ILCA
SYSTEMS STUDY 4

Maasai herding

An analysis of the livestock production system of Maasai pastoralists in eastern Kajiado District, Kenya

Edited by

Solomon Bekure
P.N. de Leeuw
B.E. Grandin
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Correct citation: Solomon Bekure, de Leeuw P N, Grandin B E and Neate P J H (eds). 1991. *Maasai herding: An analysis of the livestock production system of Maasai pastoralists in eastern Kajiado District, Kenya.* ILCA Systems Study 4. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 172 pp.

ISBN 92-9053-176-2

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Acknowledgements

Many people contributed directly and indirectly to this study and the preparation of this document and it is impossible to acknowledge them fully in this limited space. However, we would like to acknowledge the contributions of some key people

We are grateful to P. Sihm and Professor N. Dyson-Hudson for initiating the study in 1980 and for convincing both the ILCA management and the officials of the Kenya Ministry of Agriculture of its importance. Professor Dyson-Hudson participated actively in the design of the study and some of the early anthropological investigations. We would like to thank D. Pratt and L. Ayuko for their keen interest and staunch support. We are indebted to Professor C. Spedding, Professor G. Sorbo, B. Nestel and A. Provost, members of the Programme Committee of the ILCA Board of Trustees during the study period, and to P. Brumby for their encouragement and professional guidance throughout the study.

The leader of the study team was Solomon Bekure. The research responsibilities for the study were as follows:

- P.P. Semenye supervised the general animal science work in Olkarkar and Merueshi, assisted by T. Ole Tukai and E. Rugema
- C.P. Peacock supervised general animal science work in Mbirikani
- B.E. Grandin supervised the collection of socio-economic data on Olkarkar, assisted by P. Lembuya and E. Timpaine
- M. de Souza, F. Chabari and E. Kirruti collected socio-economic data on Merueshi
- I.K. Ole Pasha and C.P. Peacock supervised the collection of socio-economic data on Mbirikani, assisted by M. Ole Maki, P. Ole Muriet, D. Ole Ntinbany, S. Ole Ntawuasa, T. Ole Naroki, D. Ole Salonik and J. Ole Oloipunyi
- Solomon Bekure supervised the marketing studies, assisted by F. Chabari
- P.N. de Leeuw supervised the ecological and rangeland components of the study, and was assisted by P. Chara and E. Wachira
- J.C. Bille and Assefa Eshete conducted the preliminary ecological survey of the group ranches; P.N. de Leeuw and J.M. King were primarily responsible for the aerial surveys
- P.P. Semenye conducted intensive field studies on cattle
- C.P. Peacock conducted intensive field studies on small stock
- P. Nestel studied maternal and child nutrition and health
- The animal health investigation was a collaborative effort between ILCA and the Veterinary Research Department of the Kenya Ministry of Agriculture and Livestock Development; S. Chema, Head of the Department, actively supported and stimulated our work. S. Waghella, A. James and C. D'Souza participated in the design of the study and the analysis of the animal health data. C. Ndarathi and Odongo conducted and supervised the field work, with assistance from E. Rugema and V. Musawa.

The study team is indebted to the ILCA headquarters Computing and Biometrics Unit for their support. R. Sayers provided statistical advice on the sampling design for the field surveys and helped process and analyse the livestock marketing and part of the household economics data. J. Durkin and D. Light assisted in the processing and analysis of the livestock and ecological data. E. Kontrohr helped analyse much of the socio-economic data. Additional computing and graphic assistance was provided by R. Nyambaka of ILCA/Kenya.

We would like to thank the administrative staff of ILCA/Kenya for their support. We would like to particularly acknowledge the painstaking word processing of R. Sokoto, A. Kiura and P. Kagunda. We are grateful to Linda Ole MoiYoi for her editorial assistance and patience.

Finally, this document would not have been possible were it not for the excellent cooperation of the Maasai pastoralists in Olkarkar, Merueshi and Mbirikani group ranches. We admire their patience and tolerance in allowing us to interfere in their daily lives by our interviews, weighing and bleeding of their livestock and collection of a host of other samples. We would like to express our profound gratitude to the members of the group ranches and to their chairmen, M. Ole Kenayia, M. Ole Hamisi and T. Ololoshukoki, for their warm friendship and tolerance. We sincerely hope that they will derive some good from the findings reported herein.

This document was reviewed by J. Lambourne, J. Helland, S. Sandford and L. Coppock, to whom we are most grateful. None of them, needless to say, is responsible for any errors remaining or the views expressed herein.

Solomon Bekure
P.N. de Leeuw
Barbara E. Grandin

Preface

Between 1965 and 1980 more than US$ 650 million were spent on livestock development projects in sub-Saharan Africa, yet progress was disappointing (ILCA, 1980). The reason for this generally poor performance was that livestock development projects in the rangelands were commonly planned, designed and implemented without sufficient knowledge of the dynamics of the livestock production systems they were supposed to improve (ILCA, 1980).

Western "experts" were largely responsible for preparing these projects: with their backgrounds in ranching, they took it for granted that beef production was the most appropriate mode of livestock production in arid and semi-arid rangelands and designed projects to increase the marketable surplus of beef from pastoral production. Milk production, a major goal of pastoralists, was largely ignored. None of the projects had a major focus on improving the productivity of small ruminants or camels. Hence, little attention was given to making the pastoralists' subsistence production system more efficient. It is thus not surprising that little information was collected on the productivity of pastoral cattle and sheep and virtually none on goats and camels (Widstrand, 1975).

Livestock development projects were largely processes of trial and error. As Eicher and Baker (1982) noted, "Research on the behaviour of livestock herders in Africa is about at the same point where research was on the economics of crop production some 20 years ago... many assertions and sparse supply of facts." Dahl and Hjort (1976) emphasised that in the absence of detailed productivity data "many thousands of nomads are the objects (and victims) of reforms and programmes based on unfounded theories rather than first-hand knowledge."

After sponsoring a workshop on the design and implementation of livestock development projects in 1980, ILCA decided to conduct an in-depth interdisciplinary study on a particular pastoral production system. The objectives of this endeavour were to provide a quantitative and qualitative description of the production system in order to clarify causal relations among its components and provide information that would facilitate:

- identification and analysis of the constraints that limit the output of the system
- evaluation of the impacts of possible alternative interventions or strategies of resource exploitation
- improvement of the design of future development projects as well as evaluation of their impacts on the production system.

Kenya was selected for this in-depth study because it offered a wide range of pastoral systems, differentiated largely by environmental, cultural and historical factors. The Maasai in Kajiado District were selected because of their easy accessibility and relatively better production potential. Maasailand had also been the site of various development activities under Phases I and II of the Kenya Livestock Development Project (KLDP), which would allow observation of the effects of development efforts on a traditional production system. Finally, ILCA had already begun gathering information on Maasai livestock production so that new efforts could be built on the information obtained and analyses carried out in previous years.

After extensive discussions with officials of the Kenya Ministry of Livestock Development, who had intimate knowledge of Kajiado District, an area of about 1600 km^2 in the Kaputiei and Kisongo Sections was chosen. This study area, lying between longitude 37°30' and 37°50'E and latitude 2°10' and 2°40'S, covered three group ranches: Olkarkar, Merueshi and Mbirikani. The study involved an interdisciplinary team of scientists in animal production, veterinary science, range ecology, economics and sociology. This report synthesises the results of their research among the pastoral Maasai.

Although the research results and analyses reported in this volume pertain to the Maasai livestock production system, many of the features and the dynamic processes and problems described and the solutions suggested may be applicable to other pastoral livestock production systems in Kenya and in other African countries.

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Chapter 1

Introduction

Solomon Bekure and B E Grandin

1.1 An outline of the study

This chapter gives a brief description of a pastoral production system, as envisaged by the study team. It also outlines the multi-disciplinary approach of the study, its sampling design and the data collected.

Chapters 2 and 3 describe Kenya's biophysical and socio-economic environments, within which the Maasai livestock production system operates. The biophysical environment of the study site is described in detail in Chapter 4. Chapter 5 describes the social organisation of the Maasai and how it affects their use of livestock and grazing resources. The division and specialisation of labour by age and sex classes are described in Chapter 6. The short-term productivity of Maasai cattle, sheep and goats is analysed in Chapter 7 using the data recorded during 1981–84.

Chapter 8 analyses how the Maasai used their livestock and how this determined the mix of species, sex and age of the livestock they kept. It also analyses the pattern of food and non-food consumption and the resulting patterns of cash income and expenditure. Chapter 9 presents an economic analysis of the short-term livestock production of the Maasai. First short-term costs and returns of Maasai livestock production are analysed, as observed during the study period. Subsequently, the operation of the regional livestock market and its links with the pastoral hinterland and the final livestock markets are described and the efficiency analysed. Finally, the historical terms of trade of the pastoral Maasai and how they have affected their welfare is discussed.

The results and analyses presented in Chapters 4 to 9 were based on observations and measurements between 1981 and 1985. Most of the livestock productivity parameters were measured between 1981 and 1983. Conditions were favourable for livestock production during this period. The amount and distribution of rainfall were better than average. Both the primary productivity of the range and the livestock population were relatively high. Consequently, the levels of livestock production achieved by the Maasai during the study period were higher than average. Simulation models were therefore used to relate the observed productivity to enormous fluctuations in rainfall and productivity of the East African rangelands. The models to simulate the long-term productivity of the system used long-term records of rainfall for the area. The results of this analysis are presented in Chapter 10. Finally, the major problems which confront the Maasai and some suggested solutions are presented in Chapter 11.

1.2 Schema of a pastoral production system

Pastoral societies are composed of autonomous family production units or households[1], the size of which is determined by the labour needed to manage the herds and flocks that support the household (Dahl and Hjort, 1976). These households compete for pasture and water; the more livestock a household has the larger the part of the common resources it exploits. However, in other ways the pastoral households cooperate. In the past they organised to fend off aggression or to wage war to acquire more resources. In times of stress they cooperate to assist less-fortunate households by giving them food and by giving and loaning them animals. Individual households are thus the basic units of pastoral production, and their production activities, decisions and interactions with society and the environment were the focus of the study reported here.

Each pastoral producer manipulates the resources under his control to provide subsistence for his household and ensure its viability during periods of drought. If he succeeds he increases his social status and may accumulate wealth and gain prestige. The household's livestock are thus the basis of its material and social well-being.

Livestock are also an important medium of social exchange. A pastoralist with many animals can be generous to his friends and relations, giving them animals during ceremonies, when they are ill, or purely as a sign of friendship. He can help

1. A household is here defined as an independent male producer and his dependants.

poorer households by giving or lending them animals. A man with many animals can afford to marry more wives and have more children. He can also take in impoverished friends or relatives as dependants, adding to his prestige and his labour force. Maasai say a successful man is like a tree on a hot sunny day; he shelters many people under his shade.

Pastoral households interact with each other through a whole complex of livestock and resource management activities. The inter-household interactions begin with encampments (*bomas*), and grow into larger units of neighbourhoods, clans, sections and tribes. Modern governments have supplanted much of the traditional social and warrior organisations of the Maasai.

A primary livestock production goal for the Maasai is to produce milk for consumption by the household. Little milk is sold. Animals are sold for cash primarily to buy subsistence goods, services and production inputs. Cash may also be lent or given to relatives and friends as part of social transactions.

The productivity of a pastoral livestock production system depends largely on animal management, availability of water and the distribution, productivity and quality of forage. Forage and water resources are largely determined by the geomorphology and soil types of the grazing area, altitude and rainfall. Of these, rainfall has the greatest effect on forage production. The amount and distribution of rainfall received in East African rangelands vary widely between seasons and years. This results in large fluctuations in forage productivity, and hence in livestock productivity.

This study concentrated on the production activities and decisions of pastoral Maasai households. However, it also considered the households' interactions with the socio-economic and bio-physical environments to elaborate the extent to which these affect producers' strategies and the welfare of the Maasai in the study area.

1.3 Research methods

1.3.1 Interdisciplinary approach

Rangeland livestock production systems are complex and involve biotic and abiotic environments, livestock and human populations, and the socio-economic framework within which they operate. Such systems can be understood only if all these aspects are studied. This requires a team of scientists from various disciplines working together to develop a comprehensive picture of the system. The disciplines covered by the team involved in this study were animal production, range ecology, agricultural economics and anthropology.

1.3.2 Producer heterogeneity and sampling design

The household is the basic unit of production and decision-making in Maasai society, and was chosen as the unit of analysis for this study. Surveys were carried out in 1980 and early 1981 to determine the human and livestock populations of the three group ranches.

The surveys identified 42 households in Olkarkar, 36 in Merueshi and 46 in the north-eastern portion of Mbirikani. Initially, only this part of Mbirikani was included in the study because it was the only part considered to be ecologically similar to Olkarkar and Merueshi. This ecological homogeneity would have increased the assurance with which any observed differences in production parameters could be attributed to management factors rather than environmental factors. However, we later discovered that, unlike the pastoralists in Olkarkar and Merueshi, the pastoralists in Mbirikani were not sedentary: they moved their livestock to areas outside their ranch boundary during severe dry periods. The survey was therefore later extended to cover the rest of Mbirikani to enable a comparison to be made between pastoralists over a larger range of mobility and covering a wider spectrum of ecological conditions from semi-arid to arid. The data collected in these surveys are summarised in Table 1.1.

The distribution of livestock holdings[2] among households was highly skewed (Figure 1.1). Half of the households owned only 10% of the cattle, while the richest 20% of households controlled 60% of the cattle. Smallstock were slightly more evenly distributed, but accounted for only 10% of the livestock biomass. Thus, there is an enormous wealth disparity among pastoral households.

Sutter (1987) reported that very few studies in the last 30–40 years have focused on differences

2. Livestock holdings here refer to the number of animals under the management of the household. These included livestock not owned such as those borrowed or allocated but not transferred to sons living independently in bomas other than those in which their fathers resided.

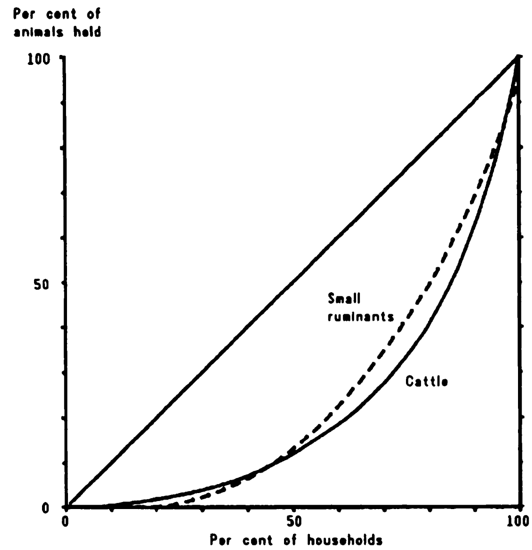
Table 1.1. *Size and population of Olkarkar, Merueshi and Mbirikani group ranches.*

	Olkarkar	Merueshi	Mbirikani	Total
Size (ha)	10 208	18 296	135 000	163 504
Registration year	1970	1970	1981	
No. of registered members[1]	64	61	932	1057
No. of households	42	36	206	284
No. of cattle (head)	3 952	4 343	37 000[a]	45 295
No. of sheep (head)	1 100	2 226	11 400[a]	14 726

[1]The number of registered members is greater than the number of households because all Maasai, including those away living in urban areas, who can claim membership in the ranches as a birthright were registered as members.

[a]Estimated from the ILCA inventory of 101 households.

