TOWARDS AN UNDERSTANDING AND EVALUATION OF PASTORAL PRODUCTION SYSTEMS IN TROPICAL AFRICA WITH SPECIAL REFERENCE TO SUDAN

A thesis submitted in partial fulfilment of requirements for the Postgraduate Diploma in Agricultural Economics at the University of New England

by

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1981

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Acknowledgements

Thanks are extended to my supervisor, Dr J. R. Anderson, for encouraging me to gather my (and others') thoughts on the economics of African pastoralism. In addition to Dr Anderson, several other persons have been helpful in supplying publications, manuscripts and information: many thanks to A. Duncan (Project Development Unit, Southern Sudan), B. Frank (DPI, Townsville), Dr G. Haaland (Chr. Michelson Institute, Norway), Prof. G.L. McClymont (UNE, Armidale), Dr R.L. McCown (CSIRO, Townsville), Dr W.J.A. Payne (UNDP, Khartoum), S. Sandford (Overseas Development Unit, London) and M. Vogel (Technical University of Berlin) for these services.

The assistance of the CSIRO staff in Davies Laboratory, Townsville, is gratefully acknowledged, especially that of the librarians.

Special thanks are offered to my husband, Dr W. Bayer, who was my partner is many lengthy discussions about pastoralism in eastern Africa and northern Australia and was of immense help in evaluating efficiencies of the production systems.

Several other people at the University of Juba in Southern Sudan and on various agricultural research stations and grazing properties in Queensland, the Northern Territory and the Kimberleys made invaluable contributions to furthering my understanding of pastoral systems, but are too numerous to be mentioned individually.

PART I: INTRODUCTION

Past, including even recent, attempts to improve livestock production in tropical Africa have been based on beliefs that traditional pastoralists irrationally keep large numbers of livestock, that herd management is inefficient, and that the livestock are largely unproductive. Moreover, it has been assumed that technologies which proved successful for capitalist societies in temperate environments would be equally suitable for traditional societies in tropical environments. Modernisers, apparently not deeming the traditional pastoral systems worthy of deeper investigation, acted in ignorance of the functioning of the indigenous economy. The result of their actions has been, on the most part, the complete opposite of development: natural resources have deteriorated, inequalities in wealth and income have increased and, in many areas, the level of human welfare has fallen.

The blame for the poor record of pastoral development is commonly attributed to the values and attitudes of the traditional pastoralists rather than to the ethnocentric values and attitudes of the would-be developers. Instead of finally trying to comprehend the reaction of African pastoralists to economic and technological changes, many modernisers are now inclined to solve the problem of 'uncooperative' and 'backward' pastoralists by introducing large-scale commercialised beef production enterprises (ranches) in place of the traditional system of rangeland use.

Few attempts have been made at comparing the economic and biological efficiencies of the traditional and modern systems of animal production. The present paper cannot pretend to be such a comparative study, because complete production data from existing systems are lacking. Part of the problem of evaluating traditional systems is that even the collection of production data is ethnocentric, i.e., it reflects the values of the evaluators rather than those of the people who depend on the production system for their livelihood.

If traditional pastoral systems are to be integrated into the national and international economies through trade (and even to determine whether such integration is desirable in terms of human welfare), there is need for a greater understanding of the economic motivation of pastoralists, their reasons for retaining and accumulating livestock, their attitudes towards marketing, and their responses to change. In this study the author can only hope to give some indication of the rationale behind African pastoral

economies and to suggest some of the different parameters which could be used in evaluating these production systems. If, in development planning, a concept of productivity or efficiency is applied which is inappropriate to the socio-economic realities of the region concerned, problems of environmental degradation, inequality and unemployment will be exacerbated.

Although the emphasis in this study is on pastoral production, it must be kept in mind that this represents only one sector within a larger, diversified production system which encompasses cropping, hunting, gathering, handicrafts, trading and possibly several other economic activities. Discussion here will revolve around livestock as the key determinant of the economic behaviour of pastoralists, but reference will be made repeatedly to the close connection between the pastoral and other sectors of the wider economic system of livestock-keeping peoples.

The frame of reference in this study of pastoral economies is derived mainly from pastoral areas in eastern Africa, because the author is most familiar with and informed about animal production in this part of Africa. It is difficult to generalise about pastoral production systems - in Africa, in eastern Africa, or even in a single country like the Sudan. Differences in environmental conditions and socio-cultural values of the pastoralists result in differences in livestock management techniques (particularly in the nature and scale of livestock movements) and in the degree of integration of animal production with other economic activities. However, it is thought that the basic principles of traditional pastoralism and problems of pastoral development are sufficiently similar in all arid, semi-arid and seasonally arid regions of Africa inhabited by subsistence herders to justify the emphasis on systems in eastern Africa.

1 *Definition of pastoralism*

Pastoralism is a production system by which people derive their livelihood mainly from herds of domesticated, herbivorous animals grazing predominantly natural pastures. It is usually practised in arid, seasonally arid or mountainous areas unsuitable to any agricultural use other than grazing.

Traditional pastoralism or subsistence herding is a form of pastoralism in which people depend for their survival primarily on the replenishable products of their herds - e.g. milk, blood, natural herd increase - either for their own consumption or in exchange for non-pastoral commodities. Because pastoral areas are characterised by seasonal and locational variations in the quantity and quality of pasture and water, subsistence herding involves a degree of spatial mobility dependent on the magnitude of these variations.

There is an infinite number of possible combinations of herding and cropping activities along a continuum ranging from full nomadism without cropping, at one extreme, to sedentary cultivation with stock-raising, at the other (Johnson 1969, 12). Most pastoral peoples operate between the two extremes, i.e., they are semi-nomadic agro-pastoralists who move seasonally from a base camp to areas where suitable grazing and water are available, and they either (a) supplement their herding with other activities such as cultivation or trade or (b) supplement their subsistence farming with pastoral activities.

Of the two pastoral groups whose economies are described in Part III of this study, the Baggara represent the first variant and the Dinka the second, but both are examples of pastoral peoples whose economic, social and cultural values are determined by livestock.

2 *Economic significance of pastoralism*

In *global* terms, pastoralism is an important economic activity because it adds to the world's supply of protein-rich food while using land with limited opportunities for alternative uses. More than 60 per cent of the total agricultural area in the world consists of natural grazings and scrubland which cannot be used to the advantage of man other than by means of grazing stock (Blaxter 1973, 131). Pastoralism contributes to national economies by adding to the gross national product and per capita income (in developing countries, to an extent far greater than that revealed by Western economic measures into which subsistence production is difficult to incorporate) and by earning foreign exchange through the export of livestock products.

In *Africa*, approximately one-half of the continent is desert or more or less arid grassland and savanna unsuited to cultivation (Brown 1971, 94); a large part of this can be productive only under a pastoral system. According to FAO statistics, over one-quarter of the world's grasslands lies in Africa (Crotty 1980, 117).

African pastoralism plays a key role in both subsistence and marketed production. Domestic marketing of livestock products is insufficiently covered by official statistics in most African countries, but export statistics indicate that some countries (e.g. Upper Volta, Somalia, Mali, Ethiopia, Niger) are highly dependent on livestock and livestock produce exports for their foreign exchange earnings (Anon. 1971, 28). Of these exports, a large proportion comes from the traditional pastoral sector. As one example, 95 per cent of meat exported from Angola comes from herds managed according

to the indigenous pastoral system (Cruz de Carvalho 1974, 219).

In the Democratic Republic of the *Sudan*, pastoralism is the dominant economic activity. It is estimated that about one-quarter of the total population are nomadic herders and that another one-quarter move seasonally with their herds (Nelson *et al.* 1973, vii). Thus, almost half of Sudan's population derive all or a large part of their income, whether for subsistence or above that level, from pastoralism. The nomadic and semi-nomadic pastoralists own over 90 per cent of the domesticated animals in the Sudan (El-Arifi 1975, 97). Over three-quarters of the agricultural area in the Sudan consists of natural grazing land (SBW 1978, 6).

Livestock products make up 7 per cent of the Sudan's merchandise exports in value terms (Lees & Brooks 1977, 43). These exports include not only meat, hides and skins but also a large proportion of animals shipped on the hoof to Arab countries. There are no figures available on the number of livestock driven across the Sudanese border to be marketed in neighbouring central African countries, since this trade is largely uncontrolled. Complete and reliable statistics are also not available to verify the importance of pastoral products in internal trade, but an impression may be gained from the section on livestock marketing by the Baggara and Dinka groups (see pp. 48-57 of this study).

PART II: THE TRADITIONAL PASTORAL ECONOMY

1 *Introduction*

The traditional pastoral economy is designed to combine scarce resources in such a way as to maximise utility in the attainment of a multiplicity of goals. Economic decisions are made according to a hierarchy of values reflected in the ideology and organisation of the pastoral society. The attempt will be made here to show that the economic behaviour of African pastoralists and their response to economic change is rational within the context of a socio-economic system which has enabled them to survive over several centuries in a harsh and highly variable environment.

As will be shown subsequently, the intrusion of alien values and technologies inappropriate and often diametrically opposed to the traditional system of values and land-use brought about a change too sudden for the adaptive capacities of pastoral societies. As a result, the conditions under which they must now struggle to survive are even more difficult than previously.

Before further changes are introduced in the name of 'development', the decision-making process of African pastoralists and their exhibited and likely response to specific changes must be understood. In other words, an insight must be gained into (a) the system in equilibrium and (b) the system's response to disequilibrium.

Several past attempts have been made at describing the former, particularly by anthropologists, who prefer to think in terms of closed systems and therefore tend to neglect the dynamic aspects of traditional systems in their response to inevitable external influences. Few attempts have been made at studying pastoral systems in flux until recent years with the work of such economic anthropologists as Schneider and the Dyson-Hudsons in East Africa, and the work of interdisciplinary research teams employed by development consulting firms (e.g. Hunting Technical Services) or international organisations (e.g. International Livestock Centre for Africa).

This part of the present study deals with the traditional system of African pastoralism in a state of equilibrium, admittedly extremely precarious, and the disturbances caused by alien influences. Part III contains a description of two examples of African pastoralism in a state of flux, i.e., in the process of responding to induced change.

2 *Aims of traditional pastoral production*

The primary aim of subsistence herders is to utilise the sparse natural resources in their territory to satisfy the consumption needs of their community. Livestock are used to convert herbage into the required products, foremost being food products in sufficient and regular supply. In order to maintain the human population in a highly risky environment, economic activities must be directed towards meeting consumption requirements in the worst of all conceivable circumstances. For this reason, the ultimate goal in traditional pastoralism is to accumulate as many animals as possible within the limits of the available rangeland and labour, so as to maximise chances of surviving disasters such as prolonged drought and epizootic disease.

Traditional pastoralism is not a capitalistic undertaking by which a limited number of individuals make use of present and introduced resources to maximise marketed output. Rather, it is a system designed to maximise *total* output from an environment only marginally endowed with natural resources so as to maintain the largest possible human population relative to those resources (Dyson-Hudson 1974; Western 1974; ILCA 1980b).

3 *Factors of production*

3.1 *Land and water resources*

In the semi-arid and seasonally arid areas of Africa in which pastoralism is practised, the irregularity in availability of pasture and water and the resulting need for flexibility and mobility by the pastoral production units make collective ownership of natural resources within a defined political grouping unavoidable (Swift 1977b, 464). Land and water resources are not privately owned and 'no individual or group may claim an exclusive right to a particular piece of grazing or surface water supply' (Allan 1965, 295). However, communal rights to a specified territory are generally recognised as belonging to a specific pastoral group. In emergency situations, members of one group may be permitted by reciprocal agreement to graze their livestock temporarily within the customary territory of another group (Konczacki 1978, 54).

Common rights of one group to a specific grazing area may only apply to a particular season of the year, i.e., certain segments of rangeland may lie within the recognised territory of two groups with different production systems. This often occurs at the junction between camel-keeping and cattle-keeping groups. As will be seen later in the description of patterns of land-use by the Baggara and Dinka in the Sudan, a similar overlapping of

territories may be found among groups keeping different breeds of cattle, in this case, one breed being more resistant to biting insects than the other. This overlapping of grazing territories together with the simultaneous use of better-watered areas by both migratory herders and sedentary cultivators complicates any attempt to determine the exact area grazed by a given number of animals.

Within a group's territory, all group members have the right to graze as many animals as they possess in whatever areas they see fit, although there is often a common understanding that certain areas are grazed only at certain times of the year. When cropping is combined with herding activities, appropriate areas of the communally-owned land are allocated to individuals or families for cultivation, but these temporary land rights are normally not negotiable.

All members of the pastoral community likewise have free access to all natural streams and pools within their territory. Only man-made watering points such as dams or wells are controlled by the specific individuals or groups responsible for their construction and maintenance.

Thus, within the communal territory, each pastoral production unit has virtually unlimited rights of access to all naturally occurring resources (forage, water, salt deposits) as well as to those resources which have been improved by communal efforts. Although the resources may be scarce to the pastoral community as a whole, they represent factors of production which can be used at no obvious cost to the individual production units.

The limiting factor to expansion of production is the carrying capacity of the land and water resources within the communal territory, in that this imposes an upper limit on the total number of livestock which can be kept by the pastoral community as a whole. Expansion of production beyond this point is possible only if the community's territory can be enlarged. Such expansion was traditionally achieved through movement into distant, less populated areas and through conquests.

3.2 Labour

The labour force within a subsistence herding community is highly skilled for pastoral activities. The major variable factor (within the control of the management unit) which determines herd productivity is the amount of time, thought and energy devoted to animal production.

Labour in the traditional economy is non-monetised but negotiable. Several mechanisms operate within the pastoral community that enable labour addi-

tional to that of the domestic management unit to be recruited when needed. These include cooperative herding, loaning of animals to relatives and friends, and other contractual relationships that permit the labour of a herdsman to be hired in return for the produce and, in some cases, the offspring of the animals entrusted to him.

Labour cannot be invested in animal production activities without opportunity costs to the domestic group and the pastoral community as a whole. Labour must also be allocated to such activities as cropping, hunting, fishing, gathering, trading, housebuilding and defence of the human group. The pastoral activities themselves are numerous: these include planning herd management, gathering information about pasture conditions and disease infection in different parts of the rangeland, moving the herds, digging wells, watering the animals, burning pastures to stimulate regrowth, selecting breeding stock, castrating, animal health care, protecting animals from raiders and wild predators, milking, bloodletting, slaughtering, marketing of livestock, distributing animal products for immediate consumption or processing them for later use. Because the labour available within a single management unit is usually insufficient to handle this multiplicity of often simultaneous economic activities, extensive cooperation between units is necessary.

In addition, alternative employment opportunities outside of the pastoral economy have increased in recent decades. Especially when herd losses have been high as a result of drought or disease, household members may be sent away temporarily to supplement family income with earnings from these 'reserve activities' (Dahl & Hjort 1979, 29) in the modern economy, usually with the aim of rebuilding the family herd.

Thus, the opportunity costs of labour for pastoral activities have never been zero (as has often been assumed by development planners) and are rising with the increase in external employment opportunities. Rather than being 'low cost' and 'abundant' (Crotty 1980, 121), labour in pastoral societies could well be a limiting factor in the production system. Such management practices as diversifying animal species within the herd and organising distribution and movement of stock so as to achieve better exploitation of natural resources, greater regularity in food supply and reduction in production risks, make high demands on labour. Indigenous technologies developed, for example, for the watering of livestock and animal health care, are also labour-intensive. The Agricultural Administration Unit (1976, 1) of the Overseas Development Institute refers to numerous studies which indicate that 'shortage of human labour ... is a critical constraint on growth in the size of herds'; it is also a constraint on increase in herd productivity and group survival capacity.

3.3 *Livestock*

Pastoralists keep a variety of livestock types whose feeding and reproductive characteristics enable an optimal utilisation of available natural resources and a food supply as continuous as possible in the extremes of their environment. In African pastoral economies, either cattle or camels are the most valued and, normally, the most numerous type of livestock in the herds, but sheep and goats are also kept by all African pastoralists (Jacobs 1965, 146).

Unlike land and water resources, livestock are privately owned by individuals or families (nuclear or extended), and are exchangeable. However, the concept of property or entitlement to herd produce is less absolute than in capitalistic society (Crotty 1980, 129). The rights to sell or trade animals or their products and the rights to use animal products are widely diffused not only within the kinship group but also within a wider social alliance. The head of a household may be considered the 'owner' of livestock held by his wives, children and livestock associates and may be responsible for managerial decisions relating to these animals, but he does not have absolute rights to dispose of the animals or their products according to his will alone. The extremely complicated nature of property rights and livestock transactions will be discussed in the following section and in the case studies of Baggara and Dinka pastoral economies.

4 *Roles of livestock within the production system*

The key to understanding the economic decisions and management practices of subsistence herders is recognition of the roles which livestock play within the production system. Livestock serve not only as a source of a variety of consumption goods and services, but also as a form of capital which produces additional capital goods, i.e., new animals. The saving and investment of these animals results in the accumulation of livestock wealth, from which the pastoralist enjoys similar benefits to those conferred by wealth in Western society. However, the most significant economic function of investment and accumulation of livestock is to provide insurance against production risks.

Much has been written about the cultural functions of livestock in traditional pastoral societies (e.g. Herskovits' (1926) notion of the 'cattle complex'). These can, however, also be seen in the context of the pastoral economy as mechanisms of risk avoidance, risk sharing and equitable redistribution, which enhance the community's chances of physical and political survival.

4.1 Provision of consumption goods and services

In the traditional production system, livestock serve as a direct source of food in the form of milk, blood and meat, usually in that order of importance. In order to achieve continuity of food supply, emphasis is laid on exploiting live rather than terminal animal products, i.e., milk and blood tapped from living animals rather than meat from dead animals.

Although pastoralists try to ensure that at least some portion of the herd is in lactation at a given time of the year, milk supply is irregular because the level of production varies greatly from season to season. When milk production is highest, usually in the wet season, milk excess to daily needs is preserved by processing it into sour milk or cheese-like products. However, these products cannot be stored over long periods of time. In the long dry season when water and fodder are scarce and the nutritive value of the pasture plants is barely enough to meet the maintenance requirements of the livestock, milk production is extremely low. Especially at such times, blood is sometimes (at least, in eastern Africa) extracted from the living cattle and, in some cases, sheep and eaten in fresh, clotted or dried form.

To balance the food supply from the herds, small stock (sheep and goats) are slaughtered throughout the year to be consumed as meat, or they are traded for other food products. The slaughter or sale of large stock puts an end to any further products or services from the living animals and represents a serious reduction in the household's productive capital, for large stock do not reproduce as rapidly as small stock. Large stock are slaughtered for meat and blood normally only on special occasions (ceremonies, greeting of an important guest) and, in pastoral economies with a large cropping component, to feed agricultural work parties in return for their cooperation in the fields. Such feasts at which terminal animal products are consumed communally tend to be more numerous at times of milk and grain shortage (UNESCO 1979, 269; PDU 1978b, 16), which commonly occur at the end of the dry season and the beginning of the wet.

Cattle, in contrast to sheep and goats, are too large to be consumed immediately after slaughter in a single household. Communal consumption reduces the necessity for meat preservation and promotes a more or less equal distribution of food to all members of the community. However, most pastoral groups have also developed techniques of preserving meat when necessary, usually by smoking or sun-drying.

Animals are also slaughtered for food when it is thought that they are about to die anyway, and most pastoralists eat the meat of animals which die nat-

urally or by accident or are killed by a snake or carnivore (Allan 1965, 302). Thus, although the traditional pastoral system is not aimed primarily at producing meat, the flesh of livestock not taken by predators is ultimately destined for human consumption.

In addition to providing food, livestock represent a source of various other products from the living animals (wool and hair for clothing and rugs; urine for ablutions and as a preservative when mixed with milk; dung as fertiliser on cropped land, as fuel or, in the form of dung-ash, as insect repellent) as well as carcass by-products (hides and skins for mats, covers or leatherware; bones as a source of minerals for livestock or to be fashioned into implements) and probably products for other uses of which non-pastoralists are not aware.

In the northern pastoral areas of Africa, camels are used for transport, and in some pastoral areas further south which are climatically unsuitable for camels, cattle are likewise used as pack or riding animals.

Pastoral products were traded for cultivated foods even before the introduction of the Western money economy. On present-day markets, livestock are commonly sold for cash with which other necessities are bought. The majority of African pastoralists do not, and probably never did, subsist off the milk, blood and meat of their livestock (Jacobs 1965, 150). Grain obtained in exchange for livestock is an important component in the pastoralist's diet and is often the staple food (Oxby 1975, 2). As will be seen in the subsequent description of the Baggara and Dinka economies, dependence on grain is a critical factor in determining the marketing behaviour of pastoralists.

