who can negotiate and enforce the social pacts that any development must depend on, seem absent in Sudan. (Hayami & Kikuchi, 1981) In part this reflects the 'looseness' of Sudanese social structures, which is in turn a function of a low population density. The colonial conquest also destroyed a number of emergent political leaders: the successors to the Mahdi

and, in Darfur, the Fur Sultan. Despite this many of the current Sudanese elite are representatives of families or groups that were prominent under the Mahdi and made an accomodation with the colonial government later.

In recent years, Darfur has seen increasing levels of tribal unrest. The standard explanation is that it reflects pressure on the land and competition for resources. Here it is suggested that it reflects the failure to find a neutral sovereign power in an area of loose social structure and considerable ethnic diversity: in other words a failure of political entrepeneurship. This is not to deny that there is some competition for resources but to suggest that the competition is nothing unusual. In a more densely populated area it would be greater. Therefore, the critical question is not why there is competition but why the mechanisms to deal with it are so defective?

Race and tribe might seem a plausible answer. Darfur is ethnically diverse and Islam is the only only truly common factor. On the other hand, tribal and even racial boundaries can only be described as porous. Individuals, groups and even whole clans drift from one tribe to another as best suits their circumstances. Despite the strong preference for cousin-marriages, cross-tribal marriages are frequent. In this sense the division between Arab and Non-Arab is a tribal boundary, not greatly different from that between one Arab tribe and another. "Such mobility suggests that tribal labels have only a limited ethnic content or stability and that mainly political mechanisms accounted for the preservation of territorially defined groups in an area of open frontiers. Changes in political allegiance were later legitimised by changes in one's ancestors." (O'Fahey, 1980) The economic content of tribe is also weak. Even though Baggara means cattlemen, at least one of the major Baggara Arab tribes, the Habbania, were described as principally farmers as early as 1905. (Gleichen, 1905) More recently some non-Arab Fur have taken up nomadic cattle management while the non-Arab Zaghawa are large cattle and camel-owners. (Haaland in Cunnison & James, 1972)

It is easy to conclude from the fact that the idea of tribe has neither ethnic nor economic content that it is not important; a conclusion was particularly welcome in the post-independence era of reaction against all things colonial. Yet the survival of the traditional leadership and the continued conflict over tribal boundaries shows the opposite. Ibn Khaldun, the great Arab philosopher of the fourteenth century, stated that "Kinship only serves a function when blood ties lead to actual co-operation and mutual aid in danger - other degrees of kinship being insignificant. For although kinship is natural and objective it is also imaginary." (Issawi, 1950) Studies of Sudanese tribes such as the Humr and the Rufa'a al Hoi confirm the functionality of the tribal system, especially in the restraint of internal disorder. "From the number of clusters making up the camp a leader emerges. ... His role is mediating the disputes between his camp members through the help of his elders, as well as representing the camp to the rest of the tribe and its ruling elite." (Ahmad, 1974) The flexibility and severe practicality of the arrangements is most clear in the blood money arrangements among the Humr. Blood money obligations are not fixed, so much for the close family and so much for more distant relatives, for example. On the contrary they are negotiable. "Relations between groups within omodiya or lineage are stated in formal terms by agreement or refusal to cooperate in payment and receipt of blood-money." Even among relatives, bad feeling may lead to a refusal to cooperate in blood money payments while "commonly a minor lineage seeks Book (ar kitab) allies outside the omodiya to relieve the heavy obligations if one of its men should kill." (Cunnison, 1966) Kinship is indeed 'imaginary'.

These book alliances with those outside the immediate kinship group resemble nothing so much as mutual insurance against liability. Insurance is a typical example of a market with imperfect information, such that the economics of information would predict a resort to non-market institutions. A prediction clearly supported by the non-market institution of blood money arrangements.

All of this suggests that the mechanisms of political entrepreneurship are perfectly active at the local level in Darfur. Tribal leaders at every level compete for supporters and the benefits while providing services of arbitration and conciliation. Tribesmen, on the other hand, shop around quite actively for the best leader.