Figure 1.1. *Distribution of ownership of cattle and small ruminants among households on Olkarkar, Merueshi and Mbirikani group ranches, 1980/81.*



in livestock ownership and wealth, despite the importance of these differences for understanding change. Development efforts have too often been aimed at pastoralists as if they were a homogeneous group.

Differences between households in the size of their livestock holdings can cause differences in producer behaviour and production strategies. To allow for this households were separated into three wealth classes using a wealth index. The wealth index chosen was a ratio of animals to people in each household, because livestock are a proxy for wealth in pastoral society. Livestock holdings were converted to Tropical Livestock Units (TLUs), where 1 TLU equals 250 kg liveweight. The unit used for people was the Active Adult Male Equivalent (AAME), a measure of human food energy requirements based on standards established for people in Africa by FAO (1974). The wealth index was thus the ratio of total TLUs to total AAMEs (TLU/AAME) in each household.

The three wealth classes to which households were allocated were: poor (<5 TLU per AAME); medium (5–12.9 TLU per AAME); and rich (≥13 TLU per AAME). These wealth classes also relate to the scale of production of the households, and can also be referred to as small-scale, medium-scale and large-scale producers.

Sample sizes that allowed detection of differences equal to or greater than the expected coefficient of variation (for $p = 0.05$ using a two-tailed test) were determined for each wealth class on each ranch (Table 1.2).

The average holdings per household in each wealth class varied across the three group ranches (Table 1.3). Average holdings of poor and medium-wealth producers in Mbirikani were significantly larger than those in Olkarkar and Merueshi. On the other hand, the average livestock holdings of the large-scale producers in Merueshi were twice those in the other two ranches. However, in each ranch, rich households had 8 to 10 times as many cattle as poor households, and five times as many as smallstock. Poor households have more smallstock than cattle, whereas rich households have more cattle than smallstock. The middle class tends to lie between the two. As will be made clear in Chapters 7, 8 and 9, rich and poor producers have qualitatively different problems in livestock management and in family provisioning. Rich households are thus not just larger versions of poorer households.

1.3.3 The north–south difference

The study area varied environmentally, culturally and infrastructurally from north to south.

Table 1.2. *Distribution of households among wealth classes on Olkarkar, Merueshi and Mbirikani group ranches.*

		Number of households							
		Olkarkar		Merueshi		Mbirikani[1]		Total	
Wealth class	TLU/AAME[2]	N[3]	S[4]	N	S	N	S	N	S
Poor	0–4.99	15	8	10	6	11	6	36	20
Medium	5–12.99	12	7	22	12	18	8	52	27
Rich	≥13	15	9	4	3	17	10	36	22
Total		42	24	36	21	46	24	124	69

[1]North-eastern Mbirikani only.

[2]TLU = tropical livestock unit of 250 kg liveweight. AAME = active adult male equivalent.

[3]All households.

[4]Sample households.

Table 1.3. *Distribution of livestock among households of different wealth class[1] on Olkarkar, Merueshi and Mbirikani group ranches.*

	Olkarkar			Merueshi			Mbirikani		
Average holdings	Poor	Medium	Rich	Poor	Medium	Rich	Poor	Medium	Rich
TLU[2]	29	62	272	32	79	558	37	120	240
Cattle	29	59	299	34	84	652	40	144	288
Smallstock	51	132	232	39	96	158	53	106	208
Smallstock-to-cattle ratio	1.8	2.2	0.8	1.2	1.1	0.2	1.3	0.7	0.7

[1]Poor = <5 TLU/AAME; medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[2]TLU = tropical livestock unit of 250 kg liveweight.

The amount of rainfall received by the two northern ranches (Olkarkar and Merueshi) is greater and less variable than that at Mbirikani, the southern ranch. Olkarkar and Merueshi are thus able to support higher stocking rates and human population densities than Mbirikani.

The northern and southern parts of the study area are occupied by different Maasai subtribes. Olkarkar and Merueshi are occupied by the Kaputiei subtribe; Mbirikani is occupied by the Kisongo subtribe. The Kaputiei live along the Nairobi–Mombasa road and their grazing territory formerly reached as far as Nairobi. They have thus had much more exposure to outside influences, and describe the Kisongo as primitive and backward. The Kisongo are known for their high degree of sociability, which might be related to the harsher environment they live in. They have been less exposed to outside influences. The Kisongo think that the Kaputiei are not "true" Maasai because they are not sufficiently sociable or generous. The Kisongos live in larger *bomas*, cooperate more in herding, and take off a much greater proportion of livestock through social channels than the Kaputiei.

The northern and southern areas differ in their access to livestock markets. The main road to Mombasa and Nairobi runs through Olkarkar and generates a demand for meat, especially goat meat. All three group ranches market most of their cattle through Emali, which is closer to Olkarkar than to the other ranches. Thus producers in the north of the study area, especially those on Olkarkar, can market their animals directly, whereas producers in Mbirikani usually use intermediate traders.

1.3.4 Scope of data collection

Both extensive and intensive studies were made. The extensive studies involved regular observation, interviews and recordings in all household samples. Data were recorded by trained enumerators working under field supervisors, who were in turn supervised by the scientists. The intensive studies were carried out by the scientists themselves. These studies covered fewer households or herds and sites and provided detailed information that complemented the data obtained through the extensive studies.

Productivity studies covered 678 cows, 501 ewes and 741 does and their respective offspring. Calves were tagged before they were 1 month old, and were weighed each month until weaning and again at 18 months old. Milk offtake from cows was measured once a fortnight during the evening milking and again during the following morning milking. Kids and lambs were weighed monthly until 18 months old.

At the beginning of the study a sample of 5100 cattle, 2700 sheep and 2300 goats belonging to the sample households was classified by breed, sex, age, coat colour and weight to characterise herd and flock structure (King et al, 1984).

Five aerial surveys were conducted in 1982 to determine the distribution of domestic stock and wildlife and assess the extent of grass cover in the study area. The quality of feed in cattle diets was recorded using oesophageally fistulated cows. Forage and herbage samples were taken regularly during the dry and wet seasons to determine primary productivity. Veterinarians examined about 1000 cattle and 1000 smallstock, and took samples of blood and faeces from some of them, to determine the incidence of animal diseases. Tick burdens were assessed and ticks were collected and identified (Chapter 7).

Heads of households were interviewed about the movement and management of their herds and flocks (Chapters 5 and 6). Allocation of labour and the tasks performed by each member of the sample households were recorded every 2 weeks for the first 14 months of the study (Chapter 6). All adult members of households were interviewed monthly for 2 years to determine their income, expenditure and livestock transactions (Chapter 8). Nutrition studies in 1982–83 examined dietary patterns of mothers and children on all ranches (Chapter 8). The supply of and demand for cattle at the Emali market were monitored at least once a month from 1981 to 1984; types of animal on offer, the price paid for them and their destination after sale were recorded (Chapter 9).

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Chapter 2

Introduction to the Kenyan rangelands and Kajiado District

P N de Leeuw, B E Grandin and Solomon Bekure

The Kenyan rangelands support a wide range of livestock production systems. Differences between the systems arise from the interaction of many factors, including the biophysical environment, tribal differences, population density, level of economic development and incorporation into the market economy. This chapter briefly reviews some of these factors as they relate to current livestock populations and production strategies in the Kenyan rangelands, with particular emphasis on pastoralists. It places the Maasai in a broader context and assesses their importance to livestock production in Kenya. It also briefly describes the climate, physiography, animal populations and infrastructure of Kajiado District, the focus of this study.

2.1 Agroclimatic zones and livestock-carrying capacity

Relationships between climate, vegetation and land-use potential have long been used to assess the suitability of land for different uses[1]. The major elements of climate that affect herbage growth are the intensity and duration of rainfall, the ratio between annual rainfall and potential evaporation, and the year-to-year variation in rainfall.

Kenya has been divided into seven agroclimatic zones using a moisture index (Sombroek et al, 1982). The index used is annual rainfall expressed as a percentage of potential evaporation (E_o). Areas with an index of greater than 50% have a high potential for cropping, and are designated zones I, II and III. These zones account for 12% of Kenya's land area. The semi-humid to arid regions (zones IV, V, VI and VII) have indexes of less than 50% and mean annual rainfall of less than 1100 mm. These zones are referred to in this chapter as the Kenyan rangelands and account for 88% of Kenya's land area (Table 2.1; Figure 2.1).

Table 2.1. *Moisture availability zones in the Kenya rangelands.*

Zone	Classification	Moisture index (%)	Annual rainfall (mm)	Per cent of Kenya's land area
IV	Semi-humid to semi-arid	40–50	600–1100	5
V	Semi-arid	25–50	450–900	15
VI	Arid	15–25	300–550	22
VII	Very arid	< 15	150–350	46

Source: Sombroek et al (1982).

The seven agroclimatic zones are each subdivided according to mean annual temperature to identify areas suitable for growing each of Kenya's major food and cash crops (Jaetzold and Schmidt, 1983). Most of the high-potential areas are located above 1200 m altitude and have mean annual temperatures of below 18°C; 90% of the semi-arid and arid zones lie below 1200 m and have mean annual temperatures ranging from 22° to 40°C.

Estimates of livestock-carrying capacity are usually derived directly from rainfall parameters or are linked to productivity of the vegetation (primary production). Several relationships based on annual rainfall have been proposed (Figure 2.2). According to these, average livestock carrying capacity increases from about 7 ha/tropical livestock unit (TLU)[2] in the south of Kajiado District (average annual rainfall of 300 mm) to about 3 ha/TLU in the north (average annual rainfall of 550 mm)[3]. More detailed information on carrying ca-

1. See Pratt and Gwynne (1977) and Sombroek et al (1982) for reviews.
2. A tropical livestock unit is equivalent to 250 kg liveweight.
3. The relationship between median rainfall (MR, mm) and net primary productivity (NPP, kg DM/ha) is:
   $NPP = -1000 + 7.5\ MR$
   Carrying capacity is calculated by assuming that only 33% of the NPP is consumed by livestock, which gives a daily herbage allowance of 20 kg DM/TLU per day. For further details on safe stocking rates and herbage allowance, see sections 4.4.3: *Carrying capacity* and 10.1.1: *Fodder resources*.

pacity in the ILCA study area is given in Chapters 4 (*The study area: Biophysical environment*) and 10 (*The long-term productivity of the Maasai livestock production system*), which discuss short-term and long-term trends in seasonal rainfall and the resulting fluctuations in grazing resources, carrying capacity and safe stocking rates.

While the daily management of herds and flocks aims at satisfying the immediate requirements of livestock for feed and water, longer-term strategies of grazing management are closely linked with the longer-term variations in the forage supply (See Section 5.3: *Water utilisation, grazing patterns and stocking rates*).

Figure 2.1. *Agroclimatic zones in Kenya.*

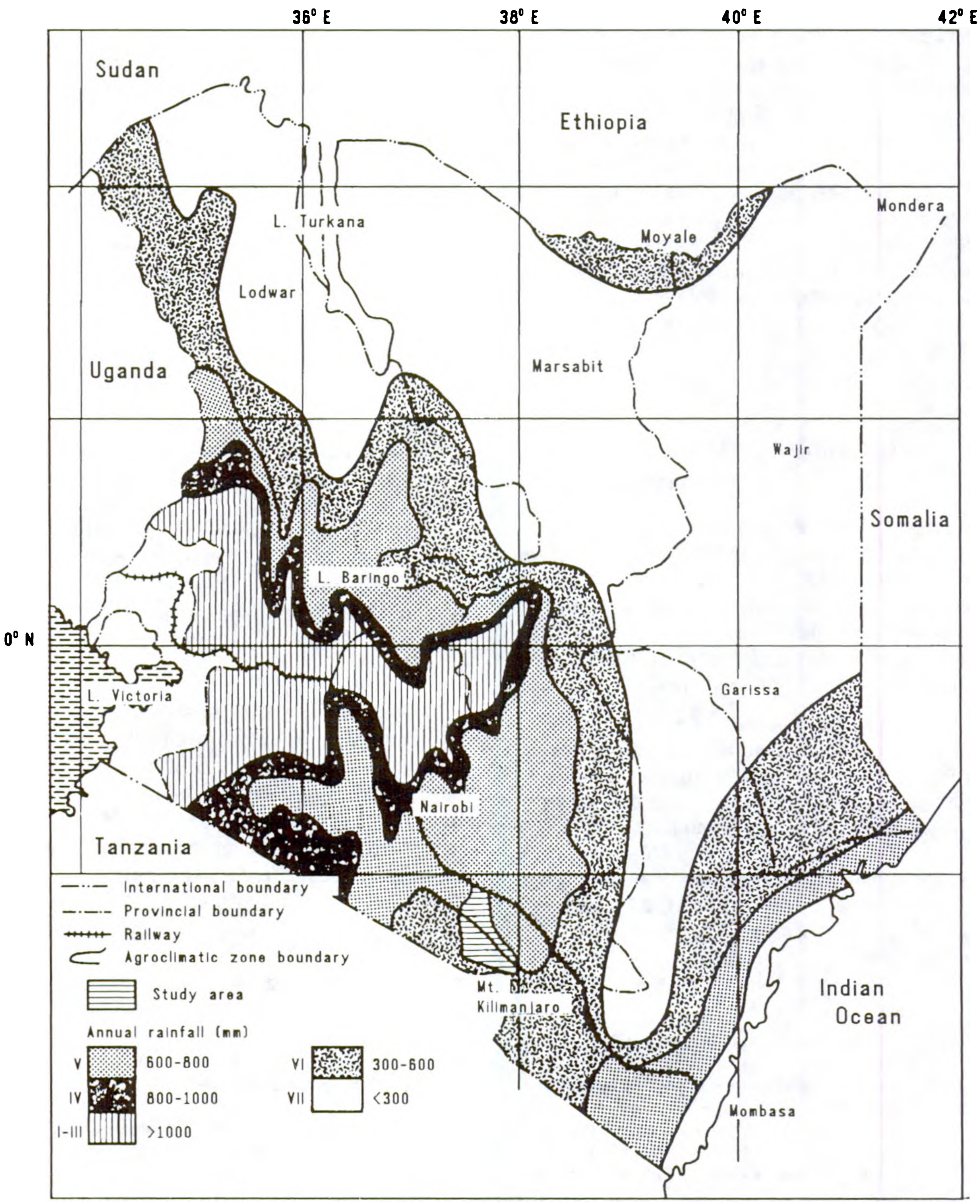
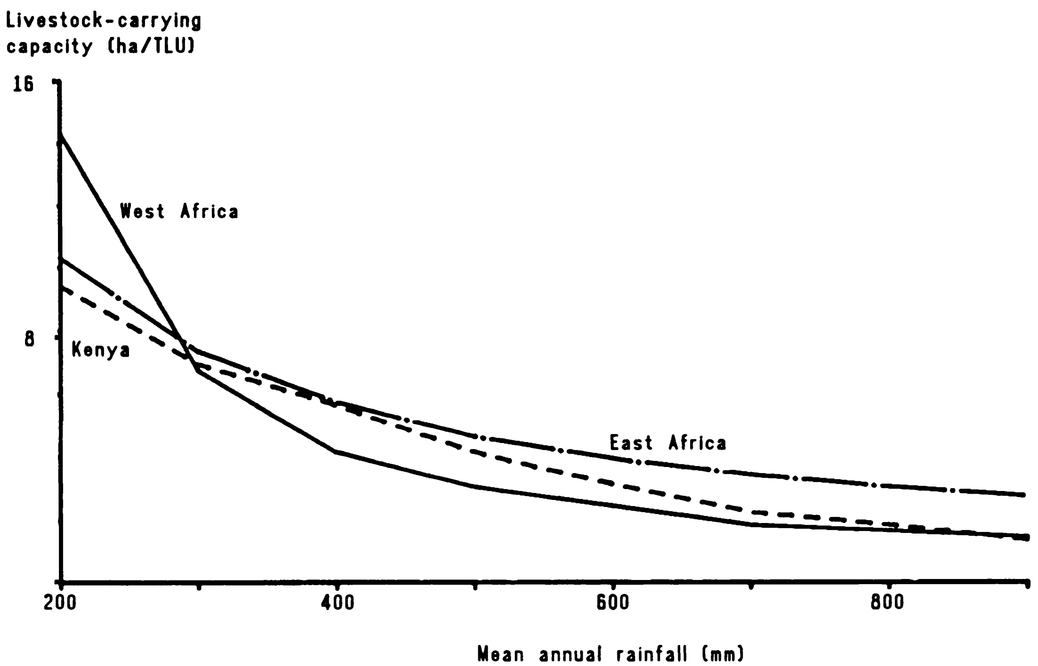


Figure 2.2. *Estimates of livestock-carrying capacity in Kenya and East and West Africa in relation to mean annual rainfall.*



Although potential grazing resources are largely associated with the overall climatic and edaphic conditions, the actual resources available at any particular time are a product of current seasonal rainfall patterns (both spatial and temporal), modified by the extent to which they have been grazed by both domestic and wild herbivores in the recent past. Thus, actual biomass production is much influenced by the current plant cover density, the spatial distribution of which is largely a function of past use (van Wijngaarden, 1985; de Leeuw and Nyambaka, 1988). In addition, the intensity with which grazing resources are used is directly related to the location of water points and the rate at which these supply water, factors that, to a large extent, determine the siting of settlements and the grazing areas of the livestock associated with them.