4.2 *Livestock as productive capital*

Rather than being consumed, livestock can be retained as productive capital, i.e., as a stock of goods devoted to the creation of other goods, thus producing an income for its owner (Konczacki 1978, 40). Return on capital takes the form of the live animal products mentioned above as well as herd increment (calves, lambs etc.), which is itself real capital. On account of their ability to reproduce themselves, breeding females represent the most valued form of livestock capital. All progeny over and above those needed as replacement stock represent capital gains.

Capital in the form of livestock is particularly convenient for people living in sparsely populated areas with few market facilities: as Barth (1964, 70-1) points out in his discussion of capital and investment in a pastoral

economy, no market mechanism is needed to effect the conversion of livestock from consumable product to productive capital, and the productive assets may likewise be consumed without the necessity of conversion through the market.

4.3 Livestock as a form of wealth

The fact that livestock represent a form of demonstrable wealth and are, thus, a source of prestige is the customary Western explanation for the pastoralist's 'irrational' accumulation of livestock. Indeed, a man who owns many animals gains social status by virtue of his superior control over productive resources (Schneider 1964a, 71). Rank is confirmed by the ability to provide animals for slaughter on ceremonial occasions[1]. Debts of gratitude are amassed by those who distribute animals to needy households. Influence over the behaviour of other people is gained by loaning or giving animals to a large number of friends and relatives who are then expected to provide political support when economic interests of the livestock owner may be at stake (Livingstone 1977, 214). Seeking utility from the prestige and political power which wealth confers is certainly not unique to traditional societies and is no more 'irrational' there than in Western economies.

In traditional as in capitalistic economies, wealth confers not only prestige but also security. The role of livestock as insurance will be discussed subsequently under a separate heading because of the paramount importance of economic security under the highly risky conditions of subsistence herding.

In the pastoral economy, livestock are a most convenient store of wealth because they are mobile and self-transporting and, being directly convertible into consumable products, they are simultaneously stores of food.

Even those traditional livestock-holding societies which depend primarily on self-produced grain for subsistence tend to regard livestock rather than grain as the supreme form of wealth. Grain is comparatively unsuitable as a store of value because it is more difficult to transport and, in tropical climates, it is highly susceptible to insect and rodent damage[2]. Moreover,

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[1] In his model of cattle values in traditional pastoral economies, Crotty (1980, 123) incorporates the prestige and debts of gratitude earned by livestock owners who provide animals for communal feasts as a 'flow of future benefits, diminishing with time and proportionate to the weight of the slaughtered animal'.

[2] Studies in Tanzania revealed that up to 50 per cent of grain kept in traditional storage facilities was destroyed by insects and rodents within 6 months of placement in storage (Hadelich-Bauhoff 1974, pers.comm.).

grain holdings can be increased only through the expenditure of a considerable amount of labour, whereas livestock wealth multiplies by natural processes (Schneider 1964a, 63). Therefore, in years of good harvests, surplus grain is invested in livestock; if need arises, livestock can be sold or bartered for grain. Schneider (1964a, 74) interprets the payment of bridewealth as yet another transaction within the pastoral investment cycle[3]: livestock are 'invested' in women, who are the grain producers within the economy. The more wives a man has, the more grain can be produced to be invested in livestock to increase durable wealth. The women also, of course, bear children, who are a major source of labour for tending the livestock.

Livestock not only represent wealth in the sense of stores of value which can be exchanged for money, consumer goods or, in Schneider's interpretation, wives. The animals are also utilisable themselves as money in the sense of standards of value within the traditional economy. In his model of African indigenous economy, Schneider (1964b) outlines the monetary role of livestock as follows. Livestock are graded in value according to type, sex and maturity. Precise ratios of value are established so that various combinations of animals can be equated with each other (e.g. 1 steer equals 5 goats). Large stock (horses, camels, cattle) represent the larger denominations of money, and small stock (goats, sheep, chickens) represent the small change. All over pastoral Africa, the various kinds of livestock, augmented by iron goods and other less valuable goods, were and often still are used as currency, facilitating exchange and making possible the uniform pricing of values and payment for all types of goods and services (Schneider 1964b, 38). Both Schneider (1964b) and Barth (1975) suggest that the use of livestock as bridewealth ('payment' of livestock to the family of the bride in order to legitimise the marriage) and as bloodwealth ('payment' of livestock in compensation for homicide) even incorporates human beings into the standardised system of values in pastoral economies.

4.4 *Livestock as a form of insurance*

The production risks of subsistence herding are extremely high. Under conditions of limited and unreliable rainfall, livestock are constantly under threat of starvation or death from thirst. Wild predators or human raiders can cause animal losses, and herds can be severely depleted by epizootic

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[3] This would be only one function of the institution of bridewealth, which is also a form of insurance for the wife in case the marriage should fail, as well as an instrument of group solidarity, for several families are usually obliged to contribute to and entitled to benefit from a bridewealth payment.

disease. Therefore, the pastoralist is constantly preoccupied with maintaining herd size (replacing lost capital) and, whenever possible, enlarging the herd to provide insurance against major disasters. Animals surplus to daily consumption requirements must be accumulated as a famine reserve, either to be consumed directly or to be exchanged for grain when need arises. The more animals a production unit owns, the greater are its chances that enough animals will survive a disaster in order to provide the household with a means of subsistence and of rebuilding the herd once grazing conditions become more favourable. In the words of an African pastoralist, 'if a man has lots of cattle, and some die, he still has some left, but if a man has a few cattle and they die, he has none left' (Nibilei, ca. 1930, quoted in Oxby 1975, 6). Accumulation of livestock thus increases the probability that the pastoral production unit will remain viable.

Many of the functions of livestock which outside observers have described as 'socio-cultural' and 'non-economic' are, in fact, part of a complex insurance and welfare system. Transactions consisting of gifts or loans of animals to kin or non-kin stock associates 'symbolize formal contracts of friendship and assistance' (Ruthenberg 1976, 307). A pastoralist can expect from his stock associates that, in the event of a need for lactating cows and reproductive livestock capital as a result of stock losses, animals will likewise be given or loaned to his household. The more stock associates he has acquired through the distribution of his own animals and the greater has been his generosity to these people, the greater economic security he gains for his household.

In their study of pastoral strategies of dealing with drought, Dahl and Hjort (1979, 22) saw the prime economic advantage of having a large network of stock associates in the increased recuperative power gained by the participants. Recuperative power was defined as 'the capacity of a household to continue as an independent unit with sufficient stock after a major stock loss' (18). However, livestock capital for rebuilding herds can be mobilised from these sources only in the case of individual misfortune; if the entire pastoral community suffers serious stock losses, this insurance system based on group solidarity is inadequate.

Livestock lending contracts involving mutual rights and obligations of the participants are most commonly made between the relatively rich and poorer members of the pastoral group (Swift 1977b, 460). The households which receive livestock under the terms of these lending contracts may utilise the milk, blood, dung etc. produced by the live animals, but the offspring are usually regarded as the property of the lender. These transfers of livestock serve as a distributive mechanism which allows each household sufficient

livestock capital to produce for subsistence needs of the household members, yet still permits the actual owners to enjoy the capital gains in the form of reproduced stock. Equitable distribution of animal products is also achieved through the practice of communal consumption of animals provided by the richer stockowners for slaughter at rituals or feasts. These various forms of sharing livestock and livestock products thus constitute a social welfare system from which each group member is entitled to benefit as long as he makes the expected contributions when he is able to do so.

In addition, the spatial dispersion of a household's herd achieved through the loaning of livestock to stock associates or poorer households increases the effectiveness of accumulated livestock in their insurance function, because the risks from contagious diseases, localised fodder shortages and raids are more widely spread.

In view of their ability to provide consumption goods and services, productive capital, social prestige and influence, and economic security, it is hardly surprising that livestock represent 'the end of all economic pursuits' (Schneider 1964a, 63) in traditional pastoral societies. The economy is oriented towards the accumulation of as many domestic animals as possible within the limitations of the environment.

5 *Economic units*

According to Barth (1967), the *management unit* within an economy is the individual or group of individuals which organises production and consumption so as to transform the available resources through the efforts of the unit into a range of items that satisfies the unit's consumption profile. In eastern pastoral Africa, a management unit consists of a household, normally headed by a male who has traditional legal rights over the main privately-controlled means of production - livestock and labour - belonging to the household. However, the manager's power is severely limited by the usufructory rights of each *basic economic unit* within the household, i.e., each 'house' consisting of a woman and her dependent children (Schneider 1964b, 43), who can bring considerable social and political pressure to bear upon the household manager.

The pastoral *production unit* or herding enterprise will be regarded here as the management unit or household and the livestock belonging to the household members. Differentiation must be made between the herd owned by the household (the *property herd*) and the herd actually tended by members of the household (the *management herd*), for these two groupings of livestock are seldom identical. As a result of labour cooperation and the distribution

practices described in the previous section, a management herd is composed of animals belonging to several owners, and not all animals owned by the management unit are likely to be in the herd tended.

The size of the production unit is determined by the balance between labour and consumption. In this connection, Stenning (1965,92) introduced the concept of 'household viability': the household is viable when the labour it can provide is suitable for exploitation of its means of subsistence, while the latter is adequate for support of the household members.

Because data on the labour requirements for traditional pastoral activities are practically non-existent, discussions of household viability in pastoral economies have concentrated on the consumption requirements of the household as determinant of minimum herd size. The size of this 'basic herd' (Allan 1965, 302) depends on the type of animals in the herd and how they are exploited, the degree of integration of pastoral activities with other economic activities such as cropping or trading, the productivity of the environment, and the composition of the family (particularly the ratio of adults to children).

Brown (1971, 97) has combined various simplified assumptions, 'guesstimates' and the occasional research finding to reach the conclusion that the average African pastoral family of eight persons '*must* maintain 15-17 Standard Stock Units[4], composed of a mixture of different classes and species of stock, to meet their daily subsistence needs.' Other researchers have suggested other figures for basic herd size. However, the usefulness of these calculations is questionable, firstly, because they are based on the misconception that nomadic pastoralists subsist exclusively on the direct products of their herds; secondly, because the productivity of the animals would vary with environmental conditions in different parts of Africa; and thirdly, because reference is made to requirements under 'normal' conditions, a rare phenomenon in arid and semi-arid regions. Animal numbers must be sufficient to help the household survive the times of stress - both the annual dry periods and the frequent prolonged droughts - which are an inevitable part of pastoral existence.

Brown attempts to include a buffer to cover risks in his calculation of the 'minimum pastoral standard of living': to provide for drought, disease, raiding and the like, a pastoral family should try to keep 20-24 Standard Stock Units. This figure is purely theoretical; the practising pastoralist knows that a herd can never be large enough to provide total insurance

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[4] One Standard Stock Unit is equivalent to an animal of 1000 lb or 454 kg liveweight.

against the worst disaster that might befall the production unit. He knows from oral history, if not from personal experience, that severe droughts or epidemics have wiped out entire family herds.

The maximum size of a property herd is not normally limited by the labour capacity of the household because additional herders can be mobilised through traditional institutions of labour cooperation, livestock distribution and other contractual arrangements. However, as Dahl and Hjort (1979, 26) point out, it is conceivable that an upper limit could be reached where the livestock owner judges the costs of administering his widely dispersed holdings to be so high as to make a further increase in livestock property unprofitable.

The maximum size of a management herd would theoretically depend on the labour capacity of the household in whose care the animals have been placed, but here, too, advantage can be taken of labour cooperation between households. The migratory herds of animals that are guided to different pastures at different times of the year normally consist of several management herds. The formation of such large-scale units permits more efficient division and sharing of tasks, and thus increases the productivity of labour. In his study of the economics of pastoralism, Konczacki (1978, 36) gives several examples of the tendency of pastoral peoples 'to combine human labour and livestock-capital in proportions corresponding to an optimal combination of these two factors of production.' The large mobile groupings of herders and animals may change in size and composition from season to season and from year to year, depending on changes in climatic conditions (as well as, most likely, in interpersonal relationships). The maximum number of animals in such combined herds is probably governed by the amount of water and pasture available and the ease of protecting and maintaining control over the animals.

The maximum number of animals held by the pastoral community as a whole would indeed be determined by the total labour capacity of the community, if prior limitations to total herd numbers are not set by the carrying capacity of the range available to the community.

6 *Indigenous technologies in pastoral production*

African pastoralists have developed numerous techniques of manipulating their environment and organising production in order to increase output from the limited resources at their disposal. However, the necessity for flexibility and mobility in the use of resources has not encouraged the development of many fixed technical improvements. The main indigenous pastoral technologies can be divided into pasture technology, water technology and animal husbandry technology.

6.1 *Pasture technology*

The most obvious technique of pasture management is the rotational grazing of grasslands achieved through herd movements. The degree of utilisation (i.e. stocking rate) of specific areas of the range is varied at specific times of the year. Although herd movements may be dictated by seasonal conditions - for example, the dry season grazing area of Dinka cattle in Southern Sudan is reserved by virtue of the fact that it is flooded during the rains - some pastoral groups make deliberate attempts to rest pastures which are physically capable of being grazed, so that they will regenerate and ensure the maintenance of forage necessary for the herds' survival during the dry season (cf. Gulliver 1972, 29).

Burning of certain grazing areas to remove dry, unpalatable grass and permit the growth of green shoots is widely practised by African pastoralists. Burning also checks the spread of bush, which creates a habitat favourable for disease-carrying insects (e.g. tsetse fly). It may possibly also be done to promote the growth of desired pasture plants known to enhance livestock performance. Grazing areas are sometimes deliberately vacated so that sufficient dry matter will accumulate to allow an adequate burn for the above-mentioned purposes (Skerman 1975, 264).

Many pastoralists make additional fodder available to their livestock by climbing trees and cutting down branches, shoots and fruits beyond the reach of the animals (Western 1974, 16; ILCA 1979, 40).

6.2 *Water technology*

Most pastoral groups have developed techniques of digging temporary or permanent wells, and drawing or transporting water to ground level in order to water the herds. Water holes are often dug in the dry beds of seasonal streams. Indigenous technologies include the construction of low dams to hold surface runoff, and the hollowing out of large-trunked trees like the baobab in order to make water reservoirs.

6.3 *Animal husbandry technology*

The following are but a few examples of animal husbandry technologies developed by different pastoral groups in Africa. Instead of fixed structures which would be unsuitable for mobile herds, very effective animal restraint is achieved by manual techniques. Weaning is done by physically separating the dams and young stock into two herds, or by fitting the young stock with thorn muzzles so that the dam will not permit suckling. Reproduction is

sometimes controlled by tethering cows in heat and allowing selected bulls to serve them. Male stock surplus to breeding requirements are castrated using such implements as knives, spears or blocks of wood. Some pastoral groups have developed forms of animal vaccination; medicines to treat livestock are prepared from particular plants; ticks are controlled by picking them off the animals by hand. Techniques like blowing into the cow's vagina appear effective in stimulating milk let-down. East African pastoral groups use a tourniquet and specially-prepared spear to draw blood from the jugular vein of cattle. Kraals are commonly built to protect the animals at night and sometimes also to concentrate dung on cultivable land. Certain groups like the Dinka construct temporary barns to house their animals at night, lighting a dung-fire inside to smoke out insects (Allan 1965; Cunnison 1966; Gulliver 1972; Payne & El Amin 1978).

To date, insufficient study has been made of indigenous technologies, their purposes and their effectiveness. All tend to be highly labour intensive. The extent to which they have been developed and are practised by different pastoral peoples probably depends on the relative natural productivity of the environment and the ratio of returns gained to labour invested.

7 *Herd management decisions*

The herd management decisions of a pastoral production unit in a traditional economy reflect the same preoccupation with economic security evident in the livestock investment policies already described. At the same time as trying to minimise risk to the livestock and, thus, to the human population which depends on them, pastoralists attempt to use their environment to the upper limits of its carrying capacity in terms of both animal and human populations.

Within the boundaries of their grazing territory, pastoralists can make various decisions which influence the level of herd productivity and food security. These will be discussed under the headings: (a) species diversification, (b) animal distribution, (c) herd movements, (d) selection and breeding practices, and (e) offtake.

7.1 *Species diversification*

Diversification of animal species being herded promotes a more complete use of environmental resources, ensures a more even access to food throughout the year and, in the event of disaster, reduces the risk of total herd losses and increases the subsequent recuperative capacity of the herd (Dahl & Hjort 1979, 18). The decision to keep particular animal species in particular proportions within the herd is largely determined by the differing abi-

lities of these animals to convert the sparse natural resources in the pastoralists' territory into the desired products at the desired time.

Camels, goats, sheep and cattle, the species most commonly herded by African pastoralists, differ in their grazing habits, the former two being predominantly browsers and the latter two predominantly grazers. Also, from among the various fodder species, different diet preferences are exhibited by these animal species and by different breeds within each species. Herd diversification is an important way of increasing the carrying capacity of the range. According to Brown (1971, 96) in his study of the biology of pastoral man, a 'combination of sheep, goats, and cattle, is ecologically better able to make efficient use of vegetation than is the equivalent biomass of any one class of stock alone.'

Camels are kept in the arid areas north and directly south of the Sahara and in arid areas of eastern Africa, but in most pastoral economies south of the Sahel, cattle are usually the most important animals in the herds. In both cases, these large stock are supplemented by sheep and goats. Reference will be made here to the predominantly cattle-keeping economies.

Sheep, goats and cattle differ in the length of their gestation period, calving interval and period of lactation. This makes possible a more regular supply of milk for those pastoral groups which consume goat's and sheep's milk in addition to cow's milk. Generally, however, cattle are considered primarily as the milk producers, whereas small stock are considered primarily as meat producers as well as 'currency' exchangeable for other food products. Small stock represent a more ready and regular source of meat than cattle, because they reproduce more rapidly and are of a more convenient size for slaughtering and consumption by a single household.

The different livestock species are not all affected by the same diseases; herd diversity is thus a strategy for survival in the event of epidemics. Sheep and goats are also generally regarded as better able than cattle to cope with drought conditions and, because of their shorter generation cycle, are quicker to recommence milk production and recover in numbers after the end of a prolonged drought. The more rapidly produced small stock can then be traded for cattle from areas not affected by the disaster. In this way, the cattle herd can be rebuilt more quickly than through natural increase, or cattle herd structure can be improved so as to increase the production of calves and milk.

Species diversification makes higher demands on labour than the herding of one species only: different species of livestock must often be taken to different pastures at certain times of the year depending on their grazing and watering requirements.

7.2 *Animal distribution*

It has been seen that a major survival strategy of pastoralists is to accumulate as many animals as possible. Because of traditional systems of livestock sharing, there is no effective limit in terms of labour availability to the size of a property herd. The pastoralist attempts to achieve an optimal combination of livestock and labour by distributing his surplus animals within the community.

Decisions as to animal distribution and resulting size of management herds influence both the mobility requirements and the productivity of the herds. A wealthy pastoralist with all his animals in one herd would be obliged to move camp frequently. Partition of livestock holdings into spatially separated, smaller groups tended by relatives or stock associates with relatively few animals of their own or by contract herdsmen paid with a portion of herd increment, creates herds of manageable size and reduces the danger of localised overgrazing by large concentrations of animals. Moreover, herd dispersion permits different types or classes of animal to be taken to grazing areas most suited to their needs. For example, cows can be taken to pastures that promote rapid herd reproduction or higher milk yield, and male and immature animals can be taken to pastures more conducive to weight increase (Dahl & Hjort 1979, 20).

The lending contracts, already mentioned in connection with pastoral insurance policies, guarantee the owner a return of stock equal to the loan as well as the natural increment of the loaned animals (UNESCO 1979, 282). Thus, the owner's capacity to increase his property herd is not impaired; it is rather enhanced by virtue of the risk-spreading and resource maximising effects of spatially diversifying the property herd.

7.3 *Herd movements*

The observation that subsistence herding is closely associated with migrations of livestock and their herders has led to the common but misleading synonymous use of the terms 'traditional pastoralism' and 'nomadism'. Few pastoral peoples in Africa are 'purely' nomadic in the sense that entire households or larger social groups wander continuously with their herds. Most commonly, certain members of a pastoral group, often the youths, trek parts of the herds to distant pastures at specific times of the year. As a source of sustenance for family members not moving with the herds, a limited number of livestock are left close to the group's base camp, where crops are usually grown. Another common variant of pastoral migration is that the

entire (or a major portion of the) group leaves its base camp at certain times of the year and travels with the herds to distant pastures, returning to the home base (where dryland crops may have been sown before departure) at a later point in the year.