Without going into detail, an exactly parallel conclusion might be drawn at the regional and national levels, where active political entrepreneurship may be found, especially as expressed through the religious sects or tariqas. From their foundations in the late 18th century, the tariqas have served as channels for political and economic expression as well as for worship. One of the two most important, the Ansar, sprang out the Mahdist movement which won much of its support from traders resentful of Egyptian rule. The other, the Khatmiya, was linked to that rule. They are now each associated with one of the two largest modern political parties.

THE RULING CLASS

The slow pace at which they opened the public service to Sudanese recruitment and the limited effort they put into developing the modern education for potential candidates were major causes of resentment towards the British. Even in the later years of the Condominium they were accused of "dreamy conservatism" for believing

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that "ultimately the educated class may tend to merge in the class from which native authorities are drawn, and a nazir and a bashkatib (government clerk) may wear the same Old School Tie!" (Daly, 1991) If they were suspicious of the political problems that education was likely to cause them the British were, of course, well-advised to be so but they were not effective in preventing it. The Graduates' Congress was the earliest body to force the Condominium government to recognise its right to make its views on independence and other issues known. Whether it is thanks to the colonial government or in spite of it, Sudan has one of the strongest cadres of capable and well-trained graduates of any African country.

Similarly, if it was a dream that the educated effendia should be drawn from and merge with the tribal leadership on the basis of the 'old school tie', then the dream has largely come true. One of the strongest personal relationships among Sudanese is that of 'colleagues' at secondary school and at university, a relationship that often seems regrettably stronger than any loyalty to the greater good, when it comes to staff discipline for example. Similarly, Sudan may be a society without a strong feeling of class, as is sometimes suggested, but the closest the Sudanese come to snobbery is over the issue of educational qualifications. On one occasion at a tribal peace conference in South Darfur, the leadership of one side opened the conference by complaining that they had not been given time to summon their educated sons back to match the graduates in the other side's delegation. (Mukhtar, Unpub) Weak as it is in so many other respects, one of the strengths of the modern bureaucracy is the high proportion of qualified staff drawn from the local community. Sons of the Native Administration can and do end up as Regional Governors, as Director Generals on multi-million dollar projects, as World Bank officials and so on. The chances even seem to have been well distributed. Even in the middle of a major tribal battle such as that between the Fur and the Arabs, projects such as the JMRDP can maintain a capable staff of qualified graduates in which both sides are well represented and continue to work together. It is not necessarily easy but the fact that it can happen at all reflects the strength of the educated elite that was created.

If the preceding discussion is correct and the factor behind the travails of the Sudan is the lack of a sovereign power capable of standing above the fray, then the only obvious source of such a power within the Sudan is this educated elite. Yet the elite seems resolutely uninterested in taking up the role effectively. The only conclusion seems to be that the rewards to political entrepreneurship are inadequate when related to the admittedly considerable task such an entrepreneur would face.

It should be stressed out the outset that corruption is not the issue. A corrupt elite might be perfectly efficient because it would wish to raise taxation and to make all the little revenue earning schemes of the rural Sudanese bureaucrat as profitable as possible. Given the total collapse of accounting mechanisms, there is little to stand between them and the diversion of the greater revenues to themselves. There are many more corrupt third world states than Sudan which have vibrant and progressive economies. By all reports Indonesia has more or less institutionalised corruption without obvious direct economic damage and with hindsight it can be seen that Muscat's Bureaucratic Capitalism has been no barrier to development in Thailand. The difference seems most obvious in the approach to work. The Sudan government's employees do not steal its money. Instead they cheat it by not doing the work they are paid to do. One obvious reason for this is that the government does not have any money to steal, once it has paid the salaries.

How has this situation arisen? After all the bureaucracy inherited much of the status of their colonial predecessors. Was this not an adequate incentive to search and raise their X-efficiency? The answer appears to be that it never had the chance. Once again the reason lay in that crucial difference between a colonial state, which could take an independent view of who to employ and how much to pay them, and a post-colonial state where that decision was an intensely political one. In many ways, it was the graduates' very success in winning a share of political power as a separate entity - they have their own parliamentary constituencies and powerful unions - that led to their economic downfall. Appeasement of the graduates has been a common theme of Sudanese politics and that appeasement has led to a devaluation of their economic worth. Between independence in 1956/57 and 1968/69, the number of central government classified posts, which is to say in the middle and higher grades, rose from 15,868 to 39,769. The pressure of "jobs for the boys" was such that there was a "distribution of jobs to hundreds of graduates before the 1968 elections in an effort to boost the Unionist vote." (Woodward, 1990) The strength of these forces may be seen in the failure of the the Job Employment and Classification Scheme which has already been mentioned.