In summary, there are four interconnected factors that determine the long-term availability of grazing resources in pastoralist production systems:

- variability in rainfall;
- the efficiency with which rainfall is converted into usable forage;
- the use of grazing resources by the domestic and wild herbivores; and
- the relationship between quantity and quality of the resources.

In Chapter 4 (*The study area: Biophysical environment*) these components are discussed further in relation to the environment of eastern Kajiado, in which the study area is located.

2.2 Livestock production systems

There are two important livestock production systems in the high-potential areas (zones II and III). In the first, small farmers rear cattle and smallstock as part of a mixed-farming enterprise. Many are commercial dairy farmers; there are 2 million grade cattle in these zones. The second system consists of a few large farms and ranches developed during the colonial era. Many of these are being divided into smaller units and their importance is diminishing. These zones cover 58 000 km^2, with a stocking rate close to 1 ha/TLU. Nearly half of Kenya's cattle are found in these zones; the rest are in the rangelands (Table 2.2).

There are three main livestock production systems in the medium-potential rangeland areas: smallholder mixed farming, ranching and pastoralism. The smallholders own a few cattle, a pair of work oxen and some smallstock as important components of their mixed farms. This system accounts for at least a quarter of a million households owning close to one million cattle and 3

Table 2.2. *Livestock populations by zones and production systems*[1].

Production system	Population ('000 head) Cattle	Sheep	Goats
High-potential areas (zones I, II and III)			
Smallholders	4 830	1 440	1 380
Commercial enterprises	390	240	
Total	5 220	1 680	1 380
Medium-potential rangelands (zones IV and V, part of zone VI)			
Smallholder mixed farming	960	1 000	2 170
Commercial ranching[2]	1 230	300	
Pastoralists (including group ranches)	1 680	1 630	1 710
Total	3 870	2 930	3 880
Low-potential rangelands (zone VII, part of zone VI)			
Pastoralists	1 840	2 020	2 470
Grand total	10 930	6 630	7 730

[1]Derived from Sloane (1986), who used corrected data from the 1983 census by the Animal Production Division of the Ministry of Agriculture and Livestock Development.

[2]Adapted from Bernsten and Jacobs (1983).

million smallstock (Table 2.2). Commercial ranches are important in drier areas, particularly in Laikipia and Machakos Districts and along the coast[4]. The pastoralists are now mostly organised into group ranches. They own 90% of the cattle in Narok and Kajiado Districts, and about 40% of the cattle in Baringo in the west and in the coastal districts in the east. Their livestock holdings are estimated at 1.7 million cattle and 3.3 million smallstock (Table 2.2).

Some 4.4 million people live in the Kenyan rangelands. Of these, 73% live in the 25% of the rangelands that is under smallholder mixed farming. This area is thus quite densely populated (26 people/km^2). However, only 30% of the livestock in the rangelands are found in the area under mixed farming and consequently the ratio of livestock to people is low (0.4 to 1.3) (Table 2.3). In contrast, in pastoral regions the human population density is low and the number of livestock per person is higher (Table 2.3). The 'Maasai' pastoral districts are in medium-potential areas (mainly zones IV and V) and support three to four times as many people and livestock per unit area as the pastoral districts in the north-west and north-east, which are mainly in the arid zone. However, ratios of livestock to people tend to be similar (Table 2.3).

Cattle account for up to 85% of the livestock units in mixed farming areas, compared with 77% in the Maasai areas and less than 50% in the drier regions of the north-west and north-east. Smallstock account for most of the remaining livestock units in mixed farming areas and the Maasia areas. In contrast, camels account for up to 38% of livestock biomass in the drier areas.

Between 1968 and 1981 the number of cattle in the Kenyan rangelands increased by an average of 24%. However, the change in cattle population differed markedly between regions. The fall in cattle numbers in Baringo, West Pokot and the north-east region was due to the 1973/74 drought, security problems along the western border and rapid bush encroachment which reduced cattle-carrying capacity (Conant, 1982).

Over the same period the number of smallstock in the rangelands increased by 50%, compared with the average increase of 38% for Kenya as a whole. The largest increase was recorded in the Maasai districts, where the number of smallstock tripled in 13 years, increasing the smallstock-to-cattle ratio (in head) from 0.8 to 1.6.

The ratio of livestock (in TLUs) to people in Kenya fell between 1969 and 1979 as a consequence of rapid increases in the human population. The human population increased by 39% in Kenya as a whole (3.4% per annum), by 43% in the rangelands and by 70% in the Maasai districts (Jacobs, 1984). Large increases in the human population were also recorded in the mixed-farming districts (particularly Laikipia, where the population doubled) and the north-eastern pastoral zone. In the pastoral north-west, the human population grew by only 10%.

In summary, the ratio of livestock to people has been falling in Kenya since 1968, if not before. This decline was exacerbated by the 1983/84 drought, which reduced the cattle population substantially (Mbugua, 1986).

4. Commercial ranches include individual ranches (owner-occupied ranches with private freehold title to land), company ranches (shareholder units with leasehold rights to land use) and cooperative society ranches (with membership from neighbouring mixed-farmers on leasehold rangelands). For more details see Bernsten and Jacobs (1983).

Table 2.3. *Rangeland, people, land and livestock by region in the Kenyan rangelands.*

	Mixed-farming regions				Pastoral regions			
	West	East	Coast	Overall	South (Maasai	North-west	North-east	Overall
Human population								
Density (people/km^2)	17	37	20	26	10	2	3	3
Increase 1969–79 (%)	60	41	40	43	70	10	56	44
Per cent of total rangeland population	11	42	20	73	8	7	12	27
Per cent of total rangeland area	6	10	9	25	7	30	38	75
Livestock population								
TLU/km^2	22	18	9	16	38	8	9	11
Per cent of total rangeland TLU	10	15	6	31	22	19	28	69
TLU per person	1.3	0.5	0.4	0.6	3.7	3.6	3.4	3.6
Composition (% of total TLU)								
Cattle	74	81	85	80	77	46	52	59
Smallstock	21	18	15	18	23	26	10	19
Camels	5	1	0	2	0	24	38	22

Sources: Sloane (1986); Jacobs (1984).

2.3 Kajiado Maasailand: The biophysical environment and infrastructure

2.3.1 Physiography

Kajiado District has an area of 19 600 km^2 (CBS, 1981). It is roughly triangular, and is bordered by the Nairobi–Mombasa railway to the north-east, the border with Tanzania to the south, and the western wall of the Rift Valley to the west. The eastern boundary is formed by the Chyulu Range and western limit of Tsavo National Park. The District has been divided into four ecozones: the Rift Valley, the upland Athi Kapiti Plains, the Central Hills, and the Amboseli Plains (Republic of Kenya, 1982). The study area is in the centre of the Amboseli ecozone, occupying about one quarter of the ecozone's area (Figure 2.3).

The Rift Valley

The Rift Valley runs from north to south and is generally 50–60 km wide. The geology is predominantly quaternary volcanics. The floor of the Valley is step-faulted, and comprises a series of horsts running north and south with flat bottomlands between them. The numerous rocky scarps and slopes have shallow, reddish-brown, stony clay-loams. The bottom lands have deeper and more varied soils, including alluvial deposits. The broken and rocky terrain restricts access to much of this ecozone.

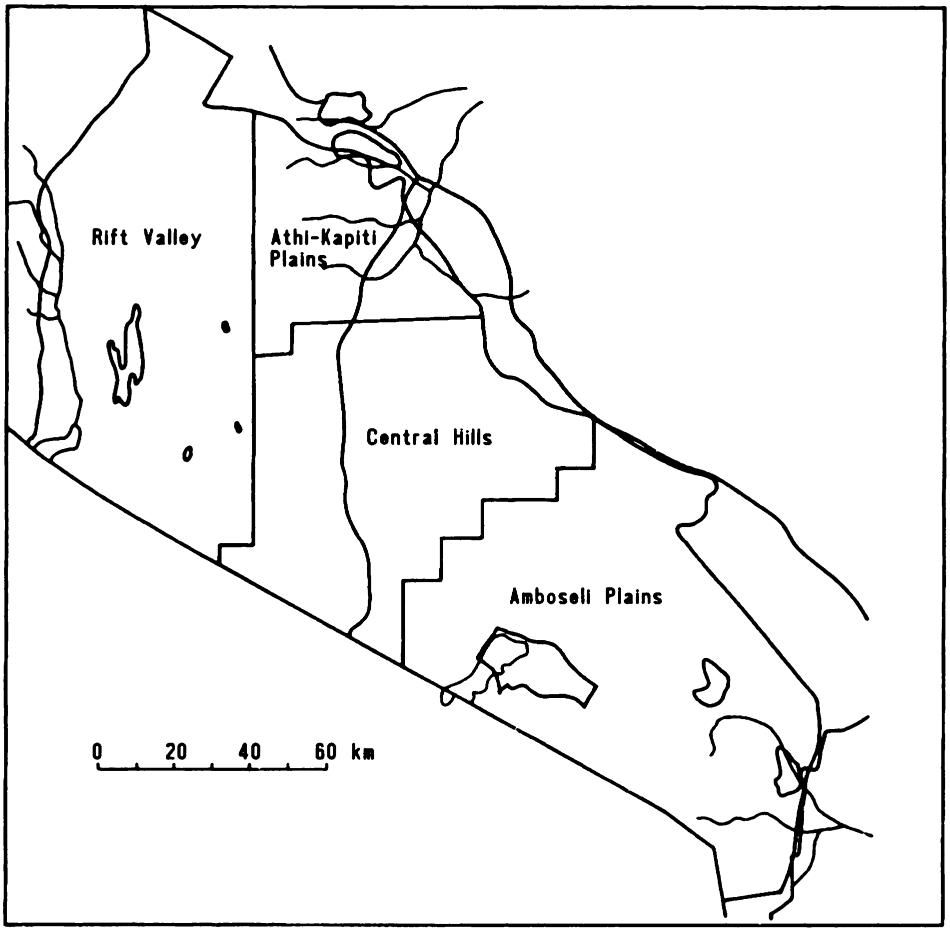
The Athi-Kapiti Plains

The upland Athi-Kapiti Plains are mainly open, rolling land. The Plains drain towards the Athi River basin in the east. Geologically, they derive from volcanics but there is a band of tertiary sediments running south-west to north-east across the centre of the plains. The soils are mostly deep black Vertisols.

The Central Hills

At the south-eastern edge of the Athi-Kapiti Plains the land falls away more steeply to the east. Numerous gneiss and limestone hills protrude from the slope, the largest, on the southern boundary, rising to 2800 m. Soils are red, sandy and often shallow. In the eastern part of the zone, the land is much dissected and divided by water courses that drain into the north-easterly flowing Kiboko River, a tributary of the Athi River.

Figure 2.3. *Ecozones in Kajiado District.*



The Amboseli Plains

The Amboseli Plains are divided into two distinct parts. The western half is, geologically, an extension of the basement system in the Central Hills. It is an area of gently undulating plains with deep, reddish-brown clay loams and a variety of poorly drained Vertisols. In the eastern part of the plains the geology changes abruptly to quaternary volcanics with deep, well-drained soils, many of which are very rocky. In the western lee of the Chyulu Range much of the land is covered by lava flows. Most of the western part of the plains drains into the Kiboko River. The eastern plains drain south-eastwards into the headwaters of the Tsavo River[5].

2.3.2 Climate

Most of Kajiado District lies in the semi-arid and arid zones (zones V and VI) (Table 2.4; Figure 2.4). Only 8% of the District's land is classified as having some potential for rainfed cropping (zone IV): most of this is in the Athi-Kapiti Plains, close to Nairobi, and in the south of the District, along the Kilimanjaro foothills.

Mean annual rainfall ranges from 300 to 800 mm. Rainfall is bimodal, with "short rains" from October to December and "long rains" from March to May. The distribution of rainfall between the two seasons changes gradually from east to west across Kajiado District. In eastern Kajiado more rain falls during the "short rains" than during

5. For more information on geomorphology and soil see Sombroek et al (1982). For more detail on vegetation and soils in the study area see Touber (1983).

Table 2.4. *Distribution of agroclimatic zones in the four ecozones of Kajiado District.*

	Per cent of ecozone land area in zone:			
Ecozone	IV	V	VI	Total area (km^2)
Rift Valley	7	71	23	6850
Athi-Kapiti	31	69		2040
Central Hills	14	69	27	4400
Amboseli	15	26	69	6270
Kajiado District	8	56	36	19 560

Source: Adapted from Republic of Kenya (1982).

the "long rains". In western Kajiado the majority of rain falls during the "long rains" (Table 2.5).