The frequency and extent of herd movements depend primarily on (a) the size and composition of the herd (the larger the herd, the more quickly it utilises available fodder and water in one area and must be moved to another; different livestock species have different dietary preferences and also vary in the frequency of watering required), and (b) the availability of suitable fodder and water, which in turn depends on the amount and distribution of rainfall, the distribution of pasture types of different palatibility and nutritive value, and the number of wild game animals sharing range resources with the domestic stock.

The pastoralist has detailed empirical knowledge of the plant and water resources of his environment. Allan (1965, 4) describes the African pastoralists as 'authorities on grasses. They know the feed value of the different grazing-and-browse species, which they usually distinguish by specific names; and they recognise ecological associations, or pasture types, and can assess their value and stock-carrying capacity at different times of the year.' They regard various species and associations as 'good for supplying mineral deficiencies, for conditioning animals, for improving the potency of bulls, and for making milk and beef.' According to Ruthenberg (1976, 306), African herdsmen also 'have exact knowledge of the position, quality, and capacity of watering places.'

Based on their knowledge of the seasonal growth cycles of pastures and corresponding changes in nutritive value, the pastoralists trek their herds to different grazing areas at times when they will be most beneficial to the animals. The pattern of herd movement is generally extremely flexible. Herders question passing travellers, discuss with other livestock-keepers at markets or similar meeting points, and send out scouts, in order to ascertain where pasture and water conditions are likely to be most favourable. Herds are quickly moved to areas where isolated showers have encouraged the growth of green pick.

The search for suitable fodder and water is usually the primary but by no means the sole reason for herd movements. Rotational use of pastures may also be practised so as to prevent the build-up of parasite populations. A herder will move his animals away from diseased herds and will not take his animals into areas known to have become infested with disease-carrying flies or ticks. The pattern of movement may also be influenced by seasonal plagues of biting flies (Allan 1965, 299). Herd movement may be in response

to the need for mineral supplementation in the animals' diet. Pastoralists are well aware of the improvement in animal performance that can be achieved through grazing in areas with 'salty' grasses or natural salt deposits.

The pastoralists' herding strategy based on the rational use of ecological variants dictates the traditional form of communal land use. Common grazing land without physical subdivisions, i.e., fences or similar barriers to free movement of the herds, allows the herders complete flexibility in decisions regarding livestock movements: they can and do continually alter the pattern of range utilisation according to seasonal and annual changes in environmental conditions.

7.4 Selection and breeding practices

Pastoral groups differ in their animal breeding aims and, as yet, insufficient research has been done into traditional breeding practices. Ruthenberg (1976, 300) claims that pastoralists select breeding stock not so much for a high yield of meat or milk per animal, as for a high level of resistence to trekking, drought, extremes in temperatures, diseases and periodic shortages of food. It could, however, be argued that natural selection takes care of many of these 'breeding aims'. It is far more likely that selection and breeding practices conform with the findings of researchers in Western and Southern Sudan, namely that, from among the animals which survive the harsh environmental conditions, breeding bulls are selected primarily according to productive criteria such as milk yield of the dam and growth rate of the bull-calf (see p. 48 of this study). Careful selection of stud bulls is based on the pastoralists' detailed knowledge of the performance traits of each animal and its progenitors. In most pastoral production systems, male animals not needed for reproductive purposes are castrated.

The high degree of selectivity in the herds is indicated by the ratio of bulls to mature females. In the figures on East African herds given by Dyson-Hudson (1974), the ratio in most herds varies between 1 : 10 and 1 : 20. Ruthenberg (1976, 310) gives ratios of 1 : 16 and 1 : 36 for two traditional pastoral systems in Uganda. In the herds of traditional pastoralists in southwestern Angola, the average bull:breeder ratio is 1 : 20 (Cruz de Carvalho 1974, 206). By way of comparison, in tropical areas of Australia where cattle ranching is conducted on a commercial basis, bull:breeder ratios generally vary between 1 : 20 and 1 : 25 (BAE 1976; ABS 1976-79). Considering the low animal densities and seasonally poor nutrition on rangelands in most of northern Australia, graziers judge that a ratio of more than 15 mature females to 1 bull brings a drop in calving rate (Allingham 1980, pers.comm.; Arnold 1980, pers.comm.). African pastoralists appear

to be aware of the ratio of bulls to cows necessary for the maintenance of conception rates under harsh environmental conditions.

7.5 *Offtake*

An examination of the composition of the herds in terms of age and sex throws some light on the economic utilisation of the animals. Over half of the cattle kept in typical African pastoral areas are cows and heifers (Dyson-Hudson 1974, 6). This high proportion of breeding females is maintained in an effort to gain a regular supply of milk and increase the recuperative capacity of the herd. Herd structure is regulated largely by the rate and composition of offtake, regarded here in the widest possible sense to include not only sales and slaughterings but also transfers to other livestock-owners, e.g., as payment of bridewealth. At the same time, the pastoralist is adding to his herd and/or altering herd structure, often in an attempt to raise the reproductive capacity of the herd, by purchasing or exchanging livestock, by receiving transferred livestock, and, to a limited extent, by raiding the herds of other livestock-keeping peoples.

As far as possible, cattle offtake is composed of stock not needed for reproductive purposes, foremost being castrated steers. These are not necessarily sold as young stock; they may be kept in the herd for some years until they are fattened and thus more valuable in trade. To the individual pastoralist in communal territory, marginal costs of retaining steers are low. Labour expended on their herding is small in comparison with the tending of cows and calves, which require more individual attention. Until their eventual disposal, steers are still valuable within the pastoral economy as sources of blood and dung and also as a famine reserve which can be slaughtered for meat or traded for grain if need be. Males surplus to breeding requirements may also be used as transport animals.

In the case of female animals, the first to be disposed of are those which are obviously infertile. Breeding cows tend to be kept until fairly old. Even though they may produce calves less frequently than younger cows, such older animals may have recovered from and developed some immunity to one or more diseases and are therefore more likely to survive renewed incidence of disease and provide the nucleus for rebuilding the herd (UNESCO 1979, 269). Less productive and non-productive cows, like the castrated males, serve as a source of blood and dung and as a famine reserve. If immediate cash or grain needs were great, a pastoralist might increase the offtake of aged breeding stock, next to go would probably be heifers which have not yet proved their breeding capabilities, but only in desperation would a pastoralist part with mature breeding cows in their prime.

This order of priority refers to cattle disposals via slaughter or trade. As far as possible, pastoralists try to apply similar principles to livestock transfers within the community, but the receivers of bridewealth, bloodwealth etc. also make every effort to counter the known tendency to transfer animals which are least productive or in poorest condition. The species, sex and age of animals actually given and received via these intra-group transactions probably reflect a compromise between the interests of both sides in maintaining or improving herd structure.

8 Traditional pastoralism in equilibrium

Before the influx of Western capitalistic values and technologies, the traditional practices of range and animal management evolved by African pastoralists were well adapted to the ecology of the arid and semi-arid zones in which they operate. For centuries, their pastoral production system survived in a state of dynamic equilibrium between numbers of humans and domesticated animals, on the one hand, and environmental resources, on the other, continually adjusting itself to gradual changes in the physical and social environment.

There is evidence that this equilibrium was not entirely enforced by Darwinian control factors such as starvation, disease and climatic disaster. The Agricultural Administration Unit of the Overseas Development Institute (1976, 50) provides numerous examples of self-regulation of human population practised by pastoral peoples. These mechanisms include customs affecting age of bride at marriage, frequency of coitus (determined partly by number of wives and sexual taboos), contraception and abortion practices, tribal warfare and homicide (the frequency of which is probably a function of population density), and social practices and attitudes which may encourage emigration of pastoralists whose livestock holdings have fallen far below a viable minimum.

Regulation of livestock numbers can be achieved through management of breeding, acquisition of stock by purchasing or raiding, and disposal of stock via slaughter, donation or sale. However, because livestock represent capital assets for the pastoral production unit and grazing is communal, the individual pastoralist recognises no economic constraints to increasing livestock numbers in his property herd. The individual can never accumulate sufficient livestock: if he has enough for daily needs, he still requires stock as annual dry season reserve as well as to raise his level of insurance against major disasters. The labour force (wives and children) within the household is not a binding constraint to accumulation of animals because additional

labour can be recruited by distributing stock to poorer community members or by entering into contractual relationships with other herders. The only partial restriction to accumulation inherent to the production unit is the consumption of milk by household members, which competes with milk consumption by calves and could slow down the accumulation process (Konczacki 1978, 40), because calf mortalities may be increased and calf growth and attainment of reproductive maturity may be retarded.

It is therefore likely that the excessive accumulation of animals which would have destroyed the rangeland was prevented primarily by biological and political factors external to the production unit. Periodic droughts and disease epidemics reduced the population of both animals and humans, as did raiding and warfare. If the total number of animals herded by the pastoral community ever increased to such an extent that total available labour was no longer sufficient for herd management and protection, animal losses would rise. Likewise, if animal numbers ever reached the upper limit of the carrying capacity of the range, stock mortality would increase as a result of malnutrition and increased susceptibility of undernourished animals to ever-present fly-borne and tick-borne diseases.

The balance between population and environment was not static. Fluctuations in supplies of fodder and water resulted in fluctuations in livestock and human populations. In good years, herds expanded; in subsequent years, 'normal' supplies were inadequate for the increased number of animals; animal mortalities increased sharply in extremely dry seasons. The precarious equilibrium of the traditional pastoral system with its environment consisted of 'peaks and troughs of plenty and deprivation' (Baker 1978, 727). It was a theoretical mean between contrasting imbalances, none of which was so widespread and enduring as to destroy completely either the pastoral peoples or the environment on which their economy depended.

9 *Causes and consequences of disequilibrium*

In an effort to increase range productivity, intervention into traditional systems of land use was executed by colonial and succeeding national African governments acting largely under foreign influence. Policies and technologies were introduced which reflected a complete lack of understanding and acceptance of the values and production techniques of pastoral peoples, the functioning of their complex economy and its tight integration with the environment.

9.1 *Induced change in technology and land tenure*

Induced 'development' tended to be a piecemeal affair, concentrated on and limited to projects which modernisers found relatively easy to implement, e.g., veterinary services and sinking of bores to pump water out of deep aquifers. Inadequate thought was given to the way in which these single components would fit into the economy and ecology of the pastoral regions. Improvements were simply based on the assumption that 'what works well in the alien's home domain and has resulted in development there must be equally suitable in the new and more "primitive" situation' (Baker 1973, 80).

The growth rate of the human pastoral population was directly influenced by means of interventions which lowered the mortality rate. Tribal warfare was forbidden, and public health measures such as vaccination campaigns were introduced. With the resulting increase in human population came an increase in animals needed to support the additional people.

Animal losses were likewise reduced by the introduction of prophylactic measures such as animal vaccination and dipping. In addition to veterinary services, the other major intervention in the traditional system was the provision of water (most commonly by means of pumped boreholes) in areas which were otherwise seasonally inaccessible to stock. The rotational pattern of pasture use which had been, at least in part, dictated by the availability of natural water sources and small-capacity wells developed by means of traditional technology was thus disturbed. Larger numbers of animals and people began to stay for longer periods of time in limited areas of arid rangeland incapable of enduring the increased and continual pressure.

Many national governments regard the presence of nomadic and semi-nomadic peoples as a problem because they are difficult to administer and tax, and because they do not provide a large marketable surplus for the benefit of the national economy. The solution has most frequently been seen in enforced sedentarisation into mixed farming schemes or conversion of a reduced number of pastoralists to commercial ranchers.

Sedentarisation policies were based on the misconception that lack of water is the sole reason for herd migrations: this 'bottleneck' could be removed by establishing year-round deep-water wells. Pastoralists were then encouraged or forced to settle near these water sources created by modern, capital-intensive techniques or near reliable dry-season wells which already existed. The reduction in animal movements, the year-round use of formerly seasonal pastures, and the concentration of animals and humans in an environment that can only support sparse and dispersed populations led to the overgrazing and deterioration of the pastures surrounding the permanent wells. This led, in

turn, to deficiency diseases in the livestock. The concentration of human and livestock populations also resulted in the build-up of parasite populations as well as increased susceptibility to contagious diseases in both animals and humans (Darling & Farvar 1969; Talbot 1969).

Comparisons of nomadic and sedentarised human populations have shown that the smaller, more widely dispersed groups in the mobile traditional system have a lower incidence of infectious disease, enjoy a better diet and are, on the whole, physically healthier than their settled neighbours (Agricultural Administration Unit 1976, 36). For those development planners concerned with population control, it is also significant that sedentary populations generally have a higher rate of increase than migratory populations (25). The result of sedentarisation would appear to be that a larger number of a faster growing population survive to live under poorer conditions, i.e., the quantity of life is increased but the quality of life lowered (Crotty 1980, 129).

The sedentary herds, because of their lack of a balanced diet and the higher incidence of disease, are usually less productive than migratory herds. For example, productivity parameters measured in sedentary and migratory herds of Baggara cattle in Western Sudan were as follows:

Table 1: Comparison of some productivity parameters in sedentary and migratory Baggara cattle herds (Wilson & Clarke 1976)

Parameter	Sedentary (149 head)	Migratory (546 head)
Calving rate (%)	40	65
Calf mortality before 6 months (%)	40	11
Heifers calving before 4 years (%)	29	65
Mortality rate in herd (%)	35	15

The lower productivity of sedentary herds has a detrimental effect not only on the welfare of the livestock-keepers but also on the quantity of pastoral products available for marketing and export. Development planners in the Sudan came to the conclusion that 'settlement inevitably means the decline in meat production' (Adams 1976, 143).

The repercussions of the other common 'solution' - the replacement of the traditional pastoral system by commercial ranching - are discussed in detail in Section 12.2 of Part III with reference to pastoral peoples in the Sudan. Suffice it to state here that ranching schemes expropriate large tracts of

grazing land from the large community of traditional users and places this land into the hands of a few favoured individuals or segments of the community, leaving the remaining pastoralists with drastically reduced opportunities to earn a living. Moreover, restriction of livestock movements on enclosed ranches leads to changes in productivity similar in tendency to those found in fully sedentary herds, if no supplementary feeding is provided.

Development interventions in pastoral areas or in production systems adjacent to pastoral areas have decreased the area of land which can be utilised by traditional pastoralists. Irrigation and mechanised farming schemes have blocked pastoral migration routes and occupied dry-season pastures and higher-rainfall areas reserved by pastoralists as drought recourse (ILCA 1980a, 7).

Development projects in more distant fertile cropping areas have administered changes in traditional concepts of property rights, and have led to the alienation of poorer farmers from the land. These have then moved into the more arid areas formerly occupied by the pastoralists (Dahl & Hjort 1979, 5). The arable-farming population, whether immigrants from non-pastoral areas or sedentarised pastoralists, usually keep their own cattle year-round on the dry season pastures which the migratory pastoralists formerly tried to keep free of livestock during the wet season. The mixed farmers also tend to invest any production surplus in livestock (Barth 1967, 61). The result of this growth in sedentary herds is overstocking such that little or no fodder is available for the migratory herds when they reach their traditional dry season pastures.

Expansion of cultivation and establishment of government ranching schemes generally occur in the more fertile grazing areas with better access to water. These developments often involve enclosures of large land areas and, thus, physical prevention of access to pasture and water resources on which the traditional pastoral system depends for part of the year (Dahl & Hjort 1979, 6). In addition, international boundaries were drawn up by colonial powers ignorant of human geography in Africa, and attempts are made to restrict the movement of herds across the frontiers. Changes in rights of access to natural resources have led to the confinement of the growing numbers of animals and humans to diminishing areas of less fertile rangelands, or the enforced shift into still more marginal arid areas which are in even higher danger of rapid deterioration under growing population pressure.

Thus, outside intervention has removed biological and political constraints on animals and human population increase, has brought about the expansion of arable-farming into pastoral areas and deprived pastoralists of their traditional land rights, and has disrupted or restricted herd movements

vital to the success of the pastoral production system. The result has been heavier and more continuous grazing of the more arid regions remaining to the pastoralists and the degradation of large areas of range.

The increased pressure on the pasture reduces the return per animal. Pastoralists are then forced to keep more animals per head of human population in order to meet subsistence requirements, or they must expand their own cropping activities to compensate for the loss in animal productivity. For example, from 1957 to 1972, the area of land under cultivation by traditionally migratory herd owners in Southern Darfur increased by 118 per cent, mostly in the rainy season grazing areas (Haaland 1976b, 251). Increased attention to cropping further reduces grazing areas and the mobility of the herds, promotes concentration around watering-points in the higher-rainfall areas which permit cultivation, and reduces animal productivity still further. Whether the pastoralists increase herd size or cultivate a larger land area (and both strategies are often pursued simultaneously), the outcome is a still greater increase of pressure on pastures to the point of overstocking, which can be defined as the situation where livestock numbers are such that the grass cover is being affected to the detriment of its capacity to maintain livestock in the future (Livingstone 1977, 210). Intervention has provoked a chain reaction of overpopulation, overstocking, overgrazing, deterioration of vegetation and, in extreme cases, loss of the more arid areas of rangeland through desertification. Degradation of resources is such that they can support fewer people than formerly under the traditional system of land use.

Moreover, reserves of pasture and animals for times of prolonged drought have been so drastically reduced as a result of these developments that the pastoral peoples of Africa are now even more vulnerable to disaster. Their own defenses and mechanisms for recovery have been broken down, and their need for famine relief is greater than would have been the case without intervention by national governments and international aid organisations. By means of a simulation model of pastoralism with and without historic interventions in the Sahel region of West Africa, Picardi (1976) shows that aid efforts in the past have increased the severity of drought disaster in both ecological and human terms and have thus increased the necessity for further aid. Development aid has become self-perpetuating.

Blame for the undeniable environmental deterioration in some pastoral areas of Africa, particularly on the fringes of the Sahara, is all too quickly placed on the shoulders of the traditional land-users and their supposedly irrational urge to accumulate livestock. As has been shown, the survival strategies of African pastoralists are based on the accumulation of live-

stock as capital, wealth and contributions to the insurance system which is inseparable from their socio-cultural institutions. The economic behaviour of pastoralists is rational within the context of their traditional system of production in an uncertain environment. The changes induced by colonial and national governments in isolated components of the production system have been too great and sudden to be accommodated smoothly by the adaptive responses of a finely-tuned traditional economy. Most modernisers fail to recognise that the major cause of the present state of disequilibrium is their own ignorance and folly in introducing inappropriate technologies and land tenure arrangements. Picardi's above-mentioned dynamic model of pastoralism reveals that the probable effects of interventions such as well-digging and veterinary and public health programmes have been a reduction in yearly forage production, a deterioration in soil conditions and a reduction in the human and animal populations which can be supported by the environment to a much greater extent than would have been the case in the complete absence of such 'aid'.

9.2 Commercialisation

Traditional pastoralists are not irrationally conservative and unwilling to accept change. Because they live under extremely variable conditions, they are accustomed to responding to disequilibrating ecological and economic forces. The changes induced by externally-generated attempts at development may have been abrupt and alien to the indigenous economy, but pastoralists have been quick to respond to those changes which they perceive to be economically advantageous. This capacity for selective change has been displayed particularly in the degree to which pastoral peoples have turned to livestock sales and the purchase of market goods (ILCA 1980a, 7).

The greater commercialisation of pastoral production in Africa is reflected not only in the emergence or expansion of indigenous livestock marketing systems and the increase in market exchanges, as described more fully in Part III, but also in the extent to which some African entrepreneurs attempt to derive advantage out of arbitrage between the indigenous and induced economies. This often takes the form of buying up female cattle relatively cheaply within the modern economy (where value is placed on animals only according to number and size) and exchanging these for a larger number of steers in the indigenous economy (where productive females are much more highly valued than unproductive male cattle), which can then be sold on the modern market for a substantial profit (Schneider 1974, 261).

Increased involvement of pastoralists in livestock marketing leads to changes in strategies of production, level of risk vulnerability and nature of

social relationships within the pastoral community. Swift (1977b, 472) lists a number of market responses which affect the basic subsistence strategy of African pastoralists. The species composition of the herd may be changed; resources may be shifted away from the safer (because more drought resistant) subsistence species such as goats to more readily marketable species such as cattle. Commercialisation of animal transactions means that fewer animals are entered into the traditional reciprocal and redistributive networks. Old female animals, with greater disease resistance and thus capable of providing the nucleus of a new breeding herd after an epidemic, are increasingly sold. At times of extreme need, even herd capital (reproductive males and females) may be sold.