In 1989, this process of bureaucratic inflation had reached the level that a Khartoum University graduate with a United Kingdom Masters of Science degree and five years experience working on an aid financed corporation, where pay was higher than in the government mainstream, was paid the equivalent of only f_{40} pounds sterling a month, valued at the official rate of exchange. At the black-market rates, which actually determined his cost of living, it was worth much less. There was no one on the project, from the Director General downwards, who could realistically survive without some other source of income: onion farming, livestock herding and so on. In

order to keep any staff at all management spends more and more time devising ways to boost pay: overtime, special incentives, staff cooperatives selling rationed goods at cheap official prices, use of project facilities and so on. Some of these indirect benefits are even institutional at the national level. Accounts departments are paid an 'incentive' by the Ministry of Finance and Economic Planning if they submit their accounts on time, or even late.

To sum up, when planning work as little attention is paid to ensuring that the staff resources are available to carry out a properly conceived programme as there is to ensuring that adequate funds are available. The concept of the staff of an operating department being the means of its achieving some programmes objectives is just as obscured as is the concept of its finance being that means. If an attractive job on a project comes up, secondment is never refused, if a long training course overseas comes up in the middle of a heavy project work-programme, permission is never refused, and if there is a job overseas with the UN or in Saudi, leave without pay is always granted.

CONCLUSION

One of the most disorientating things for an outsider working inside the Sudanese government system is the lack of any evident urgency when facing the extraordinary chaos and lack of control. Individually, most of those involved in government know full well the extent to which the system has crumbled. Many can discuss in detail what is happening and why. The overwhelming consensus clearly is, however, that nothing can be done about it. A conference held in Nyala in 1976 on local government led to no improvement. Aid financed regional planning units in both Darfur and Kordofan, have had no obvious effect on the central issues of budget and control. Instead they have been used as coordinators of aid-financed programmes and even as a means to attract more aid. Even at the national level, the most glaring of problems are only ever tackled when donor finance is provided and it soon becomes clear that there is no sincere intention to tackle the problem identified, merely a sincere desire for the foreign funds. The perversion of the Job Employment and Classification Scheme was an extreme example of this pattern.

Most of the evidence points to a conclusion that the central problem does indeed concern political entrepreneurship, in the sense defined by Hayami and Kikuchi, specifically the incentives available to encourage any political leader to attempt to negotiate adjustments to social institutions and to enforce the rules of those institutions once they are agreed. (Hayami & Kikuchi, 1981) Neither the extent of the institutional adjustments required in modern Sudan nor the pace at which the changes must be made particularly unusual. On the other hand, the weakness of the response to the need for change and, more importantly, for enforcement is unusual. Yet it cannot be argued that Sudan lacks political entrepreneurs. From tribal sheikhs, through the leaders of religious sects to the modern unions and parties, the Sudan's politics are active, some would say too active, and relatively free.

In Hayami and Kikuchi's model, institutions serve to coordinate the activities of individual units of society and to capture the externalities generated by those individual units. The structure of society, measured principally in terms of 'tightness', therefore depends on the need for coordination and the size of the externalities. In the densely populated agrarian societies they describe, Hayami and Kikuchi claim that agricultural activities are "strongly interdependent" and society is correspondingly tight. As far as the political entrepreneur is concerned, the incentive to act depends on the value he can realise from society's externalities.

Hayami and Kikuchi limit their discussion to agrarian societies. Coase makes the similar points more generally, taking as his starting point the concept of the firm as a mechanism whereby administrative decision is substituted for market trading in allocating resources. "The government is, in a sense, a superfirm since it is able to influence the use of factors of production by administrative decision." Coase emphasises that Government is a special case; because it is not subject to competitive pressures, because it commands state power and because it is subject to political pressures. (Coase, 1960)

These ideas can be summed up by saying that there are three ways in which external costs and benefits can be realised and given their proper social value. The first is by the creation of a right which makes the externality concrete and hence tradable. The second is by the creation of a firm which captures all relevant externalities within its own administrative control. The third is by the creation of non-market institutions, 'governments' which can organise the proper allocation of resources among a number of individuals or firms. Which of these three will prove most suitable depends on the transactions costs which depend in turn on the scale of the externalities, the number of individuals to be coordinated and critically the population density.