The short-term (1980–84) distribution of rainfall in eastern Kajiado is discussed further in Section 4.3: *Climate*. Its impact on primary productivity and grazing resources is discussed in Section 4.4: *Rangeland productivity*. The longer-term implications of rainfall variability and resulting cyclic changes in rangeland carrying capacity and herd productivity are dealt with in Chapter 10: *The long-term productivity of the Maasai livestock production system.*

Figure 2.4. *Agroclimatic zones of south-eastern Kenya.*

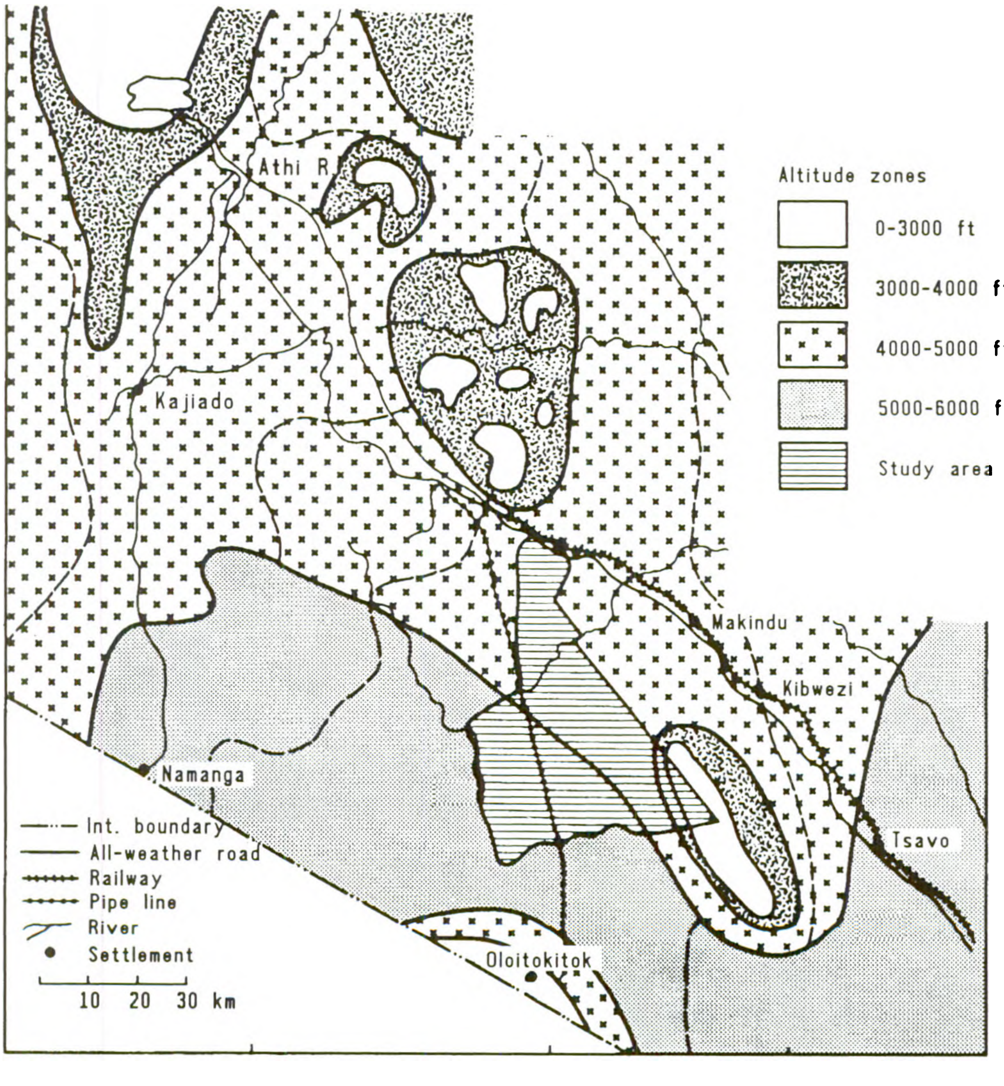


Table 2.5. *Mean monthly rainfall (mm) for four rainfall stations[1] in Kajiado District.*

	Rainfall (mm)			
	Simba	Kajiado	Namanga	Magadi
October	5	14	14	13
November	135	49	47	38
December	99	37	55	30
January	21	26	40	23
February	11	28	49	46
March	50	57	58	60
April	108	110	147	111
May	27	53	57	41
Annual total	528	463	584	545
No. of years	44	46	27	43

[1]For locations see Figure 2.5.
Source: Bille and Heemstra (1979).

2.3.3 Vegetation

Open grasslands predominate in the Athi-Kapiti Plains and many parts of the Amboseli ecozone. Bush and woodland are found mostly in the Central Hills and in the western part of the Amboseli ecozone. Forest is rare and mostly confined to isolated remnants on hill crests and on the lava flows in the Chyulu range (Table 2.6).

Several grassland types have been distinguished:[6]

- the *Themeda–Acacia drepanolobium* type in the Athi-Kapiti Plains and the volcanic plains in the north of the Rift Valley (McDowell et al, 1983;Croze, 1978).
- *Digitaria–Chloris* types in the plains in eastern Kajiado.
- *Pennisetum* species on floodplains and bottomlands with Vertisols.
- *Sporobolus* types on saline-sodic clays in the Amboseli ecozone.

There are four main types of bush and woodland:

- *Tarconanthus* types on shallow soils in the northern Rift Valley.
- Semi-deciduous bushland with *Combretum, Grewia, Acacia, Rhus* and *Premna* species on hill slopes in wetter areas (zone IV)
- *Acacia–Commiphora* bush and woodland in the Central Hills and western Amboseli where shallow soils overlie basement complex parent material.
- Open *Acacia tortilis* woodland on lacustrine plains in part of the Amboseli ecozone (de Leeuw et al, 1986).

The semi-deciduous bushland has many species in common with *Acacia–Commiphora* bushland, of which it can be considered a variant found in moister areas. A more detailed description of the vegetation of the study area is given in Chapter 4 (Section 4.2: *Landscapes, soils and vegetation*).

2.3.4 Water resources

There are few permanent natural sources of surface water in Kajiado District. The main ones are

Table 2.6. *Percentage of land area under vegetation of different types in the four ecozones of Kajiado District.*

		Per cent of area				
Woody cover (%)	Vegetation type	Rift Valley	Athi-Kapiti Plains	Central Hills	Amboseli Plains	Total
0–2	Open grassland	9	71	14	37	26
2–20	Wooded and bushed grassland	74		10		26
20–40	Bush and woodland	16	29	75	59	44
>40	Forest and other types	1		1	4	2

Source: Based on Croze (1978) and Republic of Kenya (1982). Both of these used data collected in the early 1970s, before the 1974–76 drought. Woody cover fell substantially during and after the drought and Touber (1983) gave much lower estimates of the proportion of bush and woodland in the Amboseli plains.

6. The first two types are akin to the *Themeda* and *Chloris* types identified by Rattray (1960). Their distribution is mainly related to altitude (*Themeda* at 1100–200 m; *Chloris* at 450–1200 m). The *Pennisetum* and *Sporobolus* types are found mostly under specific edaphic conditions (see Section 4.2: *Landscapes, soils and vegetation*).

the Uaso Nyiro River in the Rift Valley, two streams in the northern part of the Athi-Kapiti Plains, the Kiboko River[7], which drains much of the Central Hills and the northern part of the Amboseli ecozone, and several springs in the southern part of the Amboseli zone.

Water development

This lack of permanent sources of surface water led to the construction of several small dams and the drilling of a large number of boreholes. At least 290 boreholes were drilled between 1938 and 1982, 43% of them between 1970 and 1982.

Most of the boreholes in the Rift Valley are in the eastern half of the Valley; the Uaso Nyiro River provides water to the western side of the Valley. In the Athi-Kapiti ecozone most boreholes are clustered at the northern end, where general development has been greatest. In the Central Hills the greatest density of boreholes is close to the railway, again where development is furthest advanced.

Most boreholes in the Amboseli ecozone are in the western part, where there is no permanent source of surface water. The volcanic plains have permanent surface water from springs and thus have fewer boreholes. The most important single structure in this ecozone, in terms of provision of water to the Maasai, is the pipeline that cuts through the centre of it from the Kilimanjaro foothills to Sultan Hamud on the Nairobi–Mombasa road. There is a second, much smaller, pipeline system in the north of the Amboseli National Park; this was built in the mid-1950s to compensate the Maasai for loss of grazing land when the Park was demarcated.

No one knows how many of the boreholes and dams in Kajiado District still function. Many dams have silted up or have been washed away; the location of others has been forgotten (Dietz et al, 1986). Most of the older boreholes have broken down. Dietz et al (1986) stated that:

"*The County Council has been involved in water development and owns 36 boreholes scattered over the district. The County Council used to take care of the maintenance of these boreholes, but since the Council lost its main source of income (revenues from Amboseli due to the fact that it was turned from a Game Reserve into a National Park), they are financially unable to do so. The Ministry of Water Development (MoWD) was approached to take over the County Council boreholes, but because of the high costs involved, they are as yet also unable to do so.*

Although the information about water facilities is not very clear it appears that the MoWD currently operates 7 functioning boreholes and 5 dams. Within the district also a number of individually owned boreholes are operating, but it seems obvious that the existing and functioning water facilities are far too few to serve the population and their livestock. Running costs and maintenance are major problems. Most boreholes are equipped with an electric or a diesel pump and, thus, have high running costs. Another problem seems to be that the local people have never really participated in construction and running of the water facilities and as such do not feel themselves responsible for the maintenance of the facilities." (Dietz et al, 1986; page 13).

2.3.5 Herbivore population

Estimates of livestock and wildlife populations are notoriously inaccurate. Regular ground counts and aerial surveys can, however, indicate long-term population changes. Ground census data show that the number of cattle in Kajiado District rose from 410 000 head in 1976 to 690 000 head in 1983 (Sloane, 1986). This represents the recovery of the cattle population following the 1974–76 drought. Estimates from aerial surveys were substantially lower, averaging 360 000 during the 1974–76 drought (Croze, 1978) and 412 000 over the period 1977–83, with a maximum of 510 000 head (Table 2.7). Differences between aerial survey counts were considerable, but the rising trend apparent from ground counts was not obvious from the aerial inventories.

Most authorities agree that the number of smallstock in Kajiado District is increasing. Bernsten and Jacobs (1983) reported an increase from 168 000 head in 1968 to 600 000 head in 1981. The 1983 population of 1.2 million head reported by the Ministry of Agriculture and Livestock Development is, however, questionable (Sloane, 1986). Aerial inventories indicated average populations of 370 000 head in 1974–76 and 518 000 head between 1977 and 1983, with a peak of 718 000 head (Table 2.7).

Wild herbivores have been surveyed frequently and their populations appear to be more stable

7. The Kiboko River is not strictly a permanent source of surface water, but water is available year-round from shallow wells in the river bed.

Table 2.7. *Estimated domestic livestock populations in Kajiado District, 1977–83.*

	Domestic livestock population				
	Mean				
Species	TLU ('000)	Per cent of biomass	Head ('000)	Minimum ('000)	Maximum ('000)
Cattle	296.6	86	412	332	510
Smallstock	37.3	11	518	319	718
Donkeys	9.5	3	16	9	27

Source: Derived from Peden (1984), who summarised aerial-survey inventories of livestock and wildlife population carried out by KREMU between 1977 and 1983. The figures in Tables 2.7, 2.8 and 2.9 represent the combined estimates for several surveys.

than those of domestic herbivores. They comprise about 22% of the total livestock biomass in Kajiado District (Table 2.8). However, wild herbivores are unevenly distributed over the District: In 1974–76 they accounted for 37% of biomass in the Athi-Kapiti Plains and 29% in the Amboseli zone, but only 8% in the Central Hills (Croze, 1978). The major species in terms of biomass are wildebeest, zebra, giraffe and eland (Table 2.9).

Table 2.8. *Estimated herbivore biomass density (TLU/km^2) in Kajiado and the Amboseli ecozones.*

	Estimated herbivore biomass density (TLU/km^2)		
	Kajiado District		Amboseli ecozone
	1974–76[a]	1977–83[b]	1974–76[a]
Domestic herbivores	14.3	17.5	11.4
Wild herbivores	4.0	5.0	4.0
Total	18.3	22.5	16.0

Source: [a]Croze (1978); [b]Peden (1984).

Table 2.9. *Estimated major wild herbivore populations in Kajiado and the Amboseli ecozones.*

	Kajiado District[a]		Amboseli ecozone[b]	
	Number ('000 head)	Per cent of biomass	Number ('000 head)	Per cent of biomass
Wildebeest	43	22	11	15
Zebra	22	18	4	10
Eland	7	10	4	15
Giraffe	8	25	3	27
Other wildlife		25		33

Source: [a]Peden (1984); [b]Croze (1978).

Between 1977 and 1983 the average stocking rate in Kajiado District, based on aerial inventories, was 4.5 ha/TLU (Table 2.8). However, if the fluctuations in domestic herbivore populations indicated by ground counts reflect reality, total stocking rates varied from 2.7 to 5.4 ha/TLU [8] over that period.

2.3.6 Infrastructure

Over the last 30 years, the human population of Kajiado District has increased four-fold, or by 4.7% a year (Republic of Kenya, 1982). At least half of this increase was due to immigration. In 1979 the population of Kajiado District was estimated at 149,000, or an overall density of 7.6 people/km^2; the population density in pastoral areas was approximately 5 people/km^2 (CBS, 1981). Detailed statistics on the distribution of Maasai pastoralists are given in Chapter 3 (Section 3.4: *The socio-economic impact of group ranches in Kajiado Maasailand*). By 1979 about a quarter of the population was non-Maasai, up from just a few per cent in 1949.

The economy of Kajiado District is still dominated by the Maasai, who are largely pastoralists, but rainfed farming, largely by non-Maasai, has taken over as the major economic activity in higher potential areas. Irrigated cropping has also been increasing along river valleys and in swampy areas. The main areas for irrigated cropping are along the Ngong Hills, along the Lolturesh River in the Kimana area, in the Kilimanjaro foothills and around Namanga.

Other major economic activities include the Amboseli National Park and mining of soda from Lake Magadi. The National Park is a major tourist attraction, but provides no revenue for the District

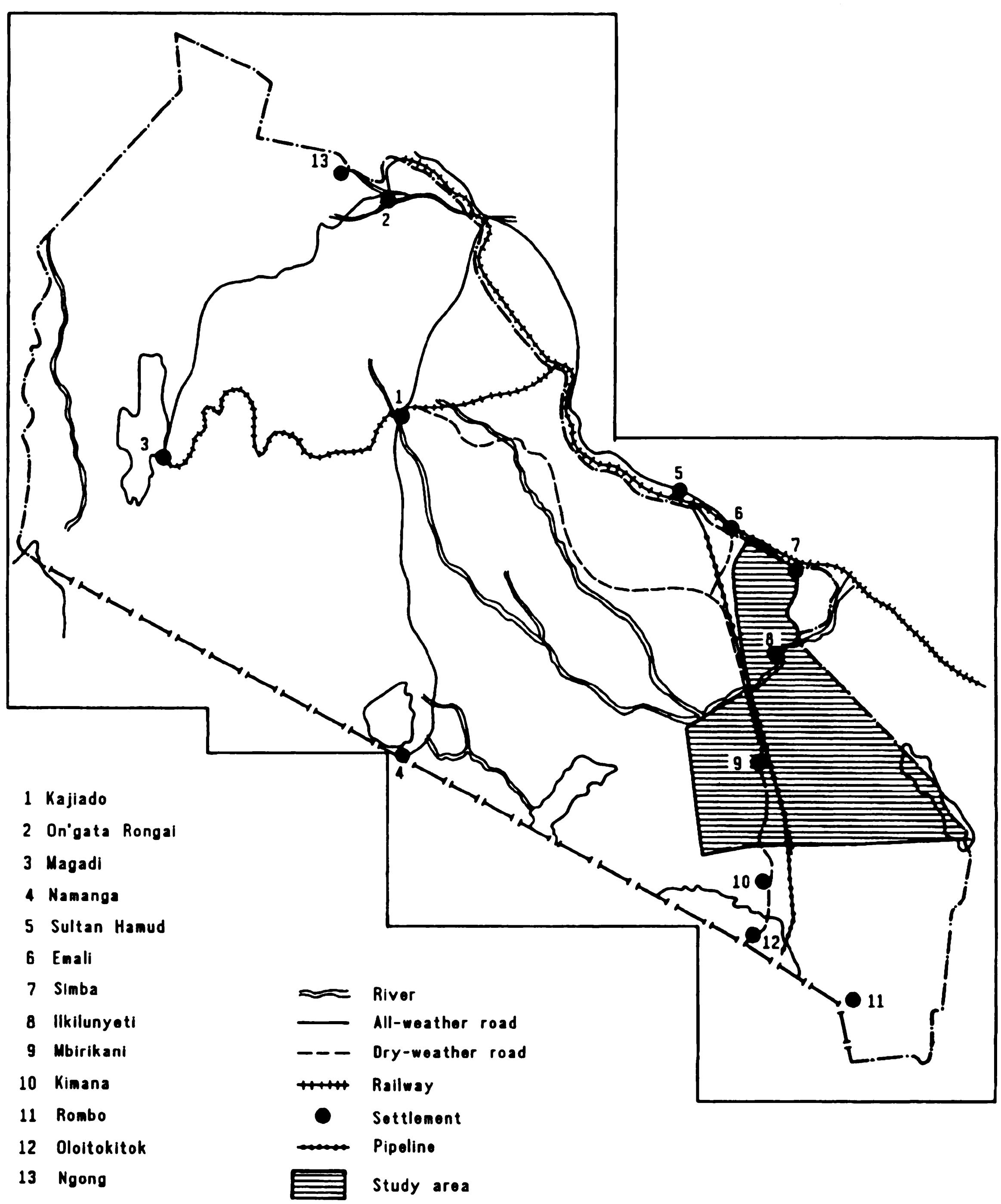
8. Based on the data from the Animal Production Division, Ministry of Agriculture and Livestock Development. Sloane (1986) calculated the stocking rate of domestic herbivores in Kajiado District for 1983 at 31 TLU/km^2 or 3.3 ha/TLU.

and generates little employment for the local people. The soda mine employs about 600 people, but most employees are immigrants from other districts.