The higher offtake of animals which are essential to the security and continued productivity of the pastoral system increases the vulnerability of both livestock and humans to disaster, particularly the inevitable droughts. Famine reserves are depleted and the recuperative capacity of the herd is reduced. Risks are also increased because a greater proportion of food is obtained through market exchange of animals for grain, and stock-keepers become more vulnerable to fluctuations in relative prices on food markets.

As a result of the response to increased demands for meat outside the pastoral sector, the local consumption of meat falls (Schneider 1964a, 69). Moreover, inequalities in food consumption within the pastoral community are increased, since both the communal occasions for meat consumption and the transfer of animals in personal relationships assume reduced importance (Haaland 1977, 183).

The introduction of capitalistic concepts of property in livestock in place of the more diffused traditional property concepts also leads to increased inequalities as well as changes in social relationships. The 'progressive' livestock owners (those most interested in modern ranching schemes and Western technologies) assume exclusive rights to their animals and animal products, and derive exclusive benefits from them. These owners are thus able to accumulate and invest in still more animals. This wealthier and, as a result, usually better educated elite has more ready access to new forms of security offered by the banking and investment facilities in the modern money economy, as well as to credit, extension and other public services which can enhance their earning power. These 'small rural capitalists' (van Raay 1975, 7), interested only in increasing their private profits, attempt to evade the now burdensome traditional mechanisms of ensuring survival and equitable distribution in the pastoral community. The remaining pastoralists thus suffer a reduction in access to the traditional forms of security and welfare based on stock alliances and redistribution of livestock and livestock produce (Crotty 1980, 129).

The so-called progress of African pastoralists towards increased commercialisation of livestock production thus appears to result, at least in some cases, in higher production and survival risks, greater inequalities in ownership of and access to resources and means for subsistence, and greater suffering by the majority of pastoralists in times of adversity. As long as new institutions of social insurance and welfare are not established or evolved to replace the traditional institutions that are destroyed in the process of modernising pastoral production systems in Africa, there is great danger that increased involvement in livestock marketing will benefit only a small elite.

PART III: TWO PASTORAL ECONOMIES IN THE SUDAN

1 Introduction

Outside attempts at 'developing' pastoral production in Africa have had many devastating effects, but the resulting changes in rural life cannot be made retrogressive. The task is now to gain an understanding of indigenous livestock production systems as they are presently being practised under conditions of induced change, so that the necessity for and the probable effects of proposed future changes can be better evaluated.

The following description of two pastoral economies in the Sudan refers to *evolved* traditional systems - the result of interaction between indigenous and induced economies - and represents a 'snapshot' of dynamic systems in the process of adaptation to a new economic and political framework. Future references to 'traditional pastoralism' will be to these evolved systems, as opposed to fully commercialised 'modern' pastoralism, i.e., ranching on demarcated areas of rangeland.

The two groups discussed here are examples of the most common form of pastoralism in Africa - semi-nomadic societies in which livestock complement, or are complemented by, crop production (Baker 1978, 721). Reference is made to two groups rather than one as a 'composite case study' in pastoralism, because available data on any one of the groups are limited to only certain aspects of their economy. The data collected by the Hunting Technical Services (HTS) on the Baggara economy in Western Sudan are more detailed with regard to herd structure and production parameters. The data collected by the Project Development Unit (PDU) on the Dinka economy in Southern Sudan are more detailed with regard to livestock marketing. Viewed together, the information about different aspects of the present production systems of the two groups gives an impression of the situation and trends that are probably typical of most pastoral economies in Africa today.

2 Human population

Various black Arab groups known collectively as the Baggara (this being the Arabic word for 'cattlemen') own almost half of the 16.5 million cattle (1978 estimate, FAO 1979, 201) in the Republic of the Sudan. The Baggara were originally camel-herders who migrated several hundred years ago from the arid north into their present territories in Southern Darfur and Southwestern Kordofan in Western Sudan. Finding the more humid conditions unsuit-

able for camels, they adopted cattle as their principal animals (El-Arifi 1975, 93). Although they developed trade relationships with the indigenous sedentary cultivators of the area, exchanging livestock for grain, the Baggara also began to grow some crops of their own. The majority of the Baggara are to be found in Southern Darfur, where the total population density was estimated in 1973 to be 6.5 per km^2 (Wilson 1977, 496). Calculated according to this density, the area covered by the HTS study would contain approximately 140,000 people, of which by far the majority are Baggara pastoralists.

The dominant pastoral group of Southern Sudan is made up of the Nilotic people known as the Dinka, who number almost two million (Deng 1972, 1). Over 85 per cent of the Dinka live in the Bahr el Ghazal and Lakes provinces and the remainder in the Upper Nile and Jonglei provinces. In 1973, the population density of Bahr el Ghazal province (before its subdivision into Bahr el Ghazal and Lakes provinces) was estimated to be 6.4 per km^2, and that of the Upper Nile (before its subdivision into Upper Nile and Jonglei provinces) was 3.4 people per km^2 (SBW 1978, 10).

3 *Location and physical environment*

The Baggara occupy the level to gently undulating plateau lying roughly between 10^o and 13^o north latitude in the savanna belt of Western Sudan. The plain is broken by widely scattered hills (*inselberge*), which rarely rise more than 50 m above it. During the summer monsoon rains, streams may flow for several days to a depth of several feet and water collects in scattered pools. The pools dry up and surface streams cease to flow during the dry season.

The study conducted by HTS, from which the production data were drawn for this paper, covers an area of 21,000 km^2 between 24^o and $25^o30'$ east longitude and 10^o and 12^o north latitude in Southern Darfur. This area is considered typical not only of the region occupied by the various Baggara groups but also of much of the savanna belt extending across Africa from the Nile to Nigeria (Wilson & Clarke 1975, 165).

Directly south of Darfur lies the province of Bahr el Ghazal and east of it, the Lakes, Upper Nile and Jonglei provinces, the four of which include the extent of the flood plain of the Nile and its tributaries in Southern Sudan. The terrain is predominantly flat, sloping only very gently upward from the clay flood plain (400 m above sea level), interrupted by relatively low *inselberge* and ridges, towards the Ironstone Plateau in the southwest and hill masses in the south. A series of streams flow in a northerly direction towards the rivers Nile and Bahr el Ghazal, but before reaching them the

streams disappear in immense permanent swamps, the Sudd. Along these streams are vast flood plains which spread into each other towards the north and are locally known as the *toich*.

A map of Western and Southern Sudan is presented in the appendix.

4 Climate

The semi-arid climate of Southern Darfur is characterised by a short, intense rainy season and a long dry season. During the 'winter' from October to May, Southern Darfur receives dry north-easterly *harmattan* winds. From June to September it receives a moist south-westerly monsoon airstream from the Atlantic. Rains are of high intensity and short duration. Seventy per cent of total annual precipitation falls in the months of July and August; from November to February normally no rain whatsoever is recorded. Precipitation increases from north to south and from east to west as the land rises towards the Sudan-Chad border. There is extreme variability from year to year in both total rainfall and the date of the onset of the rains. Years of severe drought occur at irregular but frequent intervals.

The area covered by the HTS study ranges in precipitation from 470 mm in the north (Nyala) to 720 mm in the south (Radom). The mean average maximum and minimum temperatures at Nyala are 34°C and 20°C, respectively (Wilson & Clarke 1975).

The Dinka in Southern Sudan keep livestock under moister conditions which promote the presence of the tsetse fly and thus have a detrimental effect on herd productivity. However, the higher rainfall permits more widespread cultivation of crops than in Darfur. Annual precipitation increases from 800 mm at the Bahr el Ghazal river to 1200 mm in the southwest on the rises to the Ironstone Plateau. The length of the wet season increases accordingly from 5 to over 7 months. The Dinka pastoral area is also subject to large annual variations in precipitation and to years of drought. Average temperatures are about 1°C lower than at Nyala.

In both the Baggara and Dinka pastoral areas, the pronounced dry season results in a cessation of vegetal growth during several months of each year. Concentrated rains and floods followed by drought are typical of the semi-arid and seasonally arid areas in which pastoralism is practised throughout Africa.

5 Vegetation

The dominant vegetation of Southern Darfur is low-rainfall open woodland savanna. In the north, trees are mainly Acacias and other thorny species;

further south, as rainfall improves, these are mixed with broad-leafed deciduous trees. Tall annual grasses predominate, except along the seasonal streams, where tall perennial grasses form the bulk of the grazing for Baggara cattle in the dry season (Wilson & Clarke 1975).

The areas above flood level in Southern Sudan consist of high-rainfall open woodland savanna with some thornwoods but mostly mixed broad-leafed deciduous trees and tall annual grasses. On the lower-lying intermediate areas, perennial grasses predominate which are tall and unpalatable when flood waters retreat but provide nutritious regrowth when burned. On the deep-flooded riverine pastures, pure grass stands provide valuable forage for Dinka cattle in the latter half of the dry season (Barbour 1964).

6 *Economic activities*

Both the Baggara and the Dinka engage in a variety of economic activities, the main ones being livestock-keeping, cropping, fishing, gathering and trade. The Dinka place more emphasis on growing their own crops and the Baggara on trade of cattle to purchase grains, but both groups follow both routes to the procurement of grain, which is their staple food.

Areas cultivated by the pastoralists are larger than commonly assumed (the Dinka surveyed by the PDU cultivate an area equal to 0.2 ha per person in the household, PDU 1978b&d), but yields are barely enough to meet household grain requirements in 'normal' years. Harvests are uncertain, surpluses at best are small, and grain stores are highly susceptible to damage from insects, rodents and rain. More or less severe droughts occur almost annually. The PDU study revealed that the Dinka are usually forced to sell livestock for grain during the 'hungry period' from April to July, before the quickest maturing crop varieties can be harvested.

Both the Baggara and the Dinka exhibit a fairly high level of organisation of food production in their manner of integrating migratory herding with cropping. Rainfed cultivation is practised so that it interferes as little as possible with the herd movements. During short periods before planting, livestock are tethered overnight on the fields in order to gain the fertilising benefit of manure. After harvest, livestock are fed on the residues of the grain crops.

The Baggara cultivate mainly millet for subsistence, and cotton and groundnuts for sale. The Dinka cultivate sorghum (*dura*) and, in more recent times, maize for subsistence, and tobacco and groundnuts for sale. The Baggara also gain some cash income by selling milk, meat from slaughtered animals, clarified butter, hides, eggs, wild honey, occasionally some leather- and

basketware and, to an increasing extent, livestock on local markets or to neighbours. In addition, they sometimes hire out baggage bulls, horses and donkeys. The sale of milk, meat, clarified butter, hides and eggs by the Dinka is more limited but, here too, the marketing of livestock is increasing.

An important alternative source of income among the Dinka is fishing, mainly for home consumption but occasionally also for trade. The Dinka households surveyed by the PDU were also involved to a minor extent in collecting wild honey, growing vegetables, making mats and baskets and, in a few cases, operating small shops (PDU 1978d, 9). Pastoralists from both groups also occasionally hire out their labour as cattle drovers, or become part-time livestock traders themselves.

Much of the income earned by these means is used to pay taxes, cover marriage costs, or buy grains or other consumer goods, thereby allowing the pastoralists to economise on their livestock, i.e., reduce the need to dispose of cattle for these purposes. If any surplus income remains, it is normally used to purchase more cattle and small stock (Cunnison 1966; PDU 1978d).

7 *Type and utility of livestock*

7.1 *Cattle*

In both the Baggara and the Dinka economies, cattle are by far the most valued and numerous animals owned, and they are raised primarily to produce milk.

Most cattle in Southern Darfur are of the short-horned 'zebu' type with hump and dewlap. Mature males average about 370 kg and mature females about 290 kg liveweight. The Baggara use female cattle as milk producers and males as pack and riding animals during camp movements and herding. Beef takes only third priority in production aims (Wilson & Clarke 1975, 171). Cows provide four main dairy products: fresh milk, curdled milk, whey and clarified butter. The latter is used as cooking fat or as a component of sauce eaten with grain, and is often sold for cash at market; it is also used by the Baggara as an oil for skin and hair. Cattle hides are processed into various leather articles, and complete hides are used as sleeping mats or covers for roofs, baggage etc. Cattle manure is used to fertilise homestead gardens. The bulls are also used for threshing purposes, in that they are ridden in circles over the heads of harvested grain (Cunnison 1966, 76).

Cash has largely replaced cattle and small stock for tax and brideprice payments, but many transactions within the pastoral community are still made in

kind or a mixture of cash and kind. Cattle are still handed over as blood compensation paid as the result of injury or death. The Baggara word for 'wealth' is commonly used to mean 'cattle' (sheep and goats are referred to as 'the small change of the market-place'). The Baggara also continue to value cattle as a famine reserve, and as a means of ensuring economic and political support through stock alliances, gifts or loans to less fortunate relatives, and generosity to guests (Cunnison 1966, 29-33).

The Dinka cattle are smaller and not such swift walkers as Baggara cattle. They are, however, relatively resistant to diseases and tolerant of internal and external parasites, and are adapted to swampy conditions (Payne & El Amin 1978, 18). They generally have smaller humps and longer, thick-based horns than those of Baggara cattle. Mature males are estimated to weigh about 320 kg and mature females 210 kg liveweight (Payne & El Amin 1978,76).

Dinka cattle are bred and raised for milk production. Bloodletting is not practised as regularly as previously, but blood is still a valued food supplement in years of famine. Meat is of tertiary importance. Dinka cattle are not used for transport purposes. Milk surplus to daily requirements is processed into butter or ghee. Cattle hides are used as shields and sleeping mats, or the leather is used to make ropes. Cattle manure serves as soil fertiliser: cattle are tethered on the fields, and manure is also carried from cattle enclosures and spread on the fields. Dung is dried to be used as fuel, and is also used as wall plaster in the building of huts. Dung-ash serves as an insect repellent when rubbed into the skin of livestock or humans. Livestock urine is used to disinfect milk gourds and curdle milk. Cattle and small stock are sold or bartered to compensate for deficiencies in crop production, and are slaughtered for ceremonies or to feed agricultural working parties (Lienhardt 1961; Payne & El Amin 1978; PDU 1978b).

Cattle exchanges in kinship and friendship involving reciprocal rights and obligations of receiving and providing support play a large role in the Dinka economy, but by far the most important livestock transaction within the community is the payment of bridewealth. The number of cattle and small stock paid as bridewealth (and bloodwealth) was always higher in the Dinka than in the Baggara economy, and the use of livestock in these transactions has not been replaced to nearly such an extent as among the Baggara. An idea of the importance of brideprice in present-day transactions is given by the results of the PDU survey in 1978. In a twelve-month period, 40 per cent of all cattle in the Rumbek (Lakes province) survey area were transferred in brideprice payments (PDU 1978b, 14). Several families related to the man wishing to marry are contributors to the bridewealth, which is subsequently distributed to several families related to the bride. The large number of

community members thus involved are interested in promoting the success of the marriage, so that the complications of making such a far-reaching transaction retroactive can be avoided.

It is important to note that these traditional pastoral economies utilise primarily living cattle and their produce in an effort to support the maximum number of people in their territory in a state of physical and social well-being. Offtake for slaughter or sale is practised only insofar as it is not detrimental to this aim. Unlike commercial ranching systems in Westernised countries like Australia, production is not beef-oriented.

7.2 *Sheep*

The coarse-haired sheep of the Baggara are kept mainly for meat and are said to be of a 'good mutton type by African standards' (Wilson & Clarke 1975, 175). The Baggara seldom milk their sheep. The average body weight of mature female sheep is about 42 kg. Southern Darfur conditions do not appear to be particularly favourable for the breeds of sheep which the Baggara brought with them when they entered the Darfur area many generations ago from the more arid north. Mortality rates among sheep are high; in Southern Darfur, at least, goats appear to be replacing sheep in the Baggara economy (Wilson & Clarke 1975, 182).

The small short-haired Nilotic sheep kept by the Dinka in Southern Sudan are hardier than the Baggara sheep, being more tolerant of climatic, nutritional and disease stresses. Dinka sheep are likewise considered to be 'a good mutton-type' (Payne & El Amin 1978, 20), and are slaughtered regularly for meat consumption within the household, at cooperative working parties or at minor religious ceremonies. The Dinka claim they prefer sheep to goat meat. Sheep's milk appears to be drunk mainly by small children. Payne and El Amin (1978, 87) estimate the liveweight of mature sheep to be 25 kg.

7.3 *Goats*

The goats kept by the Baggara in Southern Darfur are highly prolific and good producers of meat and milk. They are usually herded close to settled sections of the pastoral community to provide food for family members engaged in cropping. Baggara goats are predominantly short-haired animals, although some long-haired ones are present in the herds. The average body weight of mature females is 33 kg (Wilson & Clarke 1976, 179). Goats appear to exploit Southern Darfur conditions efficiently, and their numbers have increased substantially relative to cattle in recent decades. The ratio of goats to cattle is now more than 2:5 compared with 2:40 in 1944 (Wilson 1977, 503).

The Dinka goats are small, meat-type animals with short, glossy hair. They are hardy and tolerant of parasites and disease. Goat's milk is drunk mainly by women and children. Goats are slaughtered for meat and, together with sheep, are sold regularly on local markets for cash with which to buy non-pastoral goods. Payne and El Amin (1978, 90) estimate that mature animals weigh about 20 kg.

The hair of sheep and the few longer-haired goats is sometimes used to weave coarse rugs and, by some Baggara women, to make girth-straps and saddle-packs for use on bulls and donkeys (Barbour 1964, 160). Hides of sheep and goats are cured and used mainly as water-skins.

In Table 2, estimates are given of the populations of the main types of livestock held in Southern Darfur and in areas of Southern Sudan from which data were available.

Table 2: Population of cattle, sheep and goats in Southern Darfur and three provinces of Southern Sudan

Province	Southern Darfur [1]	Bahr el Ghazal [2]	Lakes [3]	Jonglei [4]
Cattle	2,153,000	1,228,000	797,000	1,404,000
Sheep	1,127,000	718,000	333,000	175,000
Goats	571,000	604,000	304,000	459,000

[1] Wilson & Clarke 1975; based on sample surveys and extrapolation from taxation revenue 1972.

[2] PDU 1978d; estimate based on Sudan National Livestock Census 1976, believed to be underestimated because taken in dry season when some cattle had been moved to pastures outside province.

[3] PDU 1978b; estimate based on census as above.

[4] Payne & El Amin 1978; estimate based on aerial survey 1977.

In their survey area in the western part of Southern Darfur, HTS estimate a livestock population of 607,365 cattle, 68,416 sheep and 245,269 goats, or a ratio of 9:1:4 (Wilson & Clarke 1975). In the areas of Bahr el Ghazal and Lakes provinces surveyed by the PDU, the ratio between cattle, sheep and goats was approximately 2:1:1. In Jonglei province, the corresponding ratio appears to be 8:1:2.5.

7.4 Other livestock

Many Baggara families own a single camel for pack purposes; the more wealthy may own a horse for personal transport. Donkeys are increasing in number to

meet growing needs for transporting cash crops to market, supplying expanding urban populations with firewood and charcoal, and supplying the rural population with domestic water (Wilson 1977, 504).

The Dinka own neither camels nor horses; donkeys are rare. Both the Baggara and the Dinka keep poultry as scavengers around the homesteads or camps to supply fresh meat and eggs, and dogs for household protection and assistance in hunting.

8 *Organisation of pastoral production*

In both the Baggara and the Dinka economies, the management unit is the household, normally consisting of a man, one or more wives, and their children.

Details as to average size of Baggara households are not included in the available HTS publications. The approximate ratios of animals to humans in Baggara production units are given as follows: cattle 4.4:1, sheep 0.5:1 and goats 1.8:1 (Wilson & Clarke 1975, 181). Two decades earlier among another group of Baggara pastoralists, Cunnison had found an average of 6 head of cattle and only 1.1 head of small stock per person (Allan 1965, 307). This would support Wilson's (1977, 503) impression that small stock are gaining in relative importance in the Baggara economy.