In a vast country like Sudan, with a low population and a relatively poor land resource, the value of the externalities will be low while the transactions costs of direct coordination through a firm will be high. This will

apply a fortiori to the superfirm, government. As the discussion in Chapter Six shows, there are many areas such as range land where the externalities are too small to even justify the allocation of individual rights.

It is implicit in Hayami and Kikuchi's model that an equilibrium will emerge. Where externalities are high, political entrepreneurs will be able to realise sufficient value to make it worth their while to act. Where they are not there will be no need for such entrepreneurs. Yet Sudan seems to be clearly out of balance. The superfirm, government, is too large for the relatively simple job it has to do, which is to provide a stable framework within which entrepreneurs, both market and political, can operate profitably. And its attempts to do too much have rendered it incapable of carrying out even that simple job.

Two factors have allowed this imbalance to develop. First, the the colonial state was technically powerful, relative to the Sudan of the late 19th century, but politically weak. This encouraged it to create State Socialism, in other words to take the superfirm approach in a country where it was not naturally appropriate. Second, the vast capital inflows to Government since independence have allowed it to push that approach to extremes. Those inflows have also ensured that the political entrepreneur can find far greater returns in the exploitation of the superfirm than he can ever realise from the relatively weak externalities of the real Sudanese economy.

By way of conclusion, one revealing example serves to illustrate how the Sudanese state has managed to avoid any realistic negotiations over resources with any of its citizens. Following the October Revolution of 1964, tension between the irrigation scheme licensees and their tenants increased. Government, under pressure from the tenants', first raised their share of profits from 40 to 50 per cent and then, in 1968 nationalised the pump schemes under the Agrarian Reform Act. This was ostensibly in response to the tenants' accusations against the scheme operators. Nevertheless, the blow for the latter was considerably softened. They were paid compensation, despite the fact that many of their licenses were nearly expired, and their debts were taken over by the new government corporations. It has been suggested that the result was to allow the scheme operators to escape just at the point when deteriorating prices meant that irrigated cotton was no longer profitable. (Mahmoud, 1984) Overall, the evidence does not support this. There was no clear decline in either the commodity or the income terms of trade for cotton in the 1960s. (Beshai, 1976)

The true reason cotton was becoming increasingly unprofitable for the scheme operators was the way the tenants were winning a greater share, both directly and indirectly. This was happening on the government schemes as well as on the private ones. Directly, the tenants' share of the profits on the cotton crop had been increased. Indirectly, they gained by diverting their efforts to other crops. The incentive to do this was strong. Because all the overhead costs of the scheme were charged to cotton the other crops were more attractive. As their political strength grew, the tenants were increasingly able to disregard the stipulated cropping patterns and practices and the area under cotton on the Gezira dropped from 57 per cent in 1954/55 to 43 per cent in 1969/70 as a result. In the face of this competition from their tenants, the pump-scheme operators preferred to abandon irrigation and shift into mechanised farming on suitably attractive compensation. By doing this they preserved their political support among those same tenants at small cost to themselves. In mechanised farming, by comparison, the seasonal labour force was never likely to develop the political strength of the irrigated tenants so the operators were unlikely to face similar pressure again. This shift kept all groups more or less happy, at the expense of Government taking over the thankless task of trying to maintain its share against the tenants' pressure, something it was manifestly failing to do on its own schemes.

As Coase points out, the superfirm is subject to political pressure and, as the pump scheme story shows, that pressure can destroy its capacity to allocate resources to the common good. The only corrective is political counter-pressure from those who have to pay for its misallocations. But while Government is able to rely on external finance, it faces no such counter-pressure.