Kajiado District is well served by a network of all-weather roads and by railways (Figure 2.5). In addition, numerous roads that are passable in the dry season penetrate the interior of the District. This network effectively links the urban and trading centres in the District, and public transport is quite readily available.

By virtue of its proximity to Nairobi, Kajiado District is able to supply this major meat consumption centre. However, the District's livestock mar-

Figure 2.5. *Map of Kajiado District showing location of towns, villages and the study area.*



keting system is well developed only for cattle. Only the western and northern parts of Kajiado seem to supply smallstock to the Nairobi market; there are no smallstock markets in the southern and eastern parts of the District (see Section 9.2.10, *Problems of the livestock marketing system*).

Until 1986 the government set and controlled prices of most commodities, including food and livestock products. However, the government prices were generally applicable only in major towns and trading centres; traders in smaller centres and more remote areas often charged prices 20–30% above those set by the government.

There are more than 100 full primary schools in Kajiado District but among the pastoralists only 40 to 45% of school-age children are enrolled in school. There are also 16 secondary schools. The Maasai Rural Training Centre operates four youth polytechnics with financial backing from the National Council of Churches in Kenya and the government. In 1986 these offered 129 adult education courses, for which 2340 people enrolled; 10% of the people enrolled were women (Dietz et al, 1986).

The District has 3 hospitals, 8 health centres and 22 dispensaries. However, these are mostly underused because they are situated in urban centres and hence are not readily accessible to the pastoralists. Mobile clinics are operated by AMREF and ICROSS (Dietz et al, 1986). Many other non-governmental organisations and foreign assistance programmes operate in the District and provide a variety of support services.

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Chapter 3

The Maasai: Socio-historical context and group ranches

B E Grandin

The Maasai are the second biggest group of pastoralists in Kenya, after the Somalis, numbering some 360 000 out of a total pastoralist population of some 1.4 million.

This chapter focuses on the socio-historical context of livestock production in Kajiado Maasailand. It first describes the social organisation of the Maasai, particularly their socio-spatial organisation and territorial control. The focus then shifts to external influences on Maasai livestock production strategies. There is a brief review of changes in range/livestock policies and land use since the turn of the century, which culminated in a land-tenure reform programme which transformed communal trust land into group and individual ranches. A brief history of group ranches is provided, including a comparison between the original concept of how group ranches should operate and how they have come to operate. This is followed by a brief review of the impact of the early group ranches on various technical and social features of Maasai livestock production.

3.1 Maasai social structure

3.1.1 Introduction

This section provides an outline of Maasai social structure as a basis for understanding the extent to which social relations have formed and still shape the Maasai's framework of production.

3.1.2 Socio-spatial integration

Maasai socio-spatial organisation is composed of five basic units: household, *boma*, neighbourhood/locality, section and Maasai society. Their main characteristics are outlined in Table 3.1.

The household was the primary unit of production. The nuclear family of husband, wives and unmarried children was often extended to include married sons and their wives, the husband's mother (and his siblings if their father is dead) and impoverished dependants[1].

Until recently, Maasai households lived together in large compounds or *bomas* (*enkang*) of 6 to 12 households (Jacobs, 1965; Njoka, 1979). Over the last 20 years, however, the average size of the *boma* has declined markedly and the single family *boma* has become increasingly common as the Maasai becamem increasingly sedentary and moved towards individualisation of production.

Bomas were grouped into larger units, or neighbourhoods, which controlled such local resources as grazing and watering facilities. A neighbourhood was a cluster of *bomas*, usually within a kilometre of each other. The term *elatia* refers to a group of neighbours[2]. Each neighbourhood was usually centred around a permanent water point and, although membership varied over time, had a core of people who resided there permanently.

Neighbourhoods were, in turn, grouped in "localities"[3] which controlled enough wet- and dry-season grazing and water resources to support their population in normal times (Jacobs, 1965).

1. The word for dependant (*napita*) implies someone who has no animals or so few that they cannot support themselves. Although a man may support his mother and her children, they are not, strictly speaking, dependants, as the man's animals were once his mothers. True dependants are often members of households that have lost all their animals, commonly through alcoholism.
2. This differs from the situation described by Jacobs (1965) in his work on the Kisongo Maasai in Tanzania, where the term *elatia* was used for the residents of the same *boma*, and no neighbourhood level existed. It is interesting that his *boma* population is close to the neighbourhood population in the present study.
3. The locality is called *enkutoto* in some *oloshon*. The *enkutoto* was recommended by some researchers (e.g. Fallon (1962), quoted in Hedlund (1971)) as the logical basis for group ranch development. According to Hedlund (1971), in Kaputiei the word *enkutoto* does not mean locality but refers to an area of fairly permanent settlement or a small area named for its ecological characteristics. He enumerated 21 *enkutotos* in a single group ranch.

Table 3.1. *Maasai socio-spatial organisation (a schema).*

Smallest	Household (*olmarei*[1])
	Locus of cattle ownership
	Autonomous decision-making unit
	Highly mobile
	Flexible; may split seasonally
	Viability (people/animal balance)
	Divided into subhouseholds called houses (*nkaji*) of each wife/children
	Boma (*enkang*) – joint residential unit
	Joint unit for herding/watering and other livestock management
	Strong prescription for food sharing
	Domestic self-help unit
	Neighbourhood/locality (*elatia/enkutoto*)
	Broader cooperation/information exchange, sociability
	Share/control of local grazing and water resources
	Often core nucleus population with regular influx/outflow of others
	Section (*oloshon*) – largest grazing unit
	Large to allow for resource fluctuations
	Theoretically free access to all members
	Largest unit of traditional administration/apex of age-set system
	May be divided into subsections
Largest	Maasai–society/ethnic group
	Ideological unit
	Shared language and culture
	Limited access throughout in times of severe stress

[1]There is no single word in Maa which corresponds precisely to "household" although the expression "*nkaji* of so-and-so", literally "so-and-so's houses" is used. More often the word *olmarei* (family) is used but it is clear from the context that it is the household that is meant.

Each Maasai producer belonged to a locality, which he considered his home area or *emparnat*, where he belongs and has a right to live (whereas permission of residents is required for him to join another locality).

A Maasai is identified primarily with his *oloshon* or section. This is, in effect, a subtribe of the Maasai with a unified political and administrative structure[4]. Each section had a fixed territory that, before group ranches, belonged to section members collectively. The territory of each section was large enough to provide adequate grazing in normal and dry times, but not during extreme droughts. In Kajiado Maasailand current administrative boundaries follow closely earlier boundaries of the eight sections (Figure 3.1; Table 3.2).

The Maasai as a whole form a distinctive social unit sharing a culture, language and social structure.

The freedom of movement of a producer and his household declined with increasing size of administrative unit: while it was easy for him to move from one *boma* to another, sectional boundaries were, and still are, difficult to cross, even in drought times. Even if allowed to cross into another section, he would remain there for as short a time as possible.

3.1.3 Cross-linkages

Relations based on proximity alone would lead to the segregation of people in localised areas. To offset this and to provide mechanisms for the wider mobility essential to livestock production, the Maasai have linkages which unite people within and even across sections. These cross-linkages are of two types: group-wide and individual (Table 3.3). Chapters 5 (*The study area: Socio-spatial organisation and land use*), 6 (*Labour and livestock management*) and 8 (*Livestock transactions, food consumption and household budgets*) examine in more detail the extent to which these relationships are used to establish co-residence, marshal labour, and determine offtake and acquisition of animals.

Group-wide ties

Group-wide ties of age-sets and clans form the most important framework for socio-political organisation. Through them every person has well-defined roles, responsibilities, rights and obligations in relation to every other person in society. They cross the ties of proximity resulting from joint residence, spanning subsection and even section boundaries.

Age sets

Traditionally the Maasai political organisation was based on a series of age-sets. As each boy was circumcised he was incorporated into a gener-

4. Jacobs (1965; 1975) prefers the word tribe as each *oloshon* was politically autonomous.

Figure 3.1. *Map of Kajiado District showing administrative Divisions and Maasai Sections.*

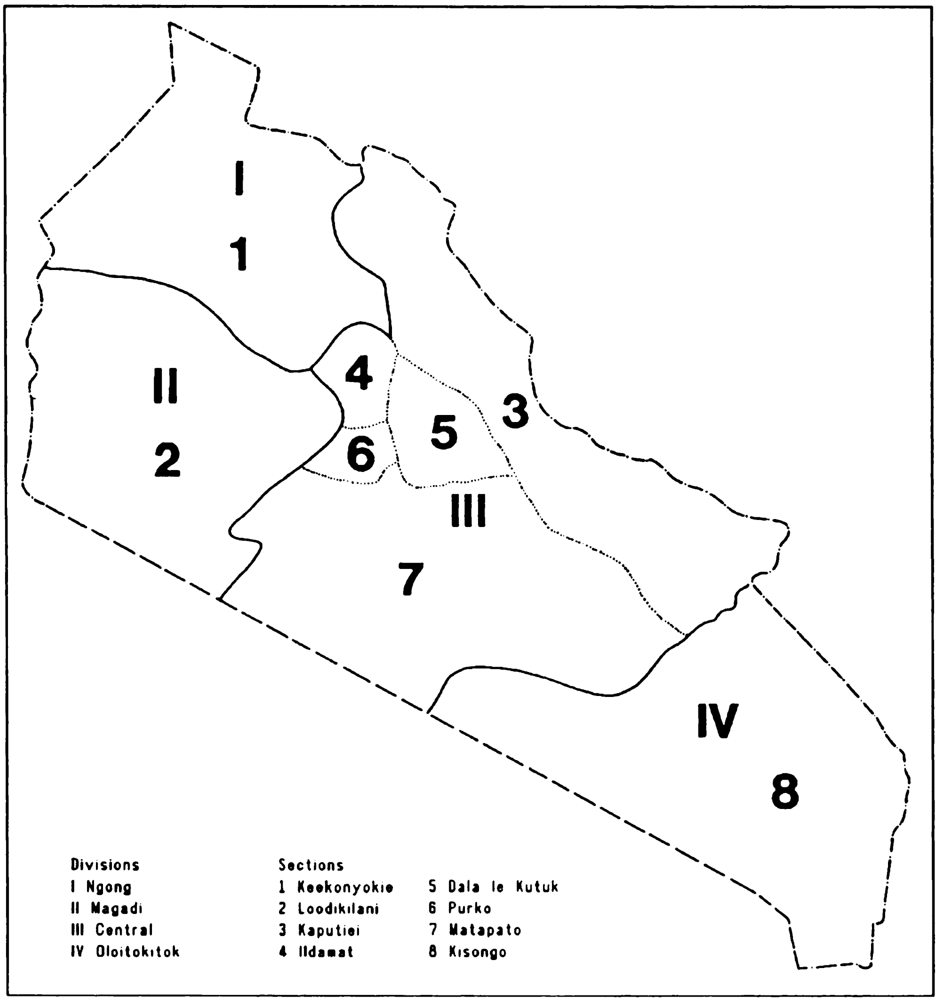


Table 3.2. *Size and human population characteristics of Kajiado Maasai sections*[1].

Section	Size (km^2)	Number of people	Number of households	Population density (people/km^2)	Number of group ranches
Keekonyokio	3 270	15 636	3 133	4.8	5
Loodikilani	3 641	14 988	2 964	4.1	6
Kaputiei	2 789	16 041	2 753	5.7	15
Ildamat	505	5 492	1 478	10.9	2
Dala le Kutuk	741	5 601	888	7.6	4
Purko[2]	204	1 808	300	8.9	2
Matapato	2 583	14 486	3 245	5.6	5
Kisongo	5 726	4 2781	7 167	7.5	6
Total	19 459	116 833	21 928		45
Mean	2 432	14 604	2 741	6.0	

[1]Area estimates are from Jaetzold and Schmidt (1983). Population estimates are from the 1979 census. However, population estimates are confounded in several locations by large urban non-Maasai populations, e.g. in Loitokitok. Ngong town has been excluded from Keekonyokie as its area is very small, while its mainly non-Maasai population is very large.

[2]A refugee group from Narok District, where Purko predominate.

Table 3.3. *Cross-cutting ties in Maasailand.*

Group-wide ties	
	Clans/moities (*orgilata*) (groupings of clans into two major lines)
	Age-sets (traditional/political)
Egocentric ties	
	Consanguineal kin, especially through the patriline
	In-laws
	Stock associates

ational category or age-set. He and his cohorts passed through the stages of warrior (*moran*), junior elder, senior elder and retired elder, each stage lasting about 15 years. The senior elder age-set had the primary responsibility for the traditional administration in Maasailand. Junior elders carried out the instructions of the senior elders.

Although most of the political and administrative functions of age-sets have been taken over by the government, age-sets still provide an important structure for socio-political relations. A man's age-set status (e.g. junior elder, senior elder) continues to affect his political possibilities, although this is increasingly offset by level of education.

Clans (*olgilata*)

A clan is a group of people who recognise descent from the same (putative) ancestor. Maasai clans are patrilineal; a child belongs to the clan of his father and remains a member for life. Non-Maasai can be ritually incorporated into a clan.

Cattle of clan-mates have the same basic branding (with each producer adding his unique identifier). Clan-mates have very strong mutual aid obligations. For example, if a man dies young with no brothers, his clan-mates are required to help raise his children and tend his cattle. If a Maasai becomes impoverished through drought or other misfortune, his clan-mates are bound to come to his aid. Clan-mates provide help in marriage (with negotiations, obtaining the necessary bride-price etc.); they are a locus of settlement of disputes (including death fines). When a producer needs wide support to solve any problem he will appeal to his clanmates. Thus, the clan has an important role in the wider political system. Although women are excluded from the age-set system, they have full recourse to their own clan-mates when in difficulty.