Due to the complicated system of livestock distribution designed to make efficient use of community labour and allow poorer families usufructory rights to animal produce, no attempt was made to determine the size of property herds. According to the HTS survey carried out in 1972-73 in Southern Darfur, management herds of Baggara cattle are mostly within the range of 50 to 150 head, with an average herd size of slightly more than 100 head of all ages and sexes (Wilson & Clarke 1975, 172). Cunnison (1966, 69) judges 150 head to be the largest convenient size for a management herd so that it can be watered easily from wells. Each household with cattle in the management herd provides at least one person, usually a youth, for herding duties on a roster basis. Poorer dependents of the household may serve as herders and receive gifts or loans of cattle in return. An owner of a large number of cattle subdivided into several management herds may hire herders from outside the pastoral community and pay them with food, clothing and a nominal wage (Cunnison 1966, 67).

Most sheep flocks herded by the Baggara in Southern Darfur are in the size range of 20 to 60 head, the average flock size being about 40 head (Wilson & Clarke 1965, 177). Sheep are often herded separately from cattle because of their differing needs for forage and water and because the Baggara like

to keep them closer to the homestead as a ready source of food.

Goats belonging to Baggara households are not usually herded in management flocks. They roam close to the homestead or camp for most of the year and come home of their own accord each evening. Only during the crop-growing season are they watched by young children in order to protect the crops, not the goats. Most goats are nominally owned by women (Wilson & Clarke 1975, 179).

Among the Dinka groups in the Bor area of Jonglei province and the Rumbek area of Lakes province, the average household size is 7 persons; larger households of 10 persons were found in the Gogrial area of Bahr el Ghazal province (Payne & El Amin 1978, 9; PDU 1978d, 8). In their survey areas, the PDU found that Dinka pastoral production units had about 1.5 cattle, 0.7 sheep and 0.6 goats per person.

The average herding unit in the Dinka pastoral system contains somewhat over 40 head of cattle (Payne & El Amin 1978, 27; PDU 1978d, 4) belonging to several households linked by kinship and friendship bonds. The Dinka are known to have a closer man-animal relationship than the Baggara and devote more time to promoting the well-being of their cattle; this could explain partially the smaller management herd size. However, at certain times of the year, e.g. when labour is needed on the fields, it has been observed that more than 4000 head of cattle were herded by 10 men (Payne & El Amin 1978, 33). Herders for such large groupings of cattle are, as in the Baggara system, provided by each household on a roster basis.

Sheep and goats belonging to Dinka households are usually kept close to the homesteads in small mixed flocks herded by children. Small stock are taken on longer migrations with the cattle herds only if an insufficient number of children are available for herding duties (as is increasingly the case with the opening of more schools in Southern Sudan).

In the following sections, reference will be made mainly to the management and productivity of the cattle held by the Baggara and Dinka, since these are the animals to which the pastoralists devote most of their attention and attribute the highest value within their economies.

9 *Techniques of pastoral production*

9.1 *Management of pasture and water resources*

The utilisation of rangeland is managed principally by means of herd movements and burning of grasses. Fodder requirements of the cattle are also met to a limited extent by stubble grazing.

The homelands or *dars* of the Baggara pastoralists are located on clayey soils roughly in the centre of their migration pattern. At the beginning of the rainy season (June), the animals thrive on the young grasses of high mineral content in the *dar* and the water in numerous natural pools. As the rains become heavier and more frequent, conditions become increasingly muddy and biting flies multiply. The cattle herds are then moved northwards into the sand plains, where herds are widely dispersed, scouts are constantly searching for favourable grazing areas, and camps are moved frequently. A limited number of cattle are left in the *dar* with the group members who pay more attention to cropping. As soon as the rains begin to recede in September, the animals are trekked home, where they graze the remaining grasses as well as crop residues, simultaneously providing manure for the plots. Once surface water has dried up and grazing is exhausted in the *dar*, the Baggara move their herds southwards towards their dry season retreats in the riverine pasture of the Bahr. On their way south, the herders move from water source to water source, often digging wells in dried-out stream beds or clearing out wells dug in previous years. The Baggara groups have come to agreements for sharing the Bahr grazing areas with Dinka groups, some of whom have permanent settlements there. The Baggara begin the trek northwards at the onset of the earliest rains in order to escape the heavy clay mud and biting insects in the Bahr region and to provide cattle manure for fields to be cropped in the *dar*. Migration patterns differ between the various Baggara groups. Normally a range of 300-400 km is covered between the northern and southern extremities of the annual migrations, although some groups cover a range of almost 600 km (Wilson & Clarke 1975; Cunnison 1966; Lebon 1965).

The homesteads of the Dinka are located on well-drained sandy ridges or natural levées of main rivers. The Dinka occupy these highlands with their herds during the wet season from May to November. As soon as flood waters have drained from the somewhat lower 'intermediate' areas, young men take the cattle away from the grazed-out highlands. Large expanses of the tall grass in the intermediate areas are burned, firstly, so that the cattle will have access to the more palatable and nutritious regrowth and, secondly, so that danger from wild predators is reduced. The cattle of each household are usually divided among two or more management herds, which are trekked differing distances from the homesteads. Once the women have harvested the sorghum, the cattle closest to the highlands are brought back to graze the stubble and fertilise the fields. As the pools dry up in the intermediate zone, the remainder (the majority) of the cattle are moved further down into the low-lying riverfront and marsh border areas known as the *toich*, from

which flood waters have receded but moisture is retained in the soil throughout the dry season. When the rains recommence and the *toich* begins to flood, the Dinka move their cattle back to the highlands to graze close to the homesteads. The distances traversed by Dinka herds between highlands and *toich* rarely exceed 100 km (Lebon 1965; El-Arifi 1975; PDU 1978b).

9.2 *Management of herd structure*

An examination of cattle herd structure (see Table 3) reveals how deliberately the production systems of the Baggara and Dinka are oriented towards a regular supply of milk for human consumption and calves to maintain and, if possible, increase herd size, as well as towards increasing chances that the herd will survive and recover from disasters. The pastoralists manage herd structure via (a) the selection of breeding stock, (b) disposals of stock through culling of animals surplus to productive and reproductive needs and through transfers of animals, and (c) acquisitions of stock through purchases or receipt of bridewealth or loans.

Table 3: Structure of Dinka and Baggara cattle herds (in % of total herd)

Type of animal	Dinka herds			Baggara herds
	Gogrial[1]	Rumbek[2]	Jonglei[3]	S. Darfur[4]
Mature males	24.1	18.7	13.8	9.5
Uncastrated	2.7	2.4	3.9	4.2(stud)
Castrated	21.4	16.3	9.9	5.3(pack)
Mature females	49.1	60.8	61.4	43.0
Cows	35.9	37.7	48.9	no data
Heifers	13.2	23.1	12.5	no data
Calves	26.8	20.5	24.8	47.5
Males	12.9	11.6	12.9	21.5
Females	13.9	8.9	11.9	26.0

[1] PDU 1978d (Bahr el Ghazal); according to PDU, herd composition data found here correspond with data from other Dinka herds in the province.

[2] PDU 1978b (Lakes).

[3] Payne & El Amin 1978.

[4] Wilson & Clarke 1975; male cattle not regarded as stud bulls are not normally castrated.

9.2.1 *Selection of breeding stock*

The high percentage of breeding females in the herds (43 per cent of the Baggara herds and 49-61 per cent of the Dinka herds) stresses the role of cows as living capital for the production of milk and calves, and for quick recuperative capacity after herd losses. Stud bulls are carefully selected to promote herd productivity.

Slightly less than 10 per cent of the cattle in the Baggara herds surveyed by HTS are mature males (defined as above 30 months of age). The Baggara regard somewhat less than half of their mature male cattle as stud bulls and the remainder primarily as pack and riding animals. However, the latter are seldom castrated (castrates made up only 0.1 per cent of the herds in the survey) and run with the female breeders when not used for work. Therefore, although the Baggara claim to keep a ratio of 1 bull to just over 10 breeding females, the ratio of uncastrated males to mature females is actually much lower. The fact that less than one-tenth of the stud bulls are over 5 years of age (Wilson & Clarke 1975, 173) indicates that their renewal rate is relatively high.

The Baggara prize their cattle for fleetness and endurance in travelling and carrying, and claim to select their breeding bulls above all for these characteristics. Of second priority in selection of bulls is the productivity of the bull's dam in terms of both milk and calves (Cunnison 1966, 37).

The ratio of breeding bulls to mature females in the Dinka herds surveyed by the PDU (1:18 in Bahr el Ghazal and 1:25 in Lakes province) indicates a high degree of selectivity. All male cattle not selected for breeding are castrated.

Evans-Pritchard (1968, c1940, 21) observed four decades ago that Nilotic pastoralists value their cattle according to their milk production, and know the merits of each cow in this respect. The PDU survey of Dinka pastoralists revealed that the most important criteria for selection of a stud bull are the milk yield and physical condition of the mother (PDU 1978b, 6). Payne and El Amin (1978, 23) found that the Dinka in Jonglei province select their bulls according to good growth rate of the animal (regarded as an indicator of the milk production ability of the dam and of the bull's growth potential) and good size at weaning.

Outside observers of Dinka herds have expressed the opinion that the Dinka select primarily according to non-productive characteristics such as long horns and ritually-valued coat colour. However, comparisons of horn size and coat colour of stud bulls and castrates did not reveal any significant difference between the two groups (PDU 1978b, 6).

9.2.2 *Disposals*

The sex structure of the Baggara and Dinka herds indicates that surplus males are culled, i.e., slaughtered for meat consumption within the pastoral community or sold at market. Less than one-third of their herds are male cattle. The age structure of the herds confirms that surplus males are disposed of at a relatively early age. In the Baggara herds, almost 70 per cent of the male cattle are immature, compared with 38 per cent of the females. In the Dinka herds, approximately 40 per cent of the male cattle are calves compared with less than 20 per cent of the females. The greater general youth of the Baggara as compared with the Dinka herds indicates a higher turnover of stock and is a reflection of the Baggara's greater integration into the commercial market (discussed later in Section 10). Almost half of the total number of cattle held by the Baggara are not yet fully mature, whereas only 20-30 per cent of the Dinka herds are calves. It must be noted, however, that a bias is incorporated in the figures as a result of the fact that HTS define 'immature' as under 30 months, whereas the PDU define it as under 27 months.

The Baggara and Dinka both cull infertile females (after they are well over 4 years of age, and obviously incapable of conceiving) as well as aged cows. However, such culling appears to be done to a somewhat greater extent by the Baggara. Of the female animals in the Baggara herds, 45 per cent are over 4 years of age (Wilson & Clarke 1975, 173), whereas 53 per cent of the females in the Dinka herds are over 4 years (PDU 1978d, 25).

The highest proportion of cattle disposals from household herds are made in payment of bridewealth, but data are not available as to the sex, age and condition of cattle given and received.

9.2.3 *Acquisitions*

In one year of study (1973), purchases by migratory Baggara pastoralists in Southern Darfur increased herd size by 3 per cent on the average (Wilson & Clarke 1976, 52). The majority of animals acquired by the Dinka are part of bridewealth payments of which, as mentioned above, exact composition is not known. The only available data on livestock purchases by the Dinka are from the Rumbek area of Lakes province, where 27 per cent of the households surveyed bought an average of 1.2 head of cattle per year. Purchases made by the Dinka and Baggara are invariably cows or heifers, just as heifers or milch cows are borrowed from relatives or friends in order to improve herd structure and productivity and to meet immediate milk requirements of the family.

9.3 *Other techniques of pastoral production*

Dinka pastoralists have developed a wide variety of techniques aimed at raising the productivity and promoting the general well-being of their cattle. At least once (in the wet season, twice) daily, they rub dung ash into the coats of all cattle in order to protect them from biting insects. Ticks are picked off the animals by hand. During the wet season, barns are built as night shelters for the cattle and dung fires are lit to keep insects out. Efforts are made to control breeding by leading stud bulls to tethered cows in heat. Cows are often assisted in calving. When cows are well into their next pregnancy, the calves are weaned by putting them into separate grazing herds from their dams. Occasionally, if a cow is in particularly poor condition, calves are weaned earlier by fitting them with spiked nosebands. The Dinka recognize a number of different cattle diseases and try to isolate diseased animals. Of the Dinka surveyed, over three-quarters stated that at least some of their cattle had been vaccinated by veterinary staff and that veterinary medicines were bought by the household (Payne & El Amin 1978; PDU 1978b&d).

The only evidence of additional pastoral techniques of the Baggara is the building of thorn-fenced enclosures to shelter calves and small stock at night. Occasionally, if wild predators are particularly numerous, the Baggara surround the entire camp of humans and livestock with thorn fences (Cunnison 1966).

10 *Livestock marketing*

Like other pastoral peoples in Africa, the Baggara and Dinka have always engaged in livestock transactions within their own groups in order to increase social and economic security. Such transactions include the transference of livestock to legitimise marriage, to compensate for damage or homicide, and to establish stock alliances. The pastoralists also engaged in trade within their own groups and across tribal boundaries in order to obtain non-pastoral foods and other commodities and services. With increasing contacts with the Western money economy, there has been a rise in the cash needs of pastoralists to purchase a widening range of goods from the non-pastoral sector (e.g. clothing, radios). The commercial market behaviour of the pastoralists is determined by the balance between utility gained through modern market transactions and utility gained through traditional livestock transactions.

The recent studies of offtake from Baggara and Dinka herds have shown that these pastoral production systems are becoming increasingly market-oriented. Livestock marketing has been expanding more quickly among the Baggara than

among the Dinka, largely because the former had not developed so many elaborate institutions of realising valued goals through non-market disposal of livestock (e.g. Baggara ritual occasions at which slaughtering of livestock is required are much less frequent, and their brideprices considerably lower than in the Dinka economy), but no doubt also because marketing and transport facilities are more developed in Western than in Southern Sudan.

As mentioned earlier, small stock are the most readily sold of the Baggara and Dinka livestock holdings. Goats form by far the largest part of livestock trade at local markets(PDU 1978b, 14; Wilson & Clarke 1975, 180). Concentration here will be on developments in the marketing of cattle, the animals of highest value in the indigenous economies as well as (potentially, at least) in the modern national economy.

10.1 Marketing behaviour

The marketable surplus of pastoral production consists primarily of live animals and dairy products. The latter can be sold on local markets, but their perishability and their need to be transported limit the extent of marketing in sparsely populated regions with poor infrastructure. Live animals are self-transporting, less perishable and, therefore, easier to market under present economic and technological conditions in Western and Southern Sudan.

Much has been surmised and written about the *market supply response* of African pastoralists, and this response has often been labelled 'perverse' (cf. Khalifa & Simpson 1972). Further explanation is needed here. Some male cattle and barren females can always be removed from the herd without detriment to the pastoral production aims of maintaining a steady supply of animal products for subsistence, building up herd numbers and insuring against future disasters. In the case of such surplus animals, the supply response of pastoralists is 'normal': these animals are sold if the price is favourable, and more are likely to be sold when the price rises. Breeding females, by contrast, are productive capital, the reduction of which would represent a threat to the pastoralist's livelihood and the herd's security, as well as a limitation to possibilities for investment. In a situation of extremely limited options for obtaining necessary cash or food, a herd owner may be forced to sell some of his productive female cattle, but he will sell only enough to satisfy his family's immediate and urgent consumption needs. The higher the price of cows, the fewer he will have to sell. This so-called 'perverse supply response' to price rises is fully rational in terms of the indigenous pastoral economy (Haaland 1976b, 244-5).

Such an inverse price/supply relationship was widely thought to be typical of *all* cattle sales by pastoral peoples. The hypothesis has been partly based on the misconceptions that traditional pastoral systems have been unaffected by external developments and that the pastoralists have extremely limited desires for non-pastoral goods. However, after extensive field work in Western Sudan, Khalifa (1970, summarised in Khalifa & Simpson 1972) discovered that the Baggara exhibit a strong desire for goods and services provided by the modern sector of the Sudanese economy, ranging from necessities like sugar, tea and cooking utensils to luxuries like radios and manufactured tents. The Baggara are fully prepared to sell animals and animal products to finance these requirements. It is therefore not surprising that Khalifa and Simpson found the Baggara's total supply response to cattle price movements (up to 1965) to be positive and above unity in elasticity. More recent data compiled by HTS (Wilson & Clarke 1976, 54) suggest that the supply response is now probably somewhat less elastic because the Baggara have been forced by adverse rainfall conditions to sell a higher proportion of productive female cattle with higher opportunity costs in terms of income security and future growth.

The HTS report the following composition of cattle sales at Nyala, the major market for Baggara animals from Southern Darfur.

Table 4: Composition of cattle sales at Nyala market (Wilson & Clarke 1976)

Year	Total No.	Bulls[2]	Cows[2]	Calves[2]
1962-68	22,913[1]	72	16	12
1968-69	25,877	75	16	9
1969-70	26,262	74	17	9
1970-71	29,126	73	12	15
1971-72	29,429	68	14	18
1972-73	20,429	60	21	19

[1] Average for 6 years.

[2] In per cent of total cattle sold.

Unfortunately, cattle price information was not given. It is evident that bulls are most readily sold, but their share in total sales is declining whereas the share of productive females being sold is rising. The total volume of sales appears to have levelled off and, if the sales in 1972-73 can be interpreted as a trend, even declining.

Insufficient data are available to permit an analysis of the response of Dinka producers to price levels, but some indication of their marketing behaviour can be gained from auction data collected by the PDU at Gogrial market in Bahr el Ghazal province. Figure 1 shows the relationship between average price and quantity of cattle sold. Not only in total sales but also in each class of animal sold (including steers), there is an inverse relationship between price and quantity. This is thought to be because, when grain supplies are depleted or the harvest is poor, Dinka pastoralists are forced to sell livestock in order to purchase grain. Consumer demand on the cattle market is inelastic (PDU 1978d, 13); therefore, the large supply of animals on the market at these times of scarcity depresses livestock prices considerably, at the same time as the high demand for grain pushes grain prices upwards. One implication of these seasonal price movements in opposite directions is that a Dinka household is obliged to keep a still larger number of animals as famine reserve than would have been the case if prices of livestock and grain had remained at their 'off-season' levels. The poorer Dinka pastoralists operating on the subsistence margin do not have the option of retaining animals until prices rise; in order to survive, they are forced to sell when food needs are greatest but livestock prices lowest. Only those households owning a large number of animals would be able to take advantage of favourable prices at other times of the year (PDU 1978a).

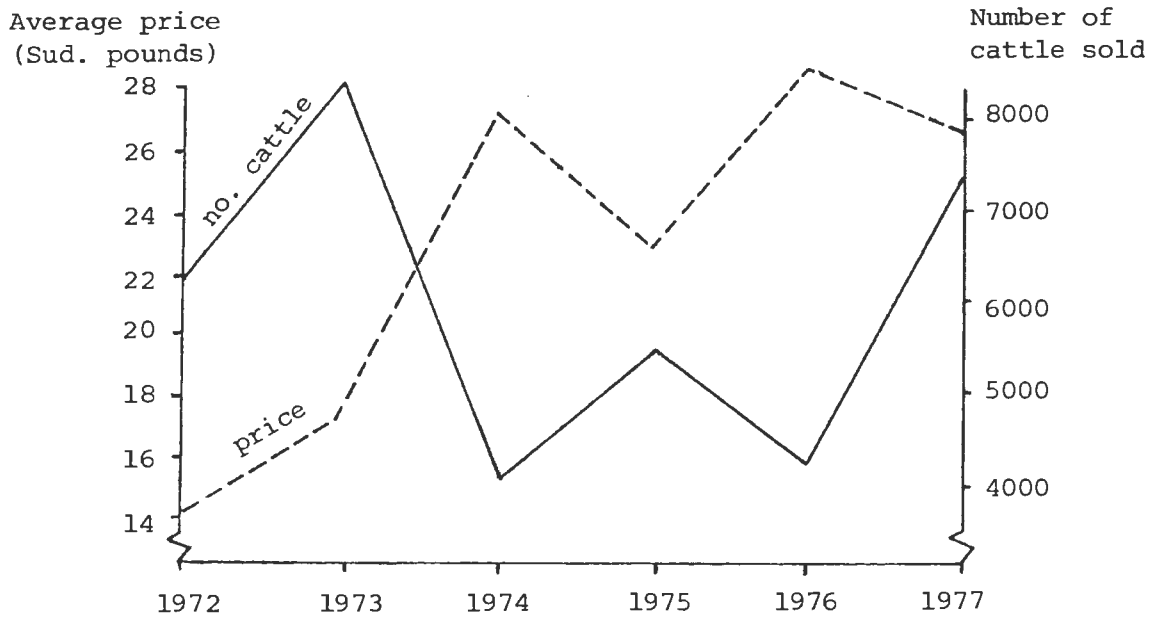

Figure 1: Average price of all cattle sold and number of cattle sold at Gogrial market (Source: PDU 1978a, pp. 9 and 14)

Table 5 presents the composition of cattle sales at two markets for Dinka livestock. Gogrial is the site of a daily auction market in the Dinka pastoral area of Bahr el Ghazal, whereas Juba is the capital city and major livestock market in Southern Sudan. Most cattle sold at Juba, which lies in an area heavily infested by the tsetse fly, are trekked from Dinka herds in Bahr el Ghazal, Lakes and Jonglei provinces (PDU 1978c, 5). Because young cattle would be less likely to survive the long and arduous journey along the stock routes to Juba, most cattle auctioned there are steers several years of age.