8. CONCLUSION

At the end of Chapter Two four theoretical issues were identified, to be examined in relation to Darfur:

- the extent to which the impact of trade has been through the processes of vent-for-surplus, of division of labour and technical change or of comparative advantage.
- the Schultz proposition that agricultural factors are inherently costly to smallholder farmers in areas like Darfur and that research and extension are required to overcome this.
- the Boserup prediction that the man:land ratio drives development and that population pressure creates its own solution.
- what may be termed Social Boserup mechanisms whereby institutional change is also driven by changes in the balance between population and the resource endowment and, as an adjunct, the impact of foreign capital on those mechanisms.

THE IMPACT OF TRADE

Trade has had a clear and substantial impact. There is no question that it has been the principal engine of development in Darfur for most of the 20th century and, at a slower pace, long before that. Three major export commodities, gum arabic, groundnuts and cattle, have shown substantial growth over long periods. Incentive consumer goods of a relatively simple kind have made up the bulk of the balancing imports, cloth, sugar, tea and others, and growth has been achieved with relatively limited capital investment. This seems to match Myint's Vent for Surplus model of development, in which increased labour effort on an abundant land resource generates increased production without the need for either new technology or capital. At a more detailed level, however, the model seems less well supported for three reasons.

The first of these is rigidity. Myint's Vent for Surplus depends on there being both unemployed labour and underused land prior to the opening up of trade. The reason for this, he argues, is that in a non-monetary, non-trading economy markets cannot adjust factor prices and that technical coefficients of production are more or less fixed with traditional technologies. This is not supported in Darfur. Export development was underway long before the development of full money markets and there is clear evidence that even in non-monetary markets there were mechanisms to adjust factor prices. Moreover, the appearance of fixed technical coefficients in smallholder agriculture on an abundant land resource is something of an illusion. Significant adjustments can be made by varying the area of land worked, by varying the intensity of weeding effort or by moving between different classes of land. In Darfur, shifts between the crop and livestock sectors are also important.

The second reason is the ample evidence that development in Darfur may have been relatively cheap but it still depended on both new technology and capital. To some extent this was obscured by the fact that some of the technologies were new to Darfur but rather old in international terms - irrigation using the manually operated shadouf and camel ploughing are prominent examples. The contribution of capital was also less obvious because the quantity was small and much of it was trade capital.

The third reason for rejecting pure Vent-for-Surplus in Darfur is the evidence of relatively strong contributions from both comparative advantage and technical change; contributions that have been generally undervalued. The modern analysis of comparative advantage compares economies which have significant differences in resource endowments but which are at a similar stage of development: typically the USA versus Europe. This has, perhaps, obscured the fact that where the disparity in resource endowment is greater, in particular in the capital endowment, there the difference between the marginal rates of substitution in production and in exchange is also much greater. Under these circumstances, comparative advantage is much more powerful.

One example serves to make the point. Prior to the appearance of cheap imported cloth in Darfur, the labour effort involved in growing tree cotton and in manufacturing cloth using craft techniques was very substantial indeed. Trade allowed a far higher quality of product to be acquired for considerably less effort. There is a wide range of similar imports, consumer and intermediate goods, for which the same is true. They were substitutes which were vastly cheaper than existing Darfur products but which were technically no different; in the sense that the purchaser was not required to make any changes to the way he used them. Cloth was cloth, wherever it was made.

Similarly, the fact that the absolute value of capital imports was small does not mean that the labour effort saved was not substantial. The diesel driven flour mill is one striking example but transport was the most important of

all. Myint explicitly excludes transport as a "method of making a given volume of resources more productive". For a remote landlocked area such as Darfur this is clearly not true and changing transport technologies have had a radical effect on the overall balance of the economy.

During the 20th century there have been many such shifts in the balance of the economy, all of them pointing to one conclusion: that factor combinations are changing significantly in response to the opportunities provided by trade. Geographically, there has been a shift from North Darfur to South, from country to town and from non-goz to goz farming. Increased specialisation has seen the abandonment of local production of cotton textiles and salt and the development of new enterprises, notably in horticulture, in construction and brick-making and in the service sector: blacksmiths, bakers, millers and others. Cattle owners have shifted from dairy to beef production. There has even been a certain amount of capital deepening and vertical integration, including groundnut hulling and milling.