There are five major clans and about 40 subclans in Kajiado District. The clans are grouped into two moieties (*orok kiteng* and *odo mongi*), each descended from one of the two wives of the first Maasai ancestor.

Egocentric ties

Every producer has his own egocentric network composed of:

- blood relatives, especially patrilineal kin (agnates) and, to a lesser extent, other blood relatives (cognates), especially those of his mother;
- affines, especially his wife's kin, and later, to a lesser extent, through the marriage of his daughters; and
- stock associates, a relationship established by the exchange of animals (this practice is often used to enhance an existing tie).

Full brothers have much greater reciprocal responsibilities than do half-brothers. Full brothers often remain together even after the death of their father. When a man diversifies out of purely pastoral production (e.g. by becoming a trader) his brother will usually help to look after his family and animals in his absence. A brother retains a responsibility for his sisters throughout his life. Sisters are always seen as belonging to his family; they can always return to his home if they are in trouble.

Other agnatic relationships (father's brothers, their sons etc.) may be viewed as less intense versions of the brother relationship (as may clan-mates). The nature of the relationship is affected by seniority: the more senior relative is an important source of social and economic support and advice to the junior relative, while the junior relative may be expected to provide help to the senior one.

As with clan-mates, agnates help each other in disputes, with marital negotiations and difficulties and generally in times of need. Agnates, particularly brothers, often give cattle to new wives on their wedding day. Gifts and loans of money are common among these relatives.

Unlike agnates, cognates are not of one's clan. Most important among cognates are close relatives of one's mother, particularly her brother. As a man remains responsible for his sister, he also feels some responsibility for her children, particularly her sons. The relationship between a man and his mother's brother or sister is close and affectionate. A young man will turn to his mother's brother where he might fear the response of his father or his father's brother. By extension, the mother's clan-mates are also seen as a source of affectionate non-judgmental support.

Affinal relationships are asymmetrical, with the family receiving the bride being beholden to the family giving the bride. Marriage is polygamous; it is viewed as a relationship between families as well as between the bride and groom. A man's first marriage is usually arranged by his father, who also provides the bride-wealth cattle (with the help of agnates and sometimes clan-mates). Marriages are usually between people from the same section but from different clans. Marriages outside the clan are usually within the moiety.

Sons-in-law are indebted to their fathers-in-law, and subsequently to their brothers-in-law. Affinal relationships are marked by much giving, primarily from the husband's family to the wife's. When in-laws visit from far away a man should slaughter a goat or sheep for them. There is much giving and lending of cash between in-laws.

The stock associate is of particular importance in Maasailand. Exchange of animals leads to life-long commitment of friendship and assistance. Clan-mates and age-mates may become stock associates, thus strengthening an already existing tie and adding new dimensions of responsibility and obligation. Generally, through the gifting of animals, a Maasai gathers support and cements his social relationships. As animals, particularly cattle, are an important medium for maintaining relationships, the person with few animals is poor not only in subsistence terms but also socially.

3.1.4 Summary

This section outlined the general internal structure of Maasai society, covering both socio-spatial organisation and cross-linking relationships. Production is embedded in these social relationships. Social relations provide access to factors of production, a source of daily cooperation and long-term social security. They are the structure on which all production hinges.

3.2 Kajiado District: An historical overview of land use and policy

This historical overview of Kajiado District focuses on the evolution of current land-use practices and government policy and administration. It shows that the last hundred years have been marked by great turbulence caused both by natural and man-made events. The most important changes have been the loss of land and the loss of traditional mobility and flexibility.

Traditional flexibility involved both spatial mobility and variation in the primary means of subsistence. Although some scholars (Jacobs, 1975; Galaty, 1980) have stressed the dichotomy between Maa-speaking pastoralists and farmers, Bernsten (1979:109) has shown that "the relation between Maa-speaking pastoralists, farmers and hunters was not static, but dynamic; individuals moved between these three modes of subsistence according to their economic status at a given time." Bernsten shows that in the past 150 years, agricultural settlements in highland areas in Maasailand "have been abandoned, resettled and abandoned again, depending on the fortunes of the pastoralists who occupied the plains." The long-standing descriptions of pastoral Maasai as living solely by direct consumption of livestock products represents a stereotype which was probably achieved by most people only in good times.

3.2.1 Human and livestock population trends

Estimates of livestock populations are notoriously inaccurate; even human population figures are problematic for nomadic societies. This section presents broad trends in population change. The livestock figures represent compromises among the often conflicting estimates originating largely from government records and reported in: Great Britain (1934), Halderman (1972), Meadows and White (1979) and Campbell (1979a; 1981). For more recent data see Section 2.3.5: *Herbivore population*. The human population figures are based on census counts in 1948, 1962, 1969, 1979 with a correction factor estimated for non-pastoralists.

Jacobs (1984a), in an analysis of population growth in the rangeland districts of Kenya between 1969 and 1979, calcualted that the population of Kajiado District increased by 74% or 50% above the average increase for Kenya as a whole. However,only half this growth was due to an increase in the pastoral population, the remainder being accounted for by in-migration of mainly Kikuyu and Kamba from surrounding districts.

Between 1948 and 1984 the human pastoral population of Kajiado District increased steadily from about 29 000 to 109 000 people, while the cattle population fluctuated widely, particularly in response to droughts (Figure 3.2). This has led to a steady decline in the number of cattle per person in the pastoral population (Figure 3.3).

Data from the study area, as reported largely in Chapter 8 (*Livestock transactions, food consumption and household budgets*) and Chapter 9 (*An economic analysis of Maasai livestock production*), indicate that there must be at least 10

Figure 3.2. *Cattle and pastoral human populations in Kajiado District, 1948–84.*

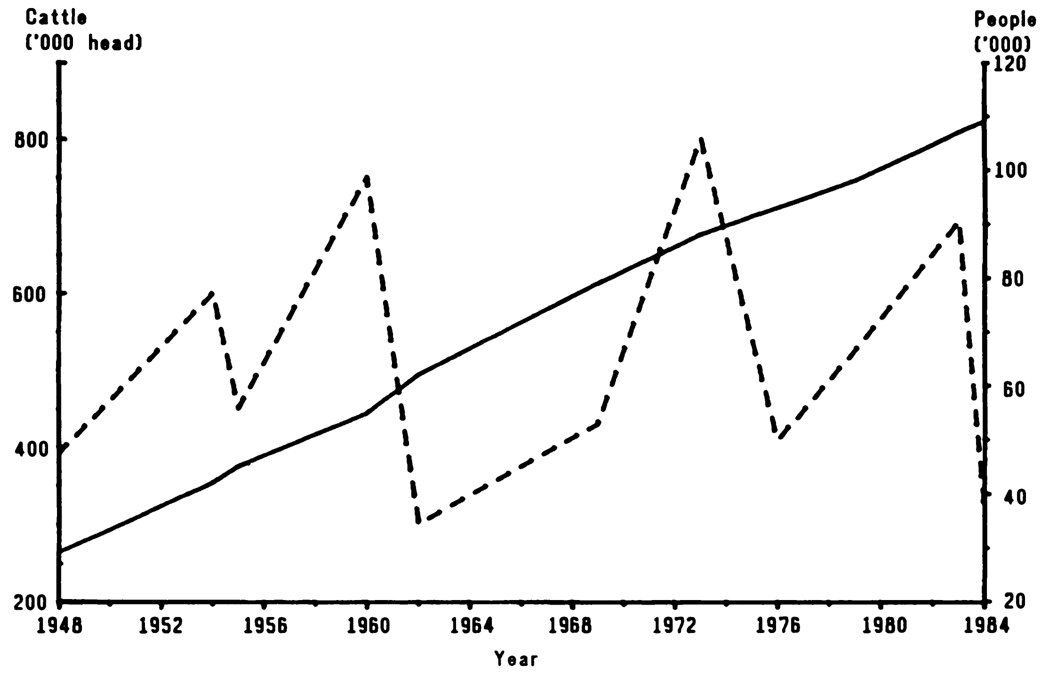


Figure 3.3. *Cattle per person in Kajiado District, 1948–84.*

cattle for each person if the population is to subsist on a diet of milk and meat alone[5]. This was the usual case before the 1960–61 drought (Figure 3.3). After the drought of 1960-61 the number of cattle per person fell to about five and may have reached a low of three cattle per person during the 1983–84 drought.

This reduction in the number of cattle per person has led to the Maasai diversifying their production, particularly through a rapid increase in smallstock, engagement in wage labour and, to a lesser extent, cultivation and increasing consumption of purchased agricultural foodstuffs, financed mainly by selling livestock and, in some areas, milk.

3.2.2 Historical influences on land use[6]

In the mid-1800s East Africa had well-developed pastoral and intensive mixed farming systems, despite the activities of the slave trade (Kjekshus, 1977). However, these were disrupted by a series of events beginning in the 1880s. Ninety to 95% of the region's cattle were killed by a Rinderpest epidemic in the 1880s. This coincided with a period of drought, and led to widespread famine. There then followed a smallpox epidemic. Lastly the jigger (sand-flea) arrived in East Africa in the 1890s, further debilitating the population. Thus, early colonialists found East African society in a state of collapse and took this to be the traditional status quo (Kjekshus, 1977).

When the Europeans arrived the Maasai occupied an area of 155 000 km^2, stretching from Mt Elgon and the Loriyu Plateau in the north to Kibaya, in modern Tanzania, in the south. In 1904 the British formed two Maasai reserves (Figure 3.4). The northern reserve was eliminated in 1911 when the southern reserve was expanded. By 1913 the area of land occupied by the Maasai had been reduced to 40 000 km^2. This remaining "reserve" is roughly congruent with present-day Narok and Kajiado districts.

Other tribes also lost land to European settlers. Starting in 1913 farmers, particularly Kikuyu, moved into Maasailand and started cropping in higher potential areas, including those on the slopes of the Ngong Hills, the foothills of Mount Kilimanjaro and of Ol Doinyo Orok near Namanga, and Nguruman on the western wall of the Rift Valley. Although the area of land involved was small, it was very important because it was land that provided critical dry-season grazing. These migrations continued into the 1950s.

Under the National Parks Ordinance of 1945 the Kajiado Maasai lost access to two areas bordering the District: Nairobi National Park and Tsavo National Park. This Ordinance also established a game reserve in Amboseli (3248 km^2), and game conservation areas at Kitengela (583 km^2) and West Chyulu (368 km^2), restricting the use of these areas by the Maasai.

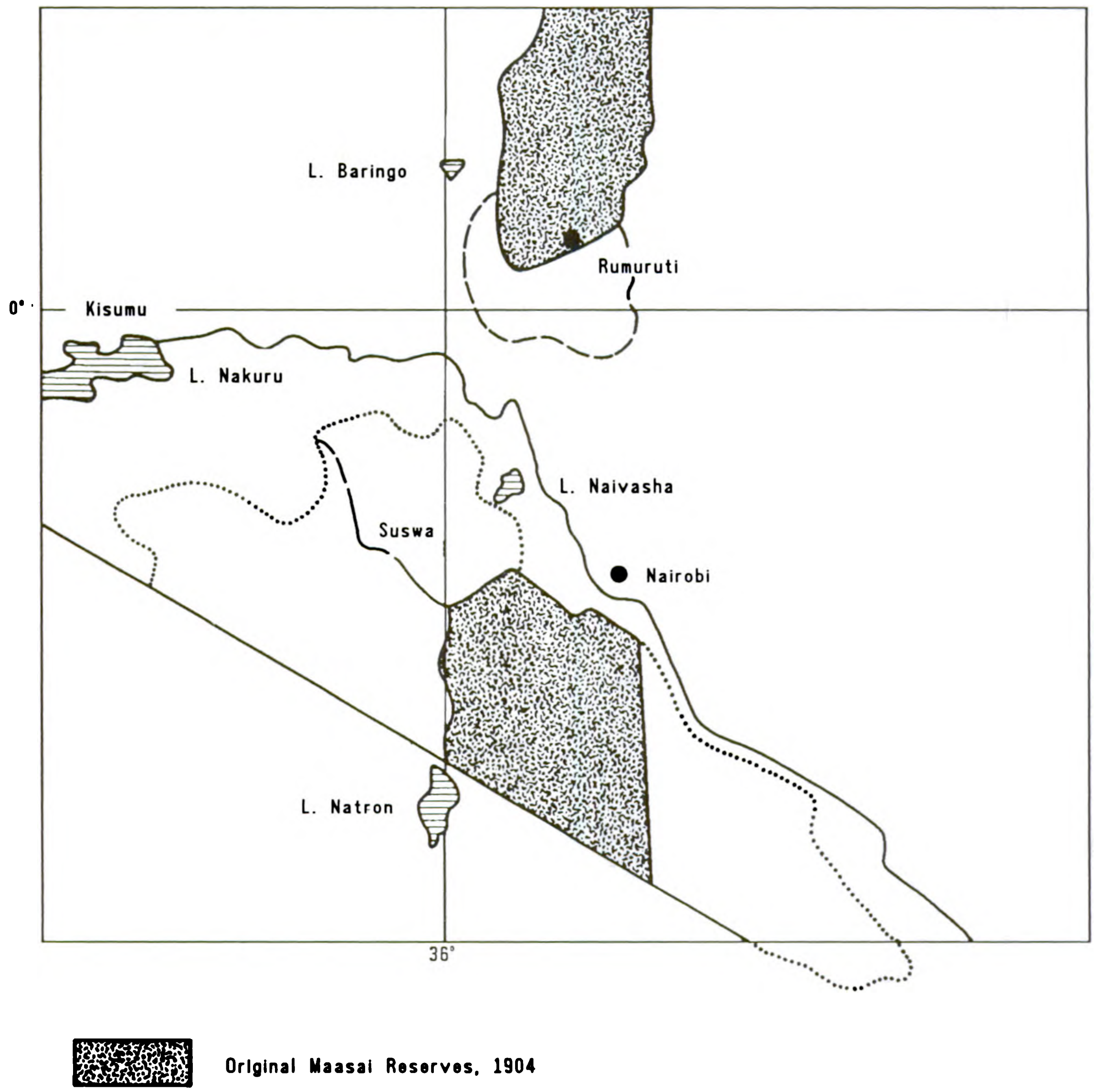
Maasai complaints about the encroachment of cultivation into dry-season grazing were common between 1940 and 1955. A drought in 1948–50 increased conflicts between the Maasai pastoralists and non-Maasai farmers; as a result in 1951 the County Council was given the power to restrict cultivation under Land Usage Bye-Laws. A state of emergency was declared in 1952 and thousands of Kikuyus were repatriated from Ngong and Loitokitok to their own reserve, temporarily reducing cultivation in Kajiado District (Campbell, 1979b).

In 1955 the Swynnerton Plan identified five conditions for sound and productive use of rangelands (Republic of Kenya, 1955:31; quoted in Campbell, 1981:223):

1. The numbers of resident stock must be limited to the carrying capacity of the land.
2. There must be assured and regular outlets which will absorb all excess stock.
3. An adequate system of permanent water supplies must be constructed.
4. Grazing must be controlled and managed at a productive level and owners must maintain their grazing area.