Table 5: Composition of cattle sales at Gogrial and Juba markets in % of total cattle sold (PDU 1978a&c)

Year	Gogrial market				Juba market		
	Est.no. sold	Bulls[1]	Cows	Heifers	Est.no.[2] sold	Bulls[1]	Cows[3]
1972	6100	41	34	25	4060	62	38
1973	8400	46	27	27	3770	76	24
1974	4200	59	27	14	3140	80	20
1975	5500	54	24	22	2380	73	27
1976	4200	62	21	17	2710	n.a.	n.a.
1977	7300	60	19	21	3080	n.a.	n.a.

[1] PDU uses the term 'bull' to denote all mature male cattle, whether castrated or uncastrated.

[2] No. of animals auctioned, which represents only about one-third of animals known to be slaughtered in Juba (PDU 1978c, 3).

[3] Includes a small number of heifers.

With reference to Dinka cattle sales in general, most cattle sold are steers; cows are sold usually only when they are obviously not or no longer fertile; heifers appear to be sold as a last resort. In the years of greater food scarcity in the Gogrial area (1973, 1975 and 1977, according to PDU 1978a), when total cattle sales were considerably higher than in the alternate, relatively 'normal' years, the Dinka were forced to sell almost as many heifers as cows, in 1977 even somewhat more. However, when food needs were less pressing and fewer animals were sold in total, the Dinka were quick to reduce the offtake of heifers from their herds.

The difference in livestock marketing behaviour of the Baggara and Dinka pastoralists is largely a result of differences in dependency on grain purchases. The Baggara have considerably more livestock per head of human pop-

ulation than do the Dinka and are, therefore, not so dependent on grain for subsistence.

10.2 Commercial offtake

The HTS give a figure of 5 per cent as the rate of commercial offtake from Baggara herds in the province of Darfur as a whole (M.E. Adams 1975, 280). The ILO gives the same figure as average offtake rate from all Baggara herds on the western savanna of Sudan (Haaland 1976b, 248).

The total number of cattle slaughtered in Southern Sudan (excluding local slaughter by cattle owners) or exported from the province is estimated to be in the order of 110,000 per annum (PDU 1978a, 6). Commercial offtake from Dinka herds in Bahr el Ghazal, Lakes and Jonglei provinces ranges between 2 and 3 per cent of total cattle numbers (PDU 1978a, 6; Payne & El Amin 1978, 94). The PDU studies indicate that market transactions by the Dinka are increasing: the number of cattle officially slaughtered in the main urban and semi-urban consuming centres of Southern Sudan has been rising steadily in recent years, especially since the end of the civil war in 1972 (PDU 1978c, 5).

It has frequently been claimed that the Dinka value their bulls and steers so highly in socio-cultural terms that they refuse to sell them. As can be seen in Table 5, the number of mature male cattle auctioned at Gogrial market has been increasing from 2500 head or 41 per cent of total cattle sales in 1972 to 4400 head or 60 per cent of total cattle sales in 1977. Observing the greater readiness of the Dinka to sell male cattle, the PDU has come to the conclusion that traditional attitudes do not represent a constraint on increased marketed offtake (PDU 1978a, 1).

Marketed output from the cattle herds includes not only live animals but also dairy products and hides. A limited number (13 per cent) of the Dinka interviewed in Jonglei province during a 1976 UNDP survey stated that they sometimes sold milk outside the cattle camp or village. Some of the hides from cattle slaughtered in the camps and villages are also sold to merchants (Payne & El Amin 1978, 100). It is reported that the Baggara sell large quantities of dairy products on local markets and to centralised buying points organised by the Veterinary Department (Cunnison 1966; Wilson & Clarke 1975), but data on exact or even estimated total quantities were not available.

The data given previously in Table 3 on structure of the Baggara and Dinka cattle herds indicate that the low rate of commercial offtake does not im-

ply vast numbers of unproductive animals in the herds. Males not needed for reproductive purposes in the Baggara herds make up only 5.3 per cent of the total number, and are used for transport purposes. The conclusion which HTS draw from the survey of Baggara herds is that there is no large untapped supply of slaughter stock. Several successive years of below average rainfall and poor pasture conditions in Southern Darfur have led to a decline in cattle population, at least in the survey area, yet numbers of cattle sold at Nyala, the most important livestock market in the area, have been maintained until the last year recorded (see Table 4). It is feared that this has been at the expense of alteration in herd structure to the detriment of herd productivity and income security. An increasing percentage of cows and young animals are being sold in the attempt to maintain income levels. In the early to mid-sixties, cows made up 16 per cent of total cattle sales and calves 12 per cent; by 1972-73 the respective figures were 21 and 19 per cent. Herd capital is obviously being reduced and emergency buffers of stock depleted. HTS believe that cattle sales are probably already at the maximum level considered to be safe by the Baggara (Wilson & Clarke 1975, 55).

In Dinka herds, castrated males make up from 10 to over 20 per cent of total cattle numbers. However, these animals are particularly needed in the Dinka economy as a famine reserve. Blood for human consumption can be drawn from the living animals. Steers are also the most readily marketable class of cattle in the event of food scarcity. Calculations presented in the following table show that the number of steers held by the average Dinka household in the Gogrial area of Bahr el Ghazal and the Rumbek area of Lakes province would be barely enough to compensate for annual hunger periods from April to July before the first harvest can be made of the quickest-maturing sorghum varieties (two months to maturity). If the onset of the rains is delayed, the hunger period is correspondingly longer. In the Rumbek area, a quantity of less than 200 g of grain per day might have to suffice per person for a period of up to 4 months, or even longer in years of severe drought. Grain, it will be remembered, is the staple food in the Dinka economy. This famine reserve of grain obtainable in exchange for steers is equivalent to less than 900 kcal per person per day in the Gogrial area and less than 600 kcal per person per day in the Rumbek area. The daily food requirement of adult pastoralists has been estimated to be 2300 kcal (Pratt & Gwynne 1977, 35). It should also be noted that, because cattle ownership is unequally distributed between households, many people would have even less protection against famine than is suggested by these average figures (PDU 1978b, 8).

It can be concluded from the HTS and PDU data on cattle marketing that the Baggara and Dinka pastoralists are not reluctant to sell their cattle and

Table 6: Steers as famine reserve in Dinka households

Survey area	Gogrial[1]	Rumbek[2]
Average household herd size (no.cattle)	16.7	9.5
Per cent steers	21.4	16.3
No. steers/household herd	3.6	1.6
Equivalent in kg grain[3]	324	144
Average household size (no.persons)	10.2	6.7
kg grain/person	31.8	21.5
g grain/person/day during hunger period[4]	265	179
kcal/person/day during hunger period[5]	880	594

[1] Source: PDU 1978d.

[2] Source: PDU 1978b.

[3] Based on worst price ratio of steers to grain during hunger months of 1 steer to 1 sack or 90 kg grain (PDU 1978b, 8).

[4] Calculated as 120 days.

[5] 1 g sorghum = 3.32 kcal (Dyson-Hudson 1974, Table 4).

do not hold a vast marketable surplus of animals purely for reasons of religion or prestige.

The commercial offtake rate from sheep and goat flocks in the Baggara pastoral system is considerably higher than from the cattle herds. From the total number of sheep in Southern Darfur flocks covered by the HTS survey in 1973-74, 18 per cent were sold annually on commercial markets (Wilson 1976a, 108) and 16 per cent of the goats were marketed each year (Wilson 1976b, 227).

In the Dinka-owned flocks surveyed by the PDU in Bahr el Ghazal and Lakes provinces, annual commercial offtake of sheep was 2 per cent and of goats 7 per cent (PDU 1978b, 17). In contrast to total offtake from the Baggara flocks, over half of which consists of market sales, by far the major portion of total offtake from the Dinka flocks of small stock is not sold but is rather consumed within the pastoral household (see Section 11.4).

10.3 Indigenous livestock marketing systems

Sales of livestock from Baggara and Dinka herds are not limited to markets in or adjacent to the pastoral areas, from which most of the above figures are derived. Indigenous traders are developing systems or adapting long-established operations to meet the growing demand for meat in urban areas in other parts of the Sudan and beyond.

In the report of the ILO Employment Mission to the Sudan in 1975, Haaland (1976b, 249-50) describes indigenous cattle marketing in Western Sudan as follows. The traders (*jellaba*) 'have specialised in trade for centuries and have developed skills and organisational forms which are extremely efficient under the conditions prevailing in the Sudan.' Because communication and transportation difficulties in the sparsely populated pastoral areas prevent centralisation of buying and selling activities and because the variety of weather conditions creates wide variations in prices, the *jellaba* delegate the buying function to agents (*wakils*) who are given the money and responsibility to purchase cattle in their buying areas when local conditions are favourable. To attract a large number of sellers, the buyers often use the so-called 'telegraph' - a system of buying a certain number of animals at a price above the expected market price. Rumours about such transactions spread quickly (hence the name 'telegraph'). The resulting increased supply of animals (incidentally also proof of the non-perverse response of Baggara producers to price changes) depresses the prices below expected levels, whereupon the traders buy in quantity. When a sufficiently large number of animals has been purchased in camps, local markets or auctions, the cattle are walked in herds ranging in size from 50 to 200 head to the railhead at Nyala or to the export yards over 1000 km away in Omdurman. The walk from Darfur to Omdurman takes between 55 and 80 days. Herders for the trek are hired by contract and paid wages which seem to be sufficient to attract skilled and experienced herders, often marginal Baggara pastoralists seeking to rebuild their own herds. Traders use and often own resting paddocks for their cattle along the stock routes. Livestock trading is a traditional enterprise passed down from father to son. The Employment Mission regards the expertise and entrepreneurial abilities of the *jellaba* as a valuable resource for the further development of livestock marketing in the western savanna of the Sudan.

The livestock marketing system in Southern Sudan has been the subject of a detailed study by the PDU (1978e). Most of the trade from the Dinka pastoral area in Upper Nile to Northern Sudan is conducted by the Northern Sudanese *jellaba*, but from the centre of Dinka pastoralism in Bahr el Ghazal and Lakes provinces to the markets further south, the trade is carried out by Nilotic peoples. Most traders are Dinka who have established the business themselves and did not inherit it from their fathers. Animals are bought in the producing areas in the floodplains and trekked to the main towns in Southern Sudan. Some Dinka traders also penetrate into Northern Sudan and Zaire. All cattle movement is on the hoof (railways to the south being non-existent, roads generally in extremely poor condition, and both vehicles

and fuel scarce). Cattle are trekked 30 km per day on the average, and do not appear to lose condition seriously. Generally only steers are trekked long distances (e.g. 600-800 km to Juba). The traders usually bring the small herds (15-30 head) to market themselves, although some hire herders for this work. It is common for the herds of several traders to be trekked together for security and to minimise herding labour requirements. On arrival at their destination, the traders sell their cattle in small groups of animals each day to avoid the price depression which would result from the simultaneous arrival of a large number of animals on the market. According to PDU calculations, livestock trading is a highly profitable enterprise in Southern Sudan, the number of traders has increased markedly since the end of the civil war, and further expansion of the trade is likely. From their market studies in the Southern Region, the PDU conclude that 'the livestock trade is flexible and competitive and serves the Region well, given infrastructural limitations'(PDU 1978a, 8).

Thus, in both the Baggara and the Dinka pastoral regions, indigenous systems of livestock trading are developing in response to new economic opportunities. Other marketing institutions need not be imposed. Instead, it would be preferable to promote existing trading operations by improving the infrastructure, e.g., providing feeding and watering facilities along stock routes and facilitating transport so that more cattle can be exported from the southern areas of the Sudan.

11 Productivity of the herds

An evaluation of productivity cannot confine itself to the marketed offtake from the cattle herds, for this represents only a small portion of total offtake of animals for meat and neglects the output of other products from the slaughtered animals as well as the products obtained from the living animals. In terms of the traditional pastoral economy, the number of livestock saved and accumulated could also be considered part of the output of the system (if regarded as addition to capital). This would be determined by the reproductive performance and mortality rate within the herd, which also, of course, influence the level of output of animal products and services.

The present discussion of productivity will concentrate on the principal species of animal kept - cattle - but will also include some references to the numerous small stock which contribute substantially to the total output of the traditional pastoral system.

An overview of production parameters of Baggara and Dinka cattle herds is given in Table 8 at the end of this section. In order to put the data on herd productivity into perspective, corresponding data from areas of northern Australia with very similar climatic conditions to those in Western and Southern Sudan[5] are listed in the table and will be mentioned in the following pages. The comparison is, admittedly, of limited validity because an intensive, subsistence, milk-production system is being compared with an extremely extensive, commercial, beef-production system. However, the subsequent discussion of efficiency in use of similar resources in the Sudan and northern Australia may be of interest to those persons advocating the replacement of traditional pastoralism by modern commercial ranching.

11.1 Reproductive performance

Determinants of reproductive performance in cattle herds are the calving rate (percentage of breeding females which calve per annum) and the age of first calving.

In an intensive study of migratory herds of Baggara cattle in Southern Darfur, it was found that 65 per cent of the breeding females calved in the year the study was made (Wilson & Clarke 1976, 48). However, an estimate of approximately 50 per cent calving rate has been based on 1972-74 data from the region as a whole (Wilson & Clarke 1975, 174). The age of first calving could not be established directly, but in the migratory herds studied, 65 per cent of the heifers under 4 years of age had already produced at least one calf (Wilson & Clarke 1976, 50).

Data from the Dinka herds indicate a similar level of productivity. Data collected by the Economic and Social Research Council in 1976 and 1977 suggest a calving rate between 55 and 65 per cent in Jonglei province (Payne & El Amin 1978, 111). The calving percentage calculated by the PDU for Dinka cows in the Rumbek area of Lakes province was lower, being in the order of 50 per cent (PDU 1978b, 18). One reason for this could be that infertile

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[5] According to the MAB (1979) map of the world distribution of arid regions, the Baggara and Dinka areas of the Sudan are semi-arid to sub-humid with warm to very warm summers and warm winters. The western half of Cape York Peninsula and the northern fringe of Victoria River District in northern Australia are sub-humid regions with the same temperatures regimes as above. The Gulf and Inland North areas of Queensland and the major part of Victoria River District are classified as semi-arid with warm to very warm summers and mild winters. All are regions of concentrated summer rainfall and winter droughts of several months' duration, and the predominant vegetation of tree and shrub savanna opening into almost pure grass stands in the flood plains is subject to extreme seasonality in production and nutritive value and/or accessibility for grazing.

mature females are not culled by the Dinka until the cows are 6 or 7 years of age (Payne & El Amin 1978, 14). Age of first calving by Dinka cows is approximately 4 years. According to the PDU (1978b, 7) heifers are mainly in the age range of 27-48 months when first calving occurs, but Payne and El Amin (1978, 83) found in an examination of heifers in a Dinka cattle camp in the Jonglei area that only 2.6 per cent had calved by 43 months of age.

Statistics for northern Australia refer to branding rates (percentage of cattle branded to cows and heifers mated) rather than direct calving rates, because ranchers in these areas cannot keep track of calvings: they see their animals only once or twice per year. As Churchward (1965) has pointed out, even the branding percentage figures give only a rough measure of reproductive performance, for although the number of calves branded is counted, the exact number of breeders is seldom known. In the Peninsula-Gulf and Inland North areas of tropical Queensland, the BAE (1974b, 42) found branding rates of 50.4 and 57.5 per cent, respectively, during their 1968-71 survey of the beef cattle industry. According to ABS statistics from 1977 to 1979, the branding rates in these areas average 60 per cent. Corrected for calf losses (estimated at 10 per cent by Boorman & Arthur 1978, 56), the BAE and ABS figures would correspond to calving rates of about 55-65 per cent. According to the 1979 survey of Victoria River District in the Northern Territory, the branding rate there is 47 per cent as an average of all cattle properties. No estimate of calf mortality is hazarded, but if it is of the same order as in northern Queensland, the calving rate in Victoria River District would be around 52 per cent. Age of first calving in North Queensland is assumed to be about 3 years (Donaldson *et al.* 1967) and is probably similar in Victoria River District.

In determining the reproductive performance of the sheep kept by the Baggara in Southern Darfur, HTS regarded all female sheep over 10 months of age as breeding females. On the average, breeding females accounted for 57 per cent of the flocks (Wilson & Clarke 1975, 177). The lambing percentage during the survey was approximately 150 per cent (Wilson 1976a, 105). Similarly, all female goats over 10 months of age were regarded as breeding females, and accounted for 50 per cent of the flocks (Wilson & Clarke 1975, 180). The annual kidding percentage was 208 during the calendar year 1973. Almost 70 per cent of the kids were products of multiple births, twins being most common (Wilson 1976b, 222).

No data on the reproductive performance of sheep and goats kept by the Dinka are given in the available PDU publications, but Payne and El Amin (1978, 86-90) managed to compile some limited data on this subject. During their 1976 survey of flocks in the Bor area of Jonglei province, they found that

mature females accounted for 55 per cent of the sheep. Lambing percentage was estimated to be of the order of 100. Mature females likewise made up 55 per cent of the goat flocks. No reliable data were available on kidding percentage, but multiple births were known to occur.

No comparative data can be given on fertility or, indeed, any productivity parameters of sheep and goats in production systems in climatically similar areas of Australia, because the properties in the tropical North carry only cattle and a few horses for work or racing purposes.

11.2 Mortality rates

Because the Baggara are forbidden to eat meat not slaughtered according to Islamic custom, many cattle are slaughtered for meat shortly before their expected death. According to HTS (Wilson & Clarke 1976, 52) 'the value of cattle in both monetary and social terms is so great that it can be assumed that most of these animals would have died if not slaughtered'; HTS therefore regard them as deaths in calculating mortality rate. This assumption is questionable, since even the Dinka, who are supposed to place much higher socio-cultural value on their cattle, slaughter some beasts that are not on the brink of death. It is probable that the mortality rate in the migratory Baggara herds is somewhat lower than the figure of 15 per cent given by HTS. Based on the same assumption, the death rate in Southern Darfur herds expressed as a percentage of all cattle including births is estimated by HTS to be 19 per cent.

Among the Dinka herds surveyed in the Jonglei province in 1976, the mortality rate was slightly under 5 per cent (Payne & El Amin 1978, 94). The PDU report cattle losses equal to 6 per cent of the total herd (PDU 1978b&d).

To continue the comparison with climatically similar regions of northern Australia, annual losses of cattle from beef properties were reported by the BAE (1976) to be 8 per cent in the Northern Territory and 9 per cent among beef herds in the pastoral area of the entire state of Queensland. Unfortunately, data from the Australian Grazing Industry Survey are given on a state basis, so that statistics for specific areas being compared here are not available from this source. Calculations based on ABS statistics for the years 1976-79 in the Peninsula-Gulf and Inland North regions of tropical Queensland yield a mortality rate of over 7 per cent. Mortality rates on the properties in Victoria River District could not be established during the 1979 survey by the Northern Territory Department of Primary Production, but are given as 8 per cent in an earlier survey of the Northern Territory beef cattle industry made by the BAE (1974a, 7).

Considering the greater difficulty of pastoral production under African conditions (e.g. high number of predatory animals, scarcity of veterinary services), the low percentage of losses from Dinka herds is remarkable and can perhaps be attributed to the intimate relationship between the Dinka and their cattle[6].

Mortality rates in the Baggara sheep flocks appear to be high. During the HTS survey in the calendar year 1973, 23 per cent of the total number of sheep died. An important component of total flock mortality was the death of lambs, particularly in the first four weeks of life and particularly in the case of twins (Wilson 1976a, 107-8). Mortality rates in the Baggara goat flocks averaged 18.5 per cent, four-fifths of which was due to death of kids (including stillbirths) up to six months of age (Wilson 1976b, 224-6).

Losses of animals in the Dinka flocks surveyed by the PDU in Bahr el Ghazal and Lakes provinces amounted to 4.5 per cent of the sheep and 16 per cent of the goats. The main causes of these losses were disease and predators, to which the goats appear to be more susceptible. The PDU calculated that the meat of two-thirds of sheep mortalities and three-quarters of goat mortalities represented meat recoverable for human consumption (PDU 1978b, 17).