Myint argues that because factor combinations are rigid, communities that develop through the expansion of traditional production are uniquely vulnerable to adverse changes in the terms of trade. Since the expansion was built on the release of resources that were previously under-employed, so any contraction can only lead to a return to under-employment. The sharp impact of declining export performance in Darfur would seem to support this but it does not necessarily do so. A trading economy in which the difference between the marginal rates of substitution in production and in exchange are particularly large would be equally vulnerable, if not more so, and that seems to be more nearly the case in Darfur. The terms of trade would have to turn very sharply against Darfur field crops before it became a realistic option to start producing cloth locally again, for example, and that would only be possible at the cost of a very severe drop in living standards.

It has been emphasised that although trade may bring new hazards, it does make the portfolio of risk wider. In an environment that is already risky, this can mean that trade reduces the riskiness of the economy overall. This is another reason why a reversal of trade-led development can lead to particularly sharp falls in standards of living. Lastly, Darfur and Sudan as a whole have shown how trade-led development is uniquely vulnerable to a political failure.

PENNY CAPITALISM AND TECHNICAL CHANGE

Penny Capitalism is the title Schultz gives to traditional smallholder agriculture which is economically efficient, in that farmers allocate resources to maximum efficiency, but which cannot grow because farmers are either incapable of or unable to acquire more productive agricultural technologies.

This is because such technologies are not 'amenable to transfer'. The market for agricultural technologies is uniquely difficult to enter. Linked to this is the idea that these technologies have high positive externalities, such that entrepreneurs do not find it profitable to trade in them even though they are economically viable. Traditional farmers are risk averse and so will not experiment with new technologies. Lastly, farmers lack the training, experience and education to learn the skills required.

The position of capital and investment is ambiguous. To some, the evidence of low investment in traditional economies shows that savings are low, capital is in short supply and, by implication at least, returns to investment are high. In this view, farmers do not acquire new, more productive technologies because they do not have the necessary capital. Schultz disagrees, suggesting that the capital stock is higher than it looks; embodied as it is in houses, tree crops, livestock herds and other assets. He also argues that returns to investment are low and that this is why savings are low. It is central to his argument that returns to new technologies are just as low, because they are not amenable to transfer, as the traditional ones, otherwise farmers would raise their savings to acquire them.

In recent years, Darfur has not been a good test of Schultz' proposition. The macro-economic constraints are so great that all new technologies are enormously costly, almost unobtainable, and highly risky because, even when they can be obtained, supply is unreliable. Before these wider problems developed, however, there was little evidence to support Schultz. Even in the current, more difficult period most of the signs are against him. There are four points:

Market entry - Darfur markets are extremely active and it is difficult to see any special characteristic in agricultural inputs that might set them apart. (Except that is for one overriding characteristic, their vulnerability to bureaucratic interference.) In the early years of the century several important new technologies became established entirely through private sector initiative: foremost among them groundnuts and irrigated onions.

In this context it is worth noting that the factor that might make new agricultural factors unattractive to enterpreneurs is that precisely that they are highly amenable to transfer! The high externalities that exist in

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agricultural technology consist of the fact that it is difficult to prevent others watching what you are doing and starting to do it for free. If it were easier to keep it a secret, then entrepreneurs would be able to make greater profits from the secret. This is a fundamental inconsistency in Schultz' model.

Risk Aversion - It seems most unlikely that risk aversion is a serious barrier to the establishment of new agricultural technologies in Darfur. Because of the portfolio spreading effect it is not even clear that those new technologies are more risky anyway. Besides that, there are clearly many in Darfur who are ready to undertake substantial risks, where the returns justify it.

Experimentation - All over Darfur, there is clear evidence that farmers and indeed all the people are actively engaged in seeking new opportunities and there are more than enough examples of new technologies that have become established with little or no promotion: from tobacco and tomatoes in the 19th century to Triple-Super Phosphate on Jebel Marra in the 1980's.

Capital - It is important to distinguish the motive for saving. Schultz argues that savings are low because returns to investment are low. This was in opposition to those who implied that both savings and investment are low but that returns are high. In Darfur, savings for insurance purposes are high - grain in store above all - but investment remains low because the returns are low. The implicit insurance premium is high - storage losses for grain run as high as 20 per annum - but investment opportunities are not profitable enough or secure enough to provide an alternative.