5. Based on a reference daily adult requirement of 2300 kcal, an output of 1 litre of milk per lactating cow, with an energy value of 700 kcal (Nestel, 1985), and about 20% of the total herd being cows in milk. In addition, each head of cattle is assumed to provide 50 kcal/day as meat. The required ratio is 12.1 head of cattle per reference adult or 9.7 per person. This agrees with Dahl and Hjort (1976), who estimated that a family of six needed 64 head of cattle.
6. This and Section 3.2.3 (*Origins of the group ranches*) rely heavily on the work of Campbell, particularly as reported in Campbell (1981). Other important secondary sources include Dahl (1979), Migot-Adholla and Little (1981), Ngutter (1981) and ole Pasha (1986).

Figure 3.4. *The Maasai reserves in Kenya, 1904–11.*



Source: Huntingford (1953).

5. Where access to grazing is denied by tsetse fly, provided such grazings will be controlled, the tsetse must be eradicated.

This Plan presaged the assumptions on which group ranches were eventually to be formed.

Following independence in 1963, the government promoted transfer of land from Europeans to Africans. This was done swiftly in the high-potential areas through the programme of land settlement and land transfer in the former scheduled areas owned by white settlers. By 1970, about 1.2 million ha of land had been adjudicated in the high-potential areas, in contrast to only 0.21 million in the range areas, including individual farms, ranches and group ranches. However, land was given to the landless, unemployed and "progressive" African farmers, and was not returned to the groups which occupied them traditionally. The Maasai colonial land losses were never recouped. The Government of Kenya has vigorously pursued adjudication of land to Kenyans on the basis of freehold tenure.[7]

In the period just prior to independence the Maasai were worried that the treaties of 1911 and 1912 would be abrogated and non-Maasai would occupy their land. Such fears were exacerbated by major migrations of farmers, particularly Kikuyu and Kamba, to the well-watered areas of Ngong and Loitokitok and the mounting pressure in these areas for adjudication into individual holdings. By 1964 more than 8000 ha of the best dry-season grazing around Ngong had been adjudicated into small individual farms. In addition, grazing land was being set aside as large individual ranches for Maasai leaders and government officials with the blessing of the District Council. By 1965, 22 000 hectares (out of 322 000 ha) in Kaputiei section alone had been allocated to 28 men (Lewis (1965), quoted by Hedlund (1971)). Between 1966 and 1969 more than 16 000 hectares on the higher-potential slopes of Mount Kilimanjaro were adjudicated, largely to non-Maasai, legalising the loss of this important dry-season grazing area.

In 1963 a Range Management Division was created in the Ministry of Agriculture to advise government and implement programmes for conservation, management and use of rangelands. The Division relied heavily on Brown (1963) for its analysis of the problems to be tackled in the rangelands. Brown (1963) saw the basic goal as range preservation, which could be achieved by limiting stock to carrying capacity and controlling stock movement through rotational grazing. He thought this could be achieved in areas with communal tenure by resuscitating communal grazing schemes, establishing individual ranches or establishing of corporate grazing associations with fixed areas of land.

3.2.3 Origins of the group ranches

In late 1965 the Kenyan Government submitted a proposal for a livestock project to the World Bank[8]. This proposed a variety of organisational structures for the different social and ecological systems in Kenya: for the better-watered pastoral areas, including Kajiado, this entailed changing the orientation of production from subsistence to commercial orientation, primarily through group ranching. The United Nations Development Programme (UNDP) and the Food and Agriculture Organization of the United Nations (FAO) agreed to help inventory the range resources, livestock and wildlife populations and hydrology as a basis for more detailed planning.

Staff of the Range Management Division noted that, in communally owned grazing areas, piecemeal approaches to changing production strategies had failed. They recommended an approach that would involve comprehensive programmes for well-defined communities sharing common interests with benefits clear to each individual and with flexibility to change as the people progressed from traditional to more commercial production. They noted that the provision of infrastructures alone would not be sufficient: rather major changes in land tenure and organisation would be required.

Security of tenure was advocated as a key instrument in promoting the development of the pastoral rangelands. It was believed that security of tenure would reduce the pastoralists' tendency to overstock the ranges, increase their incentive to invest in range improvement and act as collateral for loans to invest in these improvements (Republic of Kenya, 1974).

When the Range Management Division originally proposed ranch adjudication it thought that the principles applied in the high-potential lands would also apply to the rangelands, i.e. the amount of resources allocated to a producer would be proportional to what he controlled at the time of adjudication, but "shares" would be in stock numbers rather than acreage. These stock rights would be negotiable. The exact number of stock would not be fixed because members of the group ranches would be encouraged to increase the carrying capacity of their land. The allocation of the increased number of animals resulting from increased carrying capacity would be decided by the group ranch committee, but it was hoped that some would be given to poorer households. Echoing the Swynnerton Plan, however, it was clear that many Maasai would have rights to too few stock to meet their subsistence requirements.

When the Land (Group Representatives) Act was enacted in 1968 it stated that "each member shall be deemed to share in the ownership of the group ranch in undivided shares." The issue of

7. Through adjudication, communal trust land becomes freehold title land with titles held either by groups or individuals.
8. This was revised in late 1966 to clarify land adjudication aspects and the role of a proposed UNDP project.

grazing quotas was not included in the legislation, thereby undermining the original concept.

3.3 The socio-economic impact of group ranches in Kajiado Maasailand

This section briefly describes the concept of group ranches, and the adjudication of land to group and individual ranches in Kajiado District. Particular attention is paid to territorial organisation and administration, and the current pressure for subdivision in some areas. Finally a brief review of the technical and social changes that have occurred on the Phase I group ranches from their establishment in 1970 until 1985.

3.3.1 The planners' concept of the group ranches

The group ranch concept represented a new approach to pastoral development and was a first attempt to radically transform a nomadic subsistence production system into a sedentary, commercially oriented system. It called for major changes in Maasai social and political organisation and livestock management strategies. The group ranch development plan envisaged:

- Adjudication of trust land into 'ranches' with freehold title deeds held by groups.
- Registration of permanent members of each ranch; these members were thus to be excluded from other ranches.
- Allocation of grazing quotas to members to limit animal numbers to the carrying capacity of the ranches.
- Development of shared ranch infrastructure such as water points, dips, stock handling facilities and firebreaks, using loans. Members would pay user fees and be collectively responsible for loan repayment.
- Members would manage their own livestock and would be able to obtain loans for purchasing breeding stock and cattle for fattening.
- A group ranch committee would be elected to manage all group ranch affairs including:
    - overseeing infrastructural development and loan repayments;
    - enforcing grazing quotas and grazing management;
    - maintaining the integrity of the group ranch boundary.
- The group ranch committee would be assisted by a hired ranch manager and the extension service.

It was decided to limit the first phase of group ranch development to one Maasai section, rather than to adjudicate the whole of Maasailand at once, as was the original intention of the Range Management Division. Kaputiei section was chosen in part because its leaders were strongly in favour of land adjudication because they feared encroachment on their territory by the 1-million-strong Wakamba in the north-west and by the Kisongo Maasai (the largest section in Kajiado) in the south-west. Elite Maasai were also carving out large individual ranches for themselves.

Although "Maasai" were consulted about the desirability of group ranches and were involved in their formation, these were primarily educated Maasai tied into the national political system. Many of them were also given individual ranches. The average Maasai had at best little understanding of the group ranch concept. Although most Kaputiei Maasai wanted security of tenure, many were not in favour of group ranches as initially designed. Some wanted the whole *oloshon* demarcated as one group ranch while others preferred each subsection to be a group ranch. Some wanted only individual ranches to be demarcated. Still others were never won over to the group ranch concept.

3.3.2 The land adjudication process

The land adjudication process changed with time and varied by *oloshon*. However, this section describes the basic procedure used to partition Maasai territory into individual and group ranches.

Each administrative division had a Land Adjudication Officer (DLAO) who was responsible for overseeing the adjudication procedure. Adjudication involved determining boundaries both between and within sections. To a large extent administrative boundaries were used in the initial stage as these tended to coincide with sectional boundaries.

The rough boundaries of large areas called "adjudication sections" were drawn after discussions with chiefs and elders of a section and its neighbouring sections. These boundaries were based largely on a combination of boundaries of administrative divisions and Maasai locations or subsections. After the boundaries of each adjudication section had been approved by the Registrar of Group Lands in Nairobi, the DLAO and local chiefs called a meeting to declare the adjudication section open and to appoint a committee to divide it into ranches and to register members. At this stage the issue technically became an internal, local one. However, particularly in Phase I, there appears to have been considerable interference by planners to ensure that each ranch was a suitable size and that ranch boundaries would be permanent and easy to recognise (e.g. a straight line from hill A to hill B).

Once the boundaries of the group ranches were determined, each household head was told to register for one ranch. Although in theory a person could register for only one ranch (group or individual), in practice people were commonly able to register for more than one ranch. In order not to cut off any Maasai from their culturally defined right to residence and grazing in their section, great efforts were made to register all Maasai, whether or not they were still engaged in pastoralism at the time. Maasai age-sets were used to determine a man's eligibility to register for ranch membership: A senior moran could register only if his father was deceased; a few widows and unmarried mothers were registered in trust for their children if none of the latter had reached senior moranship. In potentially arable areas, non-Maasai who had been resident for a long time were also registered.

Once registration was complete, people were given 60 days to make protests, after which the results of the adjudication were binding.

3.3.3 Phase I group ranches[9]

In 1964 the Range Management Division established the prototype group ranch, Poka, in Kaputiei section to test the feasibility of the group ranches. Poka consisted of 36 self-selected members on nearly 9000 ha of some of Kaputiei's best grazing land. The Division gave ranch members considerable technical and financial support. Water points and dips were built in 1965. The ranch was given a loan in 1967 under which every member received a Sahiwal bull and cash to buy steers for fattening; poorer people were also given credit to buy breeding stock.

Between 1968 and 1970 14 group ranches were established in Kaputiei. Several individually owned ranches were also adjudicated; these largely gave legal status to existing operations of Maasai elite. In the northernmost part of Kaputiei members of three group ranches resisted their establishment and began a legal battle for individual title deeds. In addition to being close to Nairobi, this area lies within the Athi-Kapiti plains and is of much greater ecological potential than most of the *oloshon*. There were also disputes over the Kitengela game conservation area, which the government wanted to add to the Nairobi National Park. The Maasai occupied the area, and eventually forced its adjudication into individual ranches.

With the Phase I ranches it seems that most producers registered in the location they were using at the time of adjudication. However, some signed up in areas they thought preferable to their immediate location; some educated groups of relatives signed up in different group ranches to maximise future access to dispersed resources, and some allegedly managed to register even minor sons. Committee members complained that the land adjudication officers did not follow their recommendations, claiming they were better trained to determine boundaries. In addition, they appeared to be swayed by certain local groups who were strong enough to expand their ranches at the expense of less vociferous groups. Even today, boundary disputes remain a problem in Phase I group ranches.

Planners in Phase I had strong ideas about the optimal size for group ranches and exerted a lot of pressure to make sure that ranches fitted these. They were clearly concerned about ecological viability, as this was a necessity for boundary maintenance. However, they were equally concerned that the group ranches be small enough in terms of numbers of members to be workable with elections and committee decision-making. Hence they rejected suggestions that the section or subsections should be the basis for group ranches. Planners reduced their efforts to impose their ideal ranch size in later phases as it became clear that even the small units were not working effectively, as adjudication moved to drier areas, and as the Maasai became more forceful in demanding their way. As a result, Phase I group ranches are, on the average, the smallest to be found in Kajiado District, averaging only 16 300 hectares, with an average number of registered members of 155 in 1984.

Clearly the Maasai espoused the concept of group ranches largely to stem encroachment of farmers of other ethnic groups on Maasai territory and because of the promise of finance to develop ranch infrastructure (Njoka, 1979). However, they apparently never accepted the idea of grazing quotas. These were to be allocated to each house-

9. This section is based largely on the work of Davis (1970), Hedlund (1971) and Halderman (1972).

hold in proportion to the number of animals owned at the time of incorporation; thus people with large herds at the time of incorporation would have had, in perpetuity, greater rights than people who were poor then. This goes against the Maasai ideology of equal opportunity which rejects fixed wealth or class statuses. Even now in Kaputiei subdivision of group ranches is discussed in terms of equal amounts of land[10].

Originally, the group ranch concept included provision for the purchase of steers to fatten in years of good rainfall to take advantage of higher carrying capacity. This was aimed at poor households, to compensate them for their low grazing quotas. In practice, however, the loans have been given to the group ranch as a whole and the profits used to pay off its ever-accumulating debts.

Boundary maintenance was also an integral part of the group ranch concept. By tying people to small fixed areas of land, it was hoped to sedentarise the Maasai, to make them aware of the scarcity and value of land, and to encourage them to make the investment necessary to improve the land. Clearly the Maasai now realise that land is both finite and valuable, and increasingly, they identify with their group ranch rather than with their section, particularly in Kaputiei. Group ranches often try (although weakly) to prevent non-members from using their land; this parallel earlier attempts by one section to discourage grazing by other sections on their lands. However, Maasai still acknowledge the need for mobility during drought and realise that people cannot be restricted to their own ranch at all times. They thus do not believe strict boundary maintenance is either possible or desirable.

3.3.4 Subsequent phases of group ranch development

The World Bank Appraisal mission recommended that Phase I group ranches be limited to Kaputiei section and that the effect of these be studied before adjudication spread to the rest of Maasailand. This did not happen for several reasons. First, the establishment of Phase I was delayed, partially because of delays in passing the necessary legislation. In addition, once the process of adjudication began in Kaputiei, other sections became concerned about possible loss of their land, and the declaration of adjudication areas (but not group ranch incorporation) was completed throughout Maasailand during the Phase I time period. The actual division into group ranches and their incorporation came in two later phases, Phase II (1975–78) and Phase III (1979–present), and in some areas is not complete.

The Office of the Registrar of Group Lands has had only one senior officer throughout the project periods. This has significantly hampered close interaction with the adjudication committees. In addition, as responsibility for group ranches was shifted from the Range Management Division (which developed Poka) to the Agricultural Finance Corporation (which the World Bank felt would better control financing decisions), field efforts seemed to dwindle. This problem was exacerbated as the number of ranches increased. Ranches developed in Phases II and III appear to have had far less input (and perhaps interference) than the Phase I ranches.

In Phase III, meetings to open adjudication areas and form committees were often held in towns rather than in traditional meeting places. Older, more conservative Maasai, including some of the wealthiest producers, were often against group ranches and boycotted the meetings, only to find that committees were formed of young, more urbane men, often traders with good Swahili skills and urban connections. These committee members awarded themselves large individual ranches, relegating the conservative people to a "residual" group ranch area. This led to conflicts and many areas, particularly in Keekonyoki section, are still not incorporated. Although they appear on paper as group ranches, the ranches are being subdivided.

In better-watered areas, many Maasai resolved to avoid group ranches and move directly into individual tenure. Government policy at the time did not approve of this procedure, largely out of concern for ecological viability of small holdings and a determination to make group ranches work. The result was delays in incorporation, or acceptance of incorporation into a group ranch to ensure a title deed with the tacit understanding that as soon as government policy permitted, individual titles would be obtained.

In drier areas, particularly in the southern and western parts of Kajiado, the Maasai established much larger group ranches, the borders of which essentially coincided with the original adjudication sections. This was largely true in Lodokilani and

10. Although the Maasai have a strong ideology of equality, actual livestock holdings at any one time vary markedly (see Section 1.2.2: *Producer heterogeneity and sampling design*).