11.3 Growth rates

Growth rates of calves, lambs and kids give an indication of the milk productivity of the dams and the offspring's growth potential.

The average birth weight of surviving calves in the Baggara herds surveyed by HTS was just over 19 kg. The average daily weight gain of the calves during their first 6 months was 255 g (Wilson & Clarke 1976, 50). This is considerably lower than the average birth weight (23 kg) and daily weight gain (375 g) recorded by Mukhtar (1961, 208) in Southern Darfur calves up to 35 weeks of age. Up to 78 weeks (1.5 years) of age, the daily weight gain of Baggara cattle in the HTS survey was 223 g (Wilson & Clarke 1976, 51).

Payne and El Amin estimate the birth weight of Dinka calves to be 20 kg and the average daily growth rate about 300 g. Although not specified, this figure probably refers to calves in their first year, judging from the context (Payne & El Amin 1978, 76). The PDU did not have facilities for weighing cattle.

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[6] This close relationship between Nilotic people and their animals is described, among others, by Evans-Pritchard (1968, c1940, 34), who writes of the 'very slight mortality among calves' which are given 'every attention'.

Data on average birth weight and calf growth rates under extensive ranching conditions in tropical Australia are scarce. On a research station in the dry tropics (800 mm rainfall with marked summer incidence) of North Queensland, the birth weight of Shorthorn and Brahman-cross calves (these being the predominant breeds on beef properties in North Queensland) averaged 30 kg, and the average daily weight gain from birth until weaning at 180 days was about 650 g (Holroyd *et al.* 1979, 391). However, these weight gains were achieved in part on pastures improved with an introduced legume (*Stylosanthes humilis*). Brahman-cross calves in herds with their dams on unimproved pasture at Katherine Research Station in the Northern Territory are reported to weigh approximately 30 kg at birth and gain an average of 600 g per day in their first five months (Winter 1981, pers.comm.). In both cases, the calves are suckling dams which are not milked to provide food for human consumption as well.

An approximate measure of addition to capital in pastoral enterprises through increase in herd size is given by estimates for average annual increase in cattle population in the traditional pastoral areas. The best available population estimates for Southern Sudan suggest an average annual increase in cattle numbers of about 3 per cent between 1954 and 1976, and this figure is used by the PDU to calculate appreciating value of Dinka cattle herds (PDU 1978b, 18). However, cattle population changes between 1954 and 1976 in the Jonglei area suggest that the size of Dinka herds has been increasing by less than 1 per cent per year (Payne & El Amin 1978, 14). If average reproductive, mortality and offtake (minus mortality) rates for Dinka herds are combined, the result also reveals an increase in herd capital of less than 1 per cent. Figures for Southern Darfur indicate that the higher death and offtake rates from Baggara cattle herds are leading to a decrease in the number of animals held and, thus, a reduction in herd capital.

Data on birth weights and growth rates of sheep and goats in the African pastoral production systems under consideration here are available only in the case of the Baggara flocks in Southern Darfur.

In the sheep flocks studied by HTS, lambs weighed slightly under 4 kg at birth. To 3 months of age, the average daily weight gain was 140 g; to 12 months of age, the average liveweight gain for all surviving lambs was 83 g (Wilson 1976a, 106-7). These growth rates are better than those measured for other sheep breeds in eastern Africa, and the fastest growing lamb in the study gained 264 g per day up to 3 months of age, which compares well with the weight gain of 299 g per day reported for New Zealand fat lambs of that age (Wilson 1976a, 111). These figures give some indication of the potential of Baggara sheep for meat production. In the goat flocks, the average birth

weight of kids was slightly over 2 kg, the average liveweight gain to 3 months of age was 87 g per day, and the average gain to 6 months was 67 g per day (Wilson 1976b, 224-5).

During the HTS survey, the Baggara's herd capital in the form of sheep declined by almost 10 per cent (Wilson 1976a, 110) in spite of the fairly high birth rate. The mortality rate as well as the rate of offtake for marketing and home consumption were high. By contrast, high mortality and offtake rates from the goat flocks were offset by very high birth rates, so that the total number of goats increased by about 8 per cent per annum (Wilson & Clarke 1975, 178). Moreover, if meat production is expressed per kg liveweight of breeding females, goats are clearly the most productive animal species in the Baggara herds. According to HTS calculations, goats produce 1.5 times the weight of meat produced by sheep and 8 times the weight of meat produced by cattle per kg breeding females of the respective species (Wilson 1976b, 221). In view of the comparative advantage of goats over sheep and cattle, HTS conclude that dependence on goat meat and milk production to meet cash and food needs is likely to increase in the Baggara economy (Wilson 1976b, 230).

11.4 Meat production

In addition to the animals which are sold, bartered or disposed of for payment of taxes, i.e., the commercial offtake from the herds, a larger percentage of the cattle herds is consumed as meat within the pastoral community.

Almost 9 per cent of the cattle in the Baggara herds studied by HTS were slaughtered *in extremis* to be consumed as meat. A very limited number of animals were slaughtered for ceremonial purposes. In all, slightly less than 10 per cent of the herd contributed to the total meat consumption within the pastoral community. The average carcass weight of cattle sold for slaughtering is estimated to be about 135 kg (Wilson & Clarke 1976, 53), but because most cattle slaughtered by the pastoralists themselves are presumably weak and dying, a considerably lower average carcass weight must be assumed, say 100 kg, in the case of these animals. At a very rough estimate, if the ratio of cattle to humans in Baggara production units is 4.4:1 (see p. 42) and the offtake for local meat consumption is 10 per cent, there would be over 40 kg of beef available per person per annum.

It can be assumed that the commercial offtake (5 per cent) also represents meat production. Thus, the total offtake for meat from Baggara cattle herds in Southern Darfur is almost 15 per cent (Wilson & Clarke 1976, 53).

The 1976 survey of Dinka herds in the Jonglei area revealed that 6 per cent of the cattle were sacrificed or died; the meat of these animals is generally eaten by the pastoralists, their families and friends. Adding to this the small percentage of animals slaughtered deliberately for meat consumption, slightly less than 7 per cent of the herds provided meat for the pastoral community. Calculating with unspecified figures for average liveweight and average killing-out percentage, Payne and El Amin (1978,92) estimate that the average per capita consumption of beef among the Dinka in the Jonglei area is 28 kg per year. This does not include offal meat, which is also consumed. When commercial offtake is added to the pastoralists' share of offtake, the total offtake for meat from Dinka cattle herds in that area is almost 10 per cent (Payne & El Amin 1978, 94).

The PDU figure for offtake from Dinka cattle herds in the surveyed areas of Bahr el Ghazal and Lakes provinces is almost identical, namely 9.5 per cent (PDU 1978b, 16). However, the PDU differentiates between total offtake and the percentage actually recoverable as meat for human consumption, the remainder of the animals presumably having been eaten by wild predators or stolen. Of the total cattle herd, 1.4 per cent was slaughtered, mainly for ceremonies but also expressedly to supply meat for the household or for agricultural working parties. The meat of all cattle slaughtered for ceremonies is eaten. Such ceremonies tend to be concentrated in the annual hungry period (April to July), when over half of the yearly slaughterings were done. Of the 6 per cent of cattle recorded as mortalities and losses, only about two-thirds represent recoverable meat, according to the PDU estimates. Adding slaughterings, a total of 5.4 per cent of the cattle herd is available for meat consumption within the community (PDU 1978b, 17). Dressed carcass weight is approximately 125 kg. If these figures are combined with average herd size and average household size in the Gogrial and Rumbek areas (see Table 6), annual beef consumption per person amounts to 11 and 10 kg, respectively.

When commercial offtake is included, a total offtake for meat of 7.5 per cent is reached (PDU 1978b, 17). This will, in reality, be slightly higher, because part of the difference between total losses and carcasses recoverable for meat consumption represents thefts,and the meat of these animals will eventually be eaten by their new 'owners'.

Offtake figures (marketed offtake plus cattle consumed on the property) from climatically similar regions in northern Australia once again offer an interesting comparison. ABS statistics for the years 1976-79 reveal a total offtake of just over 16 per cent from commercial ranches in the Peninsula-Gulf and Inland North regions of Queensland. According to the statistics of

the Department of Primary Production in the Northern Territory, the average offtake rate from the beef herds in Victoria River District for sale, transfer and station slaughtering was 12.5 per cent in the period 1976-79 (Shields 1979, 15). In case the objection should be raised that the Australian beef cattle industry was in a slump in the mid-seventies because of low beef prices on the world market, let it be pointed out that commercial turn-off rates in tropical Australia were stated in 1970 (i.e. before the slump) to be 'as low as 9% in parts of the Northern Territory and Peninsula, 12% in the Kimberleys and Victoria River District and 15% on the Barkly Tableland and north-west Queensland' (Woolcock 1970, 231). Johnston (1975, 8) gives the following BAE figures for net turn-off rates at the beginning of the seventies: 12 per cent in the Peninsula-Gulf region and 15 per cent in the Inland North region of Queensland. It can be generally concluded that offtake rates from commercial beef herds in North Queensland and the Northern Territory are not much different from those in traditional pastoral areas of Western and Southern Sudan. Most cattle turned off from herds in the extensive ranching areas of tropical Australia mentioned above are store steers and boner cows. According to the Queensland Department of Primary Industries, the carcass weight of cattle turned off from such areas is approximately 170 kg (Boorman & Arthur 1978, 54).

In the African pastoral production systems, an additional source of meat (and, to a limited extent, blood) is the flock of small stock. Total offtake for meat from Baggara and Dinka flocks is summarised in Table 7.

Table 7: Total annual offtake for meat from Baggara and Dinka flocks of small stock (in % of all animals of each species)

Composition of offtake	Baggara flocks[1]		Dinka flocks[2]	
	Sheep	Goats	Sheep	Goats
Market sales	19	14	2	7
Slaughter	9	14	8	17
Deaths (recoverable meat only)	-	-	3	12
Total offtake	28	28	13	36

[1] Sources: Wilson 1976a, 108; Wilson 1976b, 227.

[2] Sources: PDU 1978b, 17; PDU 1978d, Appendix 3.

From the migratory sheep herds of the Baggara in Southern Darfur during the 1973-74 HTS survey, total annual offtake was 28 per cent, composed of 19

per cent market sales, 5 per cent slaughter for ritual or hospitality purposes, and 4 per cent 'emergency' slaughter, specifically for household meat consumption or because the animal appeared ill (Wilson 1976a, 108). Most animals sold or slaughtered were males of 3-15 months of age. The average dressed carcass weight was 12.3 kg (Wilson 1976a, 109).

From the migratory goat herds of the Baggara, the total annual offtake was likewise 28 per cent, composed of 14 per cent market sales, 8 per cent slaughter for ritual or hospitality purposes, and 6 per cent 'emergency' slaughter (Wilson 1976b, 227). Most animals sold were males of 6-15 months of age, but males of 3-6 months were preferred for slaughter for home consumption, which represents half of total offtake in terms of animal numbers. Because such a high percentage of goats are slaughtered at a young age, the average dressed carcass weight measured by HTS was only 7.4 kg (Wilson 1976b, 227).

In the flocks of small stock kept by the Dinka in Bahr el Ghazal and Lakes provinces, the PDU (1978b&d) found the total annual offtake to be 14.3 per cent of the sheep and 40.4 per cent of the goats. However, because some carcasses cannot be recovered, the offtake utilisable as meat for human consumption is approximately 13 and 36 per cent, respectively. The available PDU reports do not give data on the liveweight of Dinka sheep and goats, but the calculations of value of livestock offtake appear to be based on a carcass weight of almost 20 kg in both cases, which would be rather high if the earlier mentioned liveweight estimates by Payne and El Amin (see pp. 40-1) are close to correct. In the present study, subsequent calculations of food production from small stock kept by the Dinka will be based on the assumption that carcass weight of sheep and goats is 12 and 10 kg, respectively.

11.5 Milk and blood production

A major difference between commercial ranching in areas like northern Australia and pastoral production in Africa is that meat is the primary aim of production in the former system but not in the latter. In traditional economies, animals are kept in order to extract a wide variety of products and services. Of these outputs, meat is of relatively low importance and is consumed basically because all animals eventually die. Of far greater importance to the African pastoralist is the capacity of livestock, particularly cattle, to produce milk and, in some areas of eastern Africa, blood.

Unfortunately, information on milk production from traditionally managed herds is usually vague. HTS did not make a detailed study of milk production

from Baggara herds. Daily yields of 1.5 litres over and above what the calf drinks are described as normal. Lactations of Baggara cows in Southern Darfur appeared to last for about one year (Wilson & Clarke 1975, 54). This figure is somewhat unrealistic. According to Williamson and Payne (1978, 214), the average length of lactation of Baggara-type cows is 254 days. In subsequent calculations, a lactation period of 250 days will be assumed. Yield of milk available for human consumption would thus be 375 kg/cow/year. Basing calculations of 43 per cent breeding females in the herd and 50 per cent calving rate, an average of 355 litres of milk per person per year or almost 1 litre per person per day would be available, if consumption were spread evenly throughout the year. However, this is not the case: during periods of highest production, the quantities of milk would be so great that a portion would have to be processed into a less perishable form and/or sold.

According to the survey made by the PDU among Dinka herds, the length of lactation is approximately 200 days and the milk yield about 1 litre per day after the calf has suckled (PDU 1978b, 18). Surveys by the Jonglei Investigation Team in 1954 and the UNDP research team in 1977 yielded similar figures for milk production per day but during a slightly shorter lactation period of 180 days (Payne & El Aimn 1978, 111). A rather high estimate of 2.5 litres of milk per cow per day excluding the calf's share was given by Grunnet (1962, 10). Based on PDU data, milk production from Dinka cows is about 200 litres per annum. If the average ratio of cattle to humans is 1.5:1, the portion of breeding females in the herds is 55 per cent on the average, and the calving rate is 50 per cent, then the milk yield per person per year would be 83 litres or less than one-quarter of a litre per day. If these figures are close to correct, the milk surplus in the Dinka economy would be small, if not non-existent.

Practically no data are available on the milk production of sheep and goats in the Baggara and Dinka flocks; this information would be necessary for a complete evaluation of food production from the traditional pastoral systems.

Both the Baggara and the Dinka pastoralists consume the blood from slaughtered animals. However, in addition to this, the Dinka draw blood from the jugular vein of living cattle. Milch cows, breeding bulls and suckling calves are not bled, but steers and dry cows represent a valuable source of high protein food, especially at times when milk production is low. Beef blood contains over twice as much protein per unit of volume than does cow's milk (Dyson-Hudson 1974, Table 4). Although promoters of 'modern' animal production have discouraged the practice of blood-letting, a 1976 survey conducted in the Jonglei area revealed that 'virtually all' Dinka still consume blood from living animals (Payne & El Amin 1978, 77).

Table 8: Productivity parameters in Baggara and Dinka cattle herds (with comparative data from beef properties in northern Australia)

Pastoral group	Baggara	Baggara	Dinka	Dinka	Australian	Australian
Location	Southern Darfur (Western Sudan)	Southern Darfur (Western Sudan)	Bahr el Ghazal and Lakes prov. (Southern Sudan)	Jonglei prov. (Southern Sudan)	Peninsula-Gulf and Inland North (Queensland)	Victoria River District (Northern Territory)
Source of data[1]	extensive survey	intensive survey of migratory herds	survey in Gogrial and Rumbek areas	extensive survey in Bor area	ABS/BAE/DPI statistics	DPP/BAE surveys
Calving rate (%)	50	65	50	55-65	55-65	52
Age of first calving (mo.)	n.a.	43	27-48	40-48	36	36
Herd mortality rate (%)	19	15	6	5	7	8
Birth weight (kg)	n.a.	19-23	n.a.	20	30	30
Daily weight gain to 6 months (g)	n.a.	255-375	n.a.	300	650	600
Total offtake rate (%)	16	15	9.5	10	16[2]	12.5[2]

[1] Southern Darfur: Wilson *et al.* 1980, Wilson & Clarke 1976, Wilson & Clarke 1975, Mukhtar 1961.
Bahr el Ghazal and Lakes provinces: PDU 1978b&d.
Jonglei province: Payne & El Amin 1978.
Peninsula-Gulf and Inland North: ABS 1976-79, BAE 1974b,Donaldson 1967, Boorman & Arthur 1978, Holroyd *et al.*1979.
Victoria River District: Robertson 1980, BAE 1974a, Winter 1981 (personal communication).

[2] Average for 1976-79.

No indication could be found in the literature than the output of cattle herds in terms of blood for human consumption has ever been measured. However, Dyson-Hudson (1974, 16) has made a rough calculation based on information which he and his wife collected among the Karimojong, a Nilotic pastoral people living south of the Dinka in Northern Uganda. Per 100 head of cattle, the productivity of a herd similar in structure to Dinka herds is increased by approximately 390 kg of blood per year.

The energetic efficiencies of blood production are not clear, although both Payne and El Amin (1978, 77) and Dyson-Hudson (1974, 14) agree that fodder conversion to blood is more efficient than is conversion to meat. What is more important for the food production system, however, is that blood can be extracted without causing ill-effects to the animals (Payne & El Amin 1978, 27)[7], it provides variety in the diet of the Dinka, and it is available at times of general food scarcity.

12 Attempts at evaluating efficiency in attaining production aims

Like most African national administrations, the government of the Sudan is eager to modernise pastoral production. However, attempts to introduce supposedly more productive techniques or systems cannot be justified until the would-be modernisers are capable of evaluating fully the existing system and proving that it is indeed less desirable than the proposed innovation.

The foremost aim of development planners is to increase the contribution of pastoral regions to the national economy, this contribution being seen in the limited sense of increasing the commercial offtake from the herds in order to provide more meat for domestic non-pastoral consumers and for export to earn foreign exchange. One means of achieving this aim is the replacement of the small-scale diversified subsistence production systems by large-scale commercialised monoculture - beef ranching. Higher production of beef for national and international markets may indeed be attained in this way, but other outputs presently provided by traditional pastoral systems would be lost. Moreover, under a system of commercial ranching, pastoral areas in Africa would not be able to support as many people as is now the case.

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[7] Dyson-Hudson (1974, 9) describes the practice of bleeding cattle as an energetically efficient way of utilising the capacities of the animals by 'siphoning off their growth in small amounts at need.' However, it appears that no scientific investigations have been conducted into the effect of bleeding on cattle in order to establish whether the loss of blood has any significant influence on their growth rates.

12.1 Efficiency of resource use

Ideally, the efficiency of resource use by a pastoral production system would be expressed as the ratio of effective output, say, in terms of energy, to total input measured in the same units.

Purchased inputs into traditional pastoral production systems are few, if not entirely negligible. Studies of labour inputs have been seldom and superficial, and lack of knowledge among non-pastoralists of the variety and intensity of labour demanded within the traditional pastoral economy renders even a rough estimate of labour inputs impossible.

The output side of the efficiency measure is a function of the type and intensity of herd use by African pastoralists, which has been shown to be varied and ingenious - to the extent that it has been recognised at all by Western researchers. In the foregoing attempt to give some indication of the productivity of traditional pastoral systems, only additions to herd capital and the production of meat, milk and blood have been mentioned. Yet total output of the herds also includes hides, dung, urine and energy from the cattle (for transport among the Baggara, also for drawing ploughs in other contemporary pastoral economies in Africa) as well as the varied output of small stock, to say nothing of the yields from cropping. Data on the degree to which the different animal products and services are used are scanty or non-existent. Estimates which have been made of the efficiency of pastoral production systems usually incorporate only those outputs which have been measured in some manner of speaking because they are important to commercial production.

In measures and comparisons of efficiencies, insufficient attention is paid to a question of immense importance in a world of finite natural resources but a rapidly growing population - the question of the intensity and efficiency of resource use.

Commercial ranching usually specialises in one product from one species of animal, e.g., beef from cattle. The traditional system of utilising pastoral resources in arid and semi-arid areas, combining animal species with different grazing requirements and behaviour in the herd of one pastoral group or sharing grazing land between pastoral groups using different species or breeds of animals, allows a higher overall stocking rate than does a system utilising only one species or breed of animal. People who live and migrate with their herds have greater opportunity to gain detailed knowledge of the characteristics and capacities of different types of grazing and can utilise them at optimal times of the year. Cropping activities of pastoral peoples and the integration of animal husbandry and cropping (stubble grazing, manuring of plots by night kraaling of animals) also increase the intensity of resource use beyond that possible under a system of monoculture.