This leads to an important general point, which is that one of the major gains from development generally and financial deepening in particular is the way in which resources are released from expensive insurance savings by the integration of the insurance and capital markets through profitable investment.

The conclusion is that there is no evidence that agricultural technologies are not amenable to transfer; rather the opposite. Instead it is clear that all technologies are costly or not depending on two things: the resource endowment and politics. When those two things are such that a given technology is both profitable and available, then it is rapidly taken up.

BOSERUP OR NOT?

Boserup's descriptive analysis of the African bush-fallow and of the land tenure relationships that go with it is very closely matched in Darfur. Nevertheless, Darfur is not entirely a good test of the Boserup Hypothesis because the evidence of any significant change in the balance between population and resources is ambiguous, to say the least. Apparently ample circumstantial evidence of increased population pressure does not stand up to close examination. One important conclusion is to emphasise the need for such examination in considering these issues in Africa.

For this reason the test must take a somewhat negative form. Boserup predicts that changes in the man:land ratio drive technical and other changes. Therefore if the ratio has not shifted then no changes will occur. When put in that form, the Boserup hypothesis seems strongly supported.

Cultivation Technique - Animal traction is not proving a widespread success despite an abundance of land, supporting the prediction that animal draft is a response to a need to raise production as population pressure increases.

Research and Extension - Agricultural research and extension have been largely unproductive. This is against the Schultz prediction that they are needed to make agricultural technology amenable to transfer. Instead it matches the Boserup prediction that new technologies will not find a market until the resource endowment changes.

Land Tenure - Tenure remains almost entirely usufructuary.

Although the man:land ratio has not changed significantly at the general level, there is widespread evidence of Boserup type changes in technology and land tenure relations where local changes in the resource balance have occurred. A number of examples may be cited:

Hashab Gardens - in the colonial era, the boom in gum arabic exports led to formal registration and hence secure tenure in hashab;

Irrigation - tenure has always been more secure on the small areas of irrigated land but increased markets for horticultural produce has seen a considerable expansion of the area irrigated and consequently more firmly held;

Ploughs and hoes - the African digging stick is rarely seen. Across large areas it has been replaced by the push-hoe and more locally by camel-ploughs. In both cases the new export crop of groundnuts has been an important factor behind the change in tool and technique;

Range Land - In clear breach of customary rules on land tenure, range land is being enclosed for fodder conservation. The distribution of these enclosures is related to urban markets for fodder.

Trade and market opportunities are dominant factors in all of these shifts. This points to an important extension to the Boserup Hypothesis, which does not make allowance for the way trade can affect the resource balance.

It is implicit in Boserup that changes in land tenure will occur as and when required to overcome problems of externalities. This sets it in direct opposition to the Tragedy of the Commons analysis of common access resources, which postulates that tenure, or rather the lack of it, is more or less fixed and that the resource is doomed to over-exploitation as a result. Both in Darfur and in Africa more generally, much analysis has tended to the latter conclusion, especially with regard to range land. Using Lipton's neat framework, it seems clear that neither crop land or range land in Darfur is under such pressure as to be facing a Tragedy of the Commons. (Lipton in Matthews Ed, 1985) Once again, the conclusion is that the negative Boserup prediction - that tenure will not develop until man:land ratio justifies it - is supported. That institutions are sufficiently flexible to allow tenure to develop in due course is demonstrated by the fact already cited, that range land enclosures are developing in direct breach of firmly stated and generally acknowledged customary laws.

As with technical change, a central conclusion is that macro-economic problems override any of the processes of underlying change - Boserupian or otherwise - in the short to medium term. Emigration from Sudan to the Gulf States has directly slowed and or even reversed any change in the balance of resources in Darfur. This is not only because it has reduced population pressure but also because it has sharply increased the labour wage in the region and hence reduced the implicit rent to land. That rent is the measure of Lipton's 'temptation to goodness', the incentive to tackle and solve the externality problems of common access resources.

The other dominant feature of the Sudanese macro-economy, what has been described as Sudano-Dutch disease, has exactly the same effect. The incentive to expand the service, non-tradable sector and the disincentive to the production of tradable goods also reduces the return to land and the implicit rent. This is part of the explanation for the fact that Boserupian changes in land tenure are most evident on land that is used to produce goods that are non-tradable in Darfur under present conditions: horticulture and fodder production for the urban community.