Division of rangelands into individual ranches decreases the possibilities of utilising the natural resources efficiently. Holdings are likely to cover only one part of the vast and varied ecosystem necessary to maintain the present levels of productivity in pastoral systems, to achieve which some groups like the Baggara cover several hundred kilometres in their seasonal migrations.

Comparisons of productivity between proposed modern systems and existing traditional systems of pastoral production are commonly expressed in terms of beef production, instead of including all herd yields. All too often, production from African herds is mentioned in the same breath as production from commercial herds in climatically more favourable environments, even in temperate regions. In the preceding section on the productivity of Baggara and Dinka herds, data from commercial ranching areas of northern Australia climatically similar to Western and Southern Sudan were briefly presented for sake of comparison. Calculations of food production per hectare from livestock in these areas are presented in Table 9. These reveal that the production of beef *alone* is (in the Dinka system) almost as high or (in the Baggara system) considerably higher than in the Peninsula-Gulf region of North Queensland or in the Victoria River District of the Northern Territory. Yet, in the African systems, beef is a subordinate production aim, whereas it is the sole production aim of commercial ranching in tropical Australia.

If milk and blood production from cattle and meat production from small stock are included in the calculations (and these still do not cover the total output of the Baggara and Dinka food production systems), then the African systems emerge as at least twice as efficient and, in the case of Southern Darfur, several times more efficient than the tropical Australian system in terms of energy and protein production per unit area of land.

As support for the relatively high figures for Southern Darfur, even higher figures calculated by Jahnke (1974, reproduced in Ruthenberg 1976, 310) for the Karimojong production system in Northern Uganda (500-750 mm rainfall) can be quoted: 4.5 kg beef and 20 litres of milk per hectare, and this represents only the cattle portion of the Karimojong herds. Including the production of sheep and goats, the yield of animal protein per hectare land is higher in the Karimojong system than in the modern cow-calf systems of the United States (Krummel & Dritschilo 1977, 9).

The production of modern ranching systems is achieved using less labour per hectare and beast than in the traditional systems of more intensive management, but expenditures are high for such inputs as fencing, water bores, road vehicles and aircraft, fuel, mineral supplements, veterinary services and (admittedly only to a very limited extent in northern Australia) supplementary feeding and improved pastures.

Table 9: Food production per hectare from livestock herds in Western and Southern Sudan and in northern Australia

Location	HTS survey area W. Sudan	Bahr el Ghazal + Lakes prov. S. Sudan	Queensland Northwest/ Peninsula	Victoria R. District N.T.
A. Cattle production				
ha/beast[1]	5	10.5	22	23
% offtake	10 + 5	8	16	12.5
carcass wt. (kg)	100/135	125	170	170
kg meat/ha/yr[2]	2.68[3]	0.76	0.98	0.74
kg milk/ha/yr[4]	16.1	5.24	-	-
kg blood/ha/yr[5]	-	0.37	-	-
B. Sheep production				
ha/beast[6]	31	20	-	-
% offtake	28	13	-	-
carcass wt. (kg)	12.3	12		
kg meat/ha/yr[2]	0.08	0.06	-	-
C. Goat production				
ha/beast[6]	8.5	23.5	-	-
% offtake	28	36	-	-
carcass wt. (kg)	7.4	10	-	-
kg meat/ha/yr[2]	0.18	0.11	-	-
D. Total production of food energy and protein[7]				
kcal/ha/yr	20,299	6,750	2,920	2,205
g protein/ha/yr	1,090	380	176	133

[1] Wilson & Clarke 1976, 53; PDU 1978b,4 & 1978d,6, based on entire area of provinces (214,000 km^2; SBW 1978, 10), parts of which are permanent swamps inaccessible to cattle; Hall & Acutt 1978, 13; Robertson 1980, 8 (Australian figures based on total area of grazing properties in each region).

[2] Based on approximation that meat incl. fat makes up 80% of total carcass weight of cattle and 75% of sheep and goats (Bogner & Ritter 1976).

[3] Figure lower than 4.21 kg carcass meat/ha/yr calculated by Wilson & Clarke (1976, 53) because carcasses of animals for home consumption assumed to be lighter than those of marketed animals, and bone component is subtracted.

[4] (kg milk/cow/yr X % breeding females in herd X calving rate) ÷ ha/beast

[5] 390 kg blood/100 head of Nilotic cattle (Dyson-Hudson 1974, 16).

[6] Wilson & Clarke 1975, 176-9: PDU 1978b,4 & 1978d,6; area shared with other livestock species.

[7] Based on foodstuff composition according to Kirchgessner 1970, 88, and Dyson-Hudson 1974, Table 4, as follows:

Foodstuff	Beef	Cow's milk	Beef blood	Sheep meat	Goat meat
kcal/g	2.98	0.72	0.65	2.77	2.77
% protein	18.0	3.5	8.2	16.8	16.8

A comparison made by Jahnke (Ruthenberg 1976, 310) between traditional pastoral systems and a proposed ranching scheme (with very optimistic planning data) in Uganda reveals that even a system of ranching which may be more productive in terms of gross returns from the marketed output per unit of land would not be more productive in terms of income per unit of land. This is because the level of expenditure in ranching is so high relative to traditional pastoralism. Insofar as the cost of external inputs (e.g. fuel) rises in relation to the price of beef, the introduction of modern ranching could conceivably lead to a lower income per unit of land than presently achieved under traditional systems of land use.

Figures for output per unit of land presented in Table 9 refer to meat, milk and blood. Jahnke's income calculations are based on the production of milk, meat and hides from the cattle herds only. Neither attempt at evaluating efficiency of land use covers the full range of outputs from all animals kept in the traditional pastoral system. Nevertheless, these partial evaluations already suggest that, seen in terms of intensity of resource use, the introduction of ranching could represent a regression from the diversified economies which have prevailed in pastoral areas of Africa to a less intensive use of the limited resources available and to a reduction in total output from the ecosystem.

Dyson-Hudson (1974) has made an attempt to estimate the total production from East African pastoral systems in terms of calories for human food consumption, and has compared his estimate with calculations of theoretical primary productivity in dry areas. He comes to the conclusion that 'the present pastoral systems of East Africa are already supporting about as many people as can be supported by the primary productivity of the area they inhabit.' He ventures to assert that the traditional production systems are 'optimal: brilliant solutions for supporting the largest possible human populations for the longest stretches in these regions of marginal and fluctuating resources' (Dyson-Hudson 1974, 19).

12.2 Persons supported by the pastoral system

Modern production units in the livestock sector in countries like Australia and the United States of America are designed to be labour-saving: in order to produce large quantities of marketable meat from large herds of cattle on large properties only a small number of people are employed. In such countries where the indigenous land users were exterminated or driven off the areas desired for ranching and where pastoral labour is monetised, scarce and expensive, measurements of efficiency in terms of output per unit of labour may be appropriate.

However, considerations of minimising labour inputs should assume lesser importance in Africa, where large numbers of people depend on pastoralism for their income and survival.

In relation to the environment, traditional pastoral areas in Africa are probably carrying close to (and, in some cases, more than) the maximum animal and human populations capable of being supported. In making a comparison of modern ranching and traditional pastoralism in arid and semi-arid regions of Angola, Cruz de Carvalho (1974, 218) came to the conclusion that, unlike ranching, the traditional pastoral system can be classified as *intensive* because it allows a high density of both people and cattle. He asserts that the traditional system is the only one capable of maintaining the present population densities in these areas. According to his calculations, the human biomass supported on modern ranches in Angola is less than one-third that under the traditional system (Cruz de Carvalho & Vieira da Silva 1973, 162). The introduction of ranching eliminates the dairy and cropping aspects of production and forces a large proportion of the population to leave the area.

The traditional system is designed to keep the maximum number of people alive in pastoral areas. By contrast, the commercial ranching system must try to keep the subsistence requirements within the production system to a minimum, so that the largest possible marketable surplus can be extracted. Most of the produce from traditional forms of production is used to meet subsistence requirements within the system. It was shown previously that the differences in meat offtake from Baggara herds in the Sudan and commercial ranches in climatically similar parts of northern Australia are not great in terms of percentage of total herd number. However, only 2-3 per cent of total offtake in North Queensland and 4-5 per cent of total offtake in the Northern Territory is consumed within the system, i.e., slaughtered on the property to provide meat for the labour force (ABS 1976-79; Shields 1979), whereas about 65 per cent of the offtake for meat from Baggara herds is consumed by the pastoralists themselves (Wilson & Clarke 1976).

The 1975 ILO Employment Mission to the Sudan estimated that, if attempts were made to absorb the present pastoral population into commercial ranches covering the same area, more than half of the people presently occupied with and living off the herds would be displaced (Haaland 1976b, 241). Even if only isolated ranching schemes were set up on select areas which lie within the wider ecosystem utilised by the traditional pastoralists, these people and their herds would be confined to a smaller area of range and denied access to specific (often, better-watered) areas essential to the traditional seasonal migrations. The remaining area would no longer be sufficient in size or quality to support all of the traditional pastoralists excluded from the ranching scheme, and many would have to leave and seek a source of livelihood elsewhere.

The development of commercial livestock production involving the acquisition of individual land rights and prevention of access by the original land users would favour only a small section of the pastoral population, most likely those who have extricated themselves from the traditional network of social obligations and have learned to take advantage of the introduced economic system in order to increase their private wealth and influence. While incomes are being concentrated in the few large enterprises of these people, the majority - and the poorest - of the original pastoralists would lose their means of subsistence and be reduced to 'proletarianized herdsmen working for local capitalist ranchers' (Dahl & Hjort 1979, 32) or be forced to leave the area entirely. Those displaced from subsistence herding may have been highly skilled for pastoral activities but they are untrained for work in other sectors of the national economy and are therefore likely to become part of the growing masses of unemployed on urban peripheries.

In summary, the introduction of commercialised ranching would break down the traditional welfare system which ensured a relatively equitable distribution of income (means of survival) among a large number of people. It would promote the growth of inequalities in income and wealth before new welfare institutions can be established which function as efficiently as those in the traditional system. Moreover, it would displace a large number of people who had been self-employed, before sufficient work places have been created in industry and other sectors of the modern economy to absorb the 'surplus' population - and it is highly questionable whether sufficient employment will ever be able to be generated in the capital-intensive modern sector to absorb all persons seeking a source of livelihood.

Conclusions

The traditional system of pastoral production in Africa was ecologically adapted to the utilisation of sparse and fluctuating resources. The relative success and stability of the system can be judged according to its longevity: according to recent archeological findings, pastoralists have inhabited the East African ecosystems for millenia (Western 1974, 24). The response of traditional pastoralists to the intrusion of alien technologies and values has been rational within the context of the indigenous economy, but has resulted in serious imbalance between the environment and the human and animal populations, because the new technologies and economy have so radically changed the framework of production.

Before further attempts at 'improving' animal production are made, it must be established whether contemplated innovations represent an improvement upon the present techniques or system of production, or whether the result will be yet greater disequilibria. Moreover, concepts of what constitutes 'improvement' must be based on the needs of pastoral peoples in Africa rather than on Western theories of economic efficiency which is ultimately determined by buying power, i.e., by the relatively wealthy in society. For example, in promoting the introduction of commercial ranching, modernisers argue that it is necessary to increase the marketed output of meat from the African rangelands and that surplus labour in the traditional livestock-keeping societies must be siphoned off to be more productively employed in the modern sector of the economy. However, the higher levels of productivity in terms of marketed output achieved by the introduction of beef ranching would probably mean lower levels of total productivity from the ecosystem, which would not be able to support as many people as under the traditional system. Not all of the 'surplus' population would have the opportunity to be productive in the modern sector, which would be incapable of absorbing the majority of pastoralists deprived of their livelihood by the introduction of capital-intensive, labour-saving techniques in animal production.

Conventional Western measures of productivity and techniques of increased productivity must be reappraised in the light of differences in values and resource availability in the pastoral areas of Africa. Traditional pastoralists have developed production systems which are superior to commercial ranching systems in efficiency of resource use and in the number of people able to derive sustenance from the system, largely by virtue of the mobility, flexibility and livestock diversity in the traditional system. Their proven ability to adapt to extremely difficult conditions and to derive relatively high outputs with minimal inputs in marginal environments renders the African pastoralists best qualified to determine how their use of rangelands can be improved. They have already

exhibited readiness to accept changes which alleviate limitations in their production systems, for example, in purchasing veterinary medicines and services; and their production systems are becoming increasingly market oriented. The problems which exist in many pastoral areas today - e.g. regulation of communal land use, and establishment or evolution of insurance and welfare systems to accommodate altered social and economic conditions - are probably even more obvious to the pastoralists than to outside observers. Government action should be concentrated on supporting pastoralists in their efforts to solve these problems.

It is arrogant and dangerous for non-pastoralists to make recommendations and initiate programmes for improving or replacing traditional pastoralism until the present complex systems of rangeland use have been fully comprehended and the likely effects of proposed changes can be realistically appraised. To this end, there is an urgent need for detailed studies of the production techniques, productivity and potential of the various indigenous pastoral systems presently operating in Africa.

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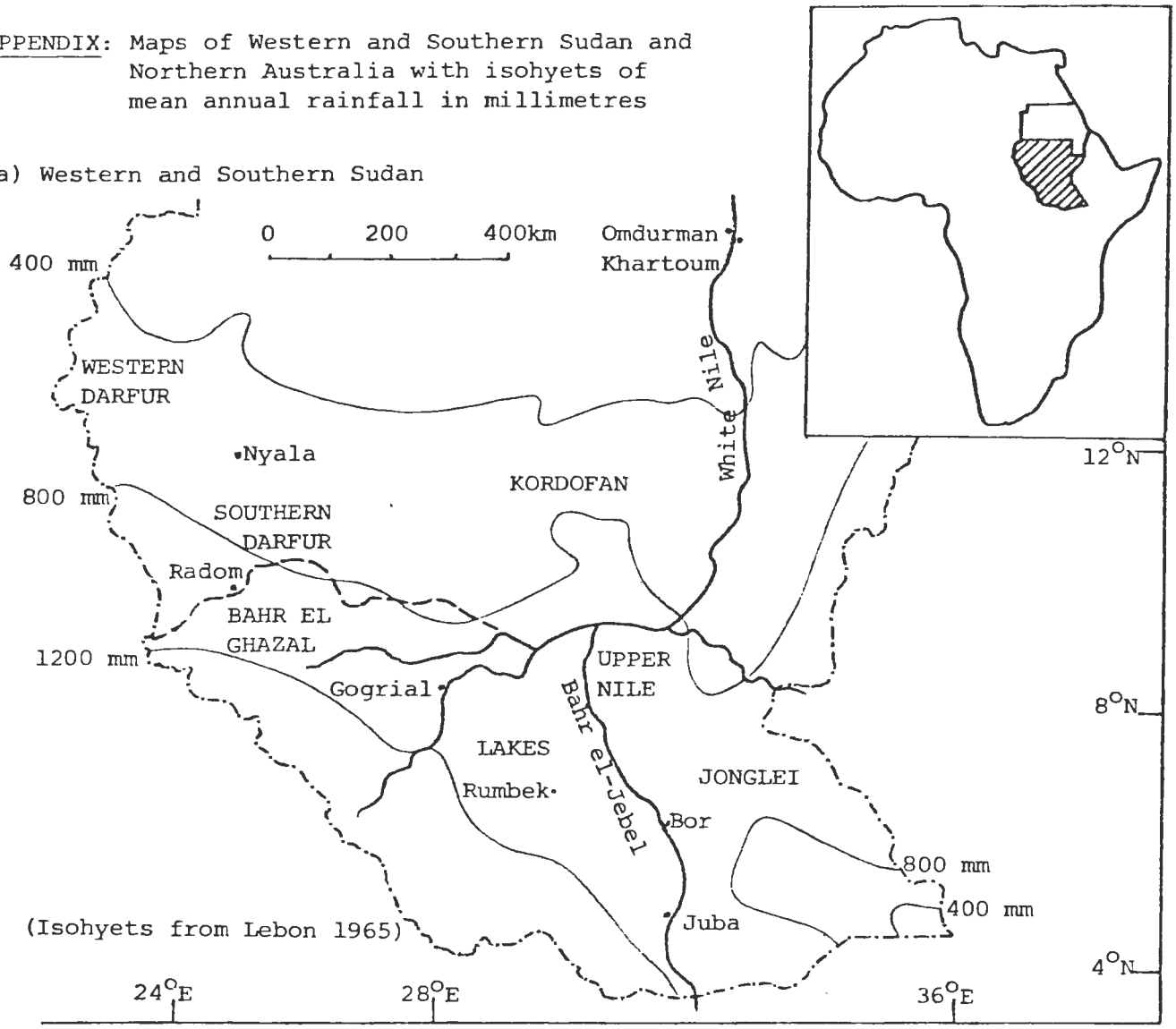
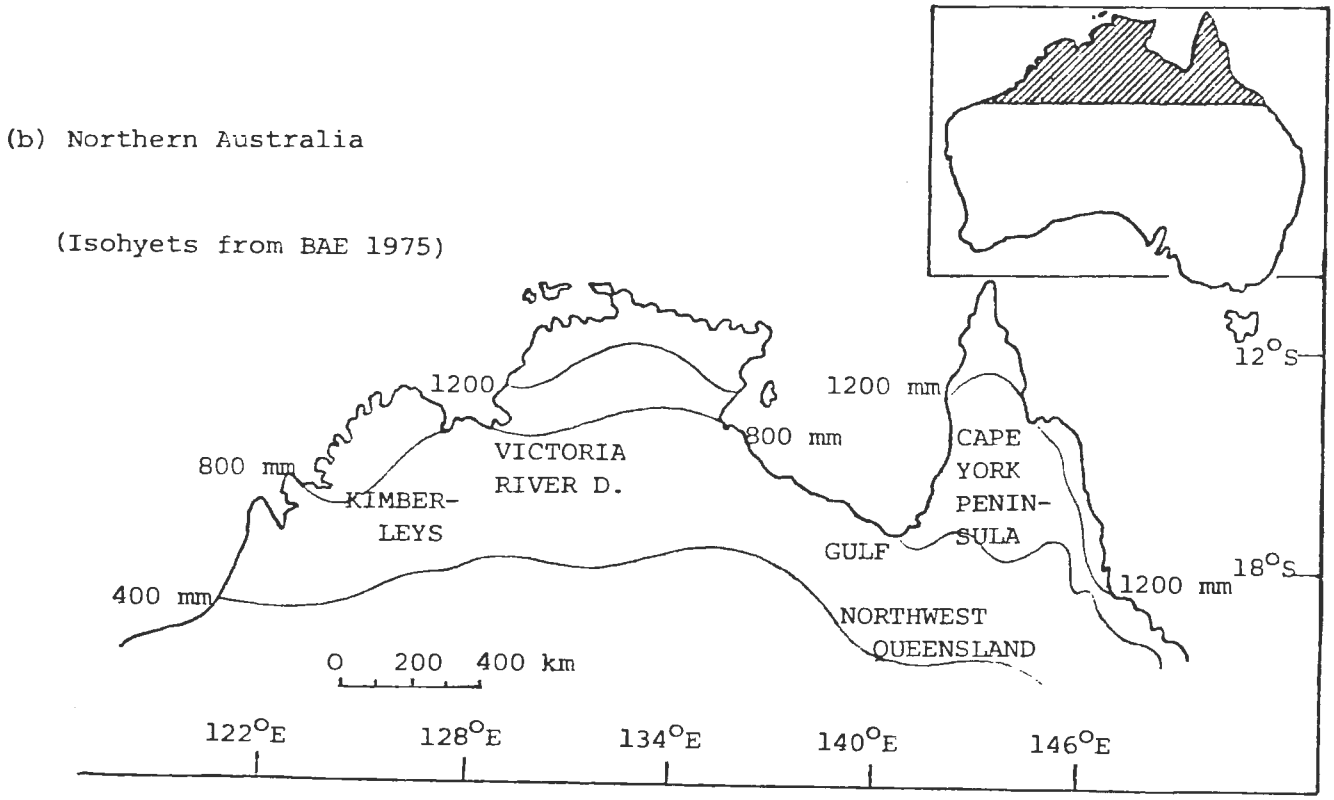
APPENDIX: Maps of Western and Southern Sudan and Northern Australia with isohyets of mean annual rainfall in millimetres

(a) Western and Southern Sudan



(Isohyets from Lebon 1965)

(b) Northern Australia



(Isohyets from BAE 1975)