SOCIAL BOSERUP

In one sense, the sole function of government, and of social institutions more generally, is to mediate externalities; they are 'non-market institutions' (NMI) specifically intended to deal with costs and benefits that cannot be traded in the market. A belief that NMI cannot adjust to increasing populations and to the rising level of externalities that results is central to Lipton's prediction that traditional societies cannot escape from the Tragedy of the Commons. This may be set in opposition to what has here been termed the Social Boserup Hypothesis of Hayami and Kikuchi; that it is precisely the externalities generated by increasing population that give political entrepreneurs the incentive to establish new NMI or negotiate changes to old ones. The prediction is, therefore, that more densely populated nations will have stronger social institutions and be more cohesive; 'tighter societies' to use Hayami and Kikuchi's phrase.

A distinction may be drawn between those social institutions which are substitutes for market exchange and those that may be termed 'natural NMI', which deal with externalities that are not amenable to market exchange at all. Arrangements such as sharecropping, labour exchange and payment in kind all fall into the substitute class and they are better described as non-money rather than non-market institutions, because the evidence from Darfur and elsewhere is that they are not significantly less effective than monetary exchange as a mechanism to adjust factor and other prices to changing market conditions. Clearly, it is the 'natural NMI' that are crucial to the processes of Social Boserup.

Innovation, Technical Change & Open Access Resources

It was outwith the scope of this thesis to examine the political and social institutions of Sudan in enough detail to present a full analysis of their development and of the political entrepreneurship that was involved. Very broadly, however, it is suggested that the 19th and 20th centuries saw considerable social development, which was built in its turn on a much longer history. Trade was clearly a driving force, from the Fur Sultanate, which was financed by the trade in slaves and ivory, to the great Islamic Tariqas, many of which were related to trading groups, to the Mahdiyya, which partly reflected the resentments of Sudanese traders against Egyptian rule, and even to the Colonial State, which was almost as dependent on trade as the Fur sultanate. At their heyday, all of these political organisations stood or aspired to stand above the competition of tribal and other groups and provided some measure of that sovereignty that is essential to political entrepreneurship; without it negotiations over adjustments to NMI are bound to fail, either because of a failure of trust among parties to the arrangement or because of an inability to control 'free riders'. Because of their dependence on trade and commerce, all of them also had a strong incentive to establish their sovereignty and make a success of their deal-making.

In Hayami and Kikuchi's terms, all of these groups may be seen as political entrepreneurs exploiting the increasing externalities that arose as the resource endowment shifted under the impact of trade. And just as the short-term macro-economic problems of the Sudan have buried Boserupian development in the exploitation of natural resources, so they have also buried the Social Boserup development of new political institutions.

This is, of course, a circular argument because those macro-economic problems are, at least in part, the reflection of a political failure. Two factors seem important and provide some exogenous explanation for the patterns described: the opportunity for emigration offered by Sudan's chance proximity, both geographical and social, to the OPEC states, and high volumes of aid, which are also partly due to the accident of Sudan's geo-political position. These have both offered returns to political entrepreneurs that make any gains they might extract from re-negotiating the NMI which manage Sudan's own resources seem paltry indeed. It is no accident that Darfur's favourite son and most well known politician, Ahmad Dereij, made his fortune not in Darfur but in the Gulf.

CONCLUSION

There seems to be one general conclusion. Despite considerable circumstantial evidence in their favour, theories which depend on one or other special characteristic of under-developed or traditional societies do not bear detailed examination. Darfur looks a classic case of Myint's Vent for Surplus, it is not. Agricultural techniques are simple and it is easy to conclude that new technologies will be 'unamenable to transfer'. They are not. Famine and drought in an area of common access natural resources, seem to point without doubt to a Tragedy of the Commons. They do not. By contrast, the more neo-classical analysis, of Boserup, of Hayami and Kikuchi and even of Adam Smith himself, seems at least not disproved; although the test cannot be rigorous because the overall compression of the Sudanese economy has disguised or even stifled many of the processes involved.

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