Matapato sections and in Kisongo section (except the arable areas). Thus, whereas the mean size of Phase I group ranches was 16 300 ha, the mean size of later group ranches was over 34 000 ha and the average number of members was over 300.

Whereas traditionally there were eight sections in Kajiado District with a mean size of 2275 km^2, in 1985 there were 51 group ranches, with a mean size of 300 km^2, and hundreds of individually owned ranches. Whereas early on in the adjudication of Kajiado District large individual ranches were the prerogative of the elite, later, as some people refused group ranches, their areas were individually adjudicated, but into much smaller ranches. It seems, however, that the land is still largely used communally in many of these areas.

3.3.5 Group ranch functioning

The group ranch structure has reduced the flexibility and mobility of the traditional Maasai system. Maasai are no longer free to move wherever they want within their sections or even within their subsection. Some localities and even neighbourhoods have been split by group ranch boundaries. Group ranches have exacerbated the erosion of traditional authority begun in colonial times, including the authority to control grazing resources, but in general the group ranch committees have not been able to replace the traditional authorities.

The effect of imposing group ranch organisation was demonstrated in Mbirikani, the southern-most study site, which was incorporated in 1980 (Peacock et al, 1982). Although the traditional neighbourhood-based grazing system had been disrupted numerous times in the recent past, for example by the loss of land to Amboseli National Park and the development of new water points, it had adapted and remained essentially intact (see Section 5.3.3: *Grazing patterns and stocking rates in the southern ranch*). However, when the area was hit by a minor drought in late 1981 and 1982, control over grazing broke down. As Peacock et al (1982:29) stated:

"*It is unclear to both group-ranch committee members and non-members what role, if any, the recently formed group ranch committee has either in the old system, or in creating a new system of grazing resource control. There is in many ... [neighbourhoods] in the ranch a vacuum of authority, whilst in other neighbourhoods the residents are trying hard to maintain the old order.*"

When people returned to the ranch at the end of the drought, they proposed restoration of traditional-style grazing control, with areas set aside for residence and for grazing during different seasons. This was accepted by the committee and enforced by the administration police, and was continuing through to 1985, when this study ended.

There is no record of similar events in Kaputiei. However, many elders say that the group ranch committees were unable to enforce grazing regulations, and in several known instances fines were levied by committees but were not collected. In extreme cases, water points that were developed under the group ranches according to Range Management Division plans were left in disrepair as the only way to enforce grazing control in what had previously been dry-season reserves.

Despite the trend towards increased sedentarisation, producers are still concerned about being confined to a single ranch. Although they tend to stay within their group ranch boundaries in normal times, especially where the group ranch includes traditional neighbourhood grazing areas, producers move beyond ranch boundaries in times of stress. For example, in June 1982, at the height of a moderate drought in Mbirikani, 75% of the sample herd were grazing outside the ranch; they remained outside the ranch until the rains resumed in November. In the droughts of 1984, 85% of Olkarkar households sent most of their cattle off the ranch (Grandin and Lembuya, 1987).

3.3.6 The impact of group ranches on territorial organisation and administration

The Kaputiei section covers about 310 000 ha (Table 3.4), all of which under the traditional system would theoretically have been available to each producer who was a member of the section. However, households tended to stay in the same subsection and even the same locality.

The effect of the organisation of group ranches is demonstrated by one locality in north-eastern Kaputiei section. Before the group ranches this is

Table 3.4. *Size of, and number of households in, each subsection in Kaputiei section before introduction of group ranches.*

		Size (ha)	Approximate number of households
North		96 000	800
South	– Matapato	80 000	700
	– Kenyawa	134 000	600
Whole section		310 000	2100

thought to have covered about 40 000 hectares, with three permanent water points and about 10 neighbourhoods. Producers had free access to all the grazing and water sources throughout the locality.

In 1970 the locality was broken up among four different group ranches. Members of each ranch retain close relationships with members of the other ranches; intermarriage is common, much gifting of livestock and other forms of sociability and mutual cooperation across ranch boundaries. However, there have been disputes between ranches over calf pastures that were formerly shared, over the location of new calf pastures and over access to surface water.

Group ranches in Kaputiei section had a mean area of 16 900 ha (Table 3.5). Thus, from having potentially free access to 310 000 ha of grazing, each Kaputiei producer has been restricted to only one twentieth of that area.

Internal administrative reorganisation

Traditionally, Maasai local affairs were decided by groups or councils of elders on the basis of consensus. Producers who disagreed with the majority were free to go to another *boma*, neighbourhood or locality. In contrast, group ranches required management by democratically elected committees with the authority to impose their will on members, who are permanently tied to the ranch.

Effective bureaucratic organisation requires the virtual absence of prior ties among individuals, while democratic decision-making can be effective only in the absence of serious factions or when conditions prevent a single faction from dominating. These conditions are not met by the Maasai, with their complex ties and tradition of individual autonomy. As a result, group ranch committees tend not to meet. If they do meet, they deal in non-controversial generalities or, if they address specifics, are unable to reach a conclusion. Even if the committee reached a conclusion it would not be able to enforce it (Dyson-Hudson, 1985).

In summary, the formation of group ranches introduced a new level of territorial and administrative organisation and a new method of decision-making, aimed at radically changing Maasai production. In practice, however, they have incapacitated traditional leadership in many parts of Maasailand, without providing a workable substitute.

3.3.7 Pressure for subdivision of group ranches

As noted earlier, high potential lands near Ngong and Loitokitok were adjudicated in the mid-1960s into individual farms with freehold tenure. At the same time elite Maasai were claiming large individual ranches on the plains. This made it difficult for policy-makers to continue to force group title deeds on people in other parts, despite the concerns of the policy-makers about the viability of individual holdings.

Even at the inception of KLDP I, some Maasai in better-watered areas of Kaputiei near Nairobi refused adjudication into group ranches and pressed for individual tenure. As problems with group ranches became apparent, Maasai in areas that had not been adjudicated opted to move directly to individual tenure. Many areas which initially accepted group ranches are now pressing for subdivision. According to Jacobs (1984a), 29 of the 52 group ranches in Kajiado District have passed resolutions to subdivide. Seven of these had, *de facto*, subdivided land equally among the registered members but were awaiting official adjudication and issuance of title deeds by the government, which will not permit subdivision while a ranch has loans outstanding. The remaining 22 were at various stages in the process leading to subdivision. Several had never functioned as group ranches, but used the group-ranch concept merely as a device to secure borders.

Table 3.5. *Number, size and membership of group ranches and approximate number of individual ranches in Kaputiei section in 1980.*

	Number	Mean size (ha)	Number of registered members[1]	Approximate number of individual ranches
North	3	15 750	143	450[a]
Matapato	5	16 000	140	0
Kenyawa	7	18 000	106	7
Whole section	15	16 900	125	457

[1]As of 1980, there has been an estimated increase in membership of 20% since that time (Jacobs, 1984b).

[a]Largely from the refusal of proposed group ranches and immediate move to individual holdings (Jacobs, 1984b).

Excludes the Ngong area.

The seven group ranches that had implemented subdivision were all close to urban centres, had areas of arable and irrigable land, and were among the first group ranches in the District. In contrast, ranches that had resolved not to subdivide had no arable land; they are all located in the drier parts of the western, southern and south-eastern parts of the District. The only exception to this is Kimana group ranch, which has patches of irrigable land along the Kimana swamps (ole Pasha, 1986).

The desire and haste for individual tenure stems from a variety of factors including:

- wanting a title deed as collateral for loans, which are denied to group ranchers as individuals;
- frustration with the inefficiency of the organisation/ management of group ranches;
- a burgeoning group of mature young men who want their own land (and collateral) rather than a share of their father's land;
- fear of further land alienation, enhanced by the government's inability to control squatting on group ranches; and
- a general move towards more individual production (Grandin, 1987a).

Those who oppose subdivision do so on several interrelated fronts: They believe that while non-Maasai were kept out of Maasailand by the group ranches, these people would find it easy to buy individual holdings. This would lead to an influx of outsiders, especially farmers taking up arable land. Increased cultivation would result in severe erosion, such as that experienced in other parts of Kenya, e.g. Machakos District. In addition, the presence of large numbers of non-Maasai among the Maasai would result in the erosion and eventual loss of Maasai culture, which they want to see preserved. Finally, they believe that people holding individual title over a piece of land will tend to see that land as their private property and protect it as such. This will curtail the usual livestock movements across what was group-ranch territory. People who grow crops will be forced to fence their farms or gardens to protect their crops from wildlife and livestock, further restricting movement of livestock (ole Pasha, 1986).

3.4 A summary of major changes in the last 20 years

The 20 years since Poka, the prototype group ranch, was established have witnessed a number of major production and social changes in Maasailand. Despite the paucity of data on the situation before the group ranches, the difficulty of segregating project effects from time effects, and the complexity of analysis arising from climatic fluctuations, some indication of the general impacts of group ranches can be observed.

3.4.1 Technical parameters

Infrastructural development

Twenty-three dips and 31 water points were installed on Phase I group ranches. By 1981 only 11 dips and 19 water points were still functional. On many group ranches, stock were dipped regularly only when acaricide was being provided using money from loads. Generally, the group ranches did not develop mechanisms for providing acaricide or a dip attendant.

Cattle herd structure and offtake

The structure of the cattle herd did not change significantly between 1967, before the establishment of the group ranches, and 1981; the proportion of females in the herd remained constant at 67% (King et al, 1984). This indicates that the Maasai continued to manage their cattle for maximum milk production and recovery, rather than opting for increased beef offtake, as the project intended.

Offtake of cattle from Maasailand has increased since the early 1960s. This may be primarily an increase in absolute numbers rather than in rates, although the decline in the number of livestock per person apparently necessitated increased rates of sale of livestock and purchase of foodstuffs (see Section 3.2.2: *Historical influences on land use*; Section 8.5: *Household patterns of income and expenditure*).

Cyclical fluctuations in animal production

Maasai pastoralists have always suffered large losses of stock during droughts (see Section 3.2.1: *Human and livestock population trends*). The establishment of group ranches did not appear to alter this during the droughts of 1976 and 1984, when they again lost a large proportion of their stock.

New inputs and strategies

The degree to which the group ranches have altered management strategies cannot be determined with available data. However, there are indications that members of group ranches:

- move their animals over shorter distances;
- make wider use of acaricide and other veterinary preparations;

- make wider use of salt licks, especially for smallstock;
- water their stock more often; and
- make more use of improved breeds of cattle, especially the Sahiwal.

Range conservation

The livestock population has not been reduced by introducing group ranches because the Maasai rejected the principle of grazing quotas. The planners apparently never determined the number and combination of animals needed to support a family from year to year and general voluntary income redistribution is no more feasible among Maasai than it would be in other societies (Dyson-Hudson, 1985).

ILCA's data on range condition indicate that, in all ranches, grazing is heaviest around human settlements, not around water points. In general, the range has regenerated well following the last two droughts, which suggests that degradation of the rangelands is not increasing. However, the data indicate that the post-drought recovery of the rangeland was possible only because of the continuation of the traditional cycle of boom and bust, i.e. because of the large reduction of the livestock population following the drought.

Introduction of cultivation

Increasingly Maasai are cultivating their land, despite strong cultural proscriptions on digging the ground (Jacobs, 1975). Njoka (1979) found that 60% of the Kaputiei households surveyed had tried cropping. More families had started cropping in the aftermath of the 1974/75 drought than had done so in all previous years (35% vs 25% of households).

Preliminary observations indicate that:

- although crop production (mainly maize and beans) is increasing, many families grow crops in post-drought periods but abandon cropping when herds and flocks recover;
- much of the cultivation is done by non-Maasai, including hired labourers from neighbouring agricultural groups, or, less commonly, by non-Maasai wives.

Rainfed crops yield well about one season in three in all but the best watered parts of Maasailand. A few Maasai have gained land in well watered or irrigable locations, but data suggest this is often rented to non-Maasai.

3.4.2 Social parameters

The impact of group ranches on territorial organisation and administration has already been outlined. Equally important changes have occurred at lower levels of socio-spatial organisation, especially affecting residence and *boma* composition. Other, related changes include increased individualisation of production, and decline in the political role of age-sets and clans.

Decreased *boma* size

The mean size of a *boma* in Kaputiei fell from 6.2 households in the 1950s to 5.1 households in the 1960s and 2.7 households in the 1970s (Njoka, 1979). Single-household *bomas*, traditionally anathema, became more common in the 1970s. Although the large decline in *boma* size coincided with the introduction of the group ranches it may not have been caused by their introduction; Jacobs (1979) noted a similar decline in *boma* size in Tanzania Maasailand, where group ranches have not been introduced.

The *boma* was traditionally the unit of cooperation in herding, and decline in *boma* size has important implications for livestock management (see Section 5.1.1: *Household size and composition*).

Sedentarisation

The people and animals of Kaputiei section have become more sedentary since group ranches were introduced there. There are indications that this is also happening in Kisongo section. Neighbourhoods and *bomas* are beginning to break down as individual producers spread out across the landscape, establishing individual *bomas* and often establishing their own individual calf pastures (Grandin, 1987b).

According to Maasai tradition, a man-made improvement (e.g. a well) gives the builder a special claim to the surrounding area. The Maasai view the building of permanent domestic structures largely as a way to claim land. In 1978, out of 365 *bomas* sampled in north-eastern Kaputiei, 65 had permanent structures, primarily houses, of which 82% had been built since the establishment of group ranches (Njoka, 1979). Most *bomas* had only one permanent structure; most people continue to live in traditional houses.

Although the Maasai see advantages to sedentarisation, particularly in terms of human comfort, it also brings socio-psychological problems. Pastoralists were used to walking away from any social problem, and thus have less well developed institutions to cope with disputes than settled farmers.

Individualisation of production and social decline

Patterns of cooperation among Maasai seem to be beginning to change. For example, the declining size of the *boma* seems to be in response to a desire for less cooperation in animal production, as illustrated by an unwillingness to share purchased inputs. Maasai claim that herds are smaller now and thus there is less need for cooperative herding. Nevertheless, this apparent decline in cooperation has coincided with an increase in the proportion of children attending school, leading to labour shortages and the use of women and occasionally hired labour for herding (see Section 6.1: *Labour*).

Maasai now obtain some livestock production inputs, such as breeding stock, labour and veterinary drugs, through the market place as well as through social channels. As they become more sedentary, the Maasai have tended to develop and maintain few, close ties; the importance of widely dispersed social ties, especially those of clanship and age-set, is apparently declining. For example, fewer animals are lent, exchanged or gifted in Phase I group ranches than in more recently established ranches (see Section 8.2.2: *Sales and purchases*).

Dietary changes and health care

The traditional Maasai reliance on milk for subsistence has begun to change dramatically, largely due to increases in human population, but also to the unequal distribution of cattle among the population.

In the past all Maasai would eat agricultural foodstuffs during droughts. Now, however, poor people rely primarily on agricultural foodstuffs throughout the year, while the rich depend on them in the dry season and use them in the wet season for dietary variation. The most important foods are sugar, tea, maize, beans, rice and potatoes. Whereas sugar and tea have had an important role for over a generation, the others are relatively new additions to the diet. Most of the agricultural foodstuffs consumed are purchased with proceeds of the sale of stock. However, as noted earlier, increasingly Maasai are trying to grow crops, particularly after droughts.

There are two hospitals in Kajiado District, one each at Kajiado and Loitokitok towns. There are clinics and health dispensaries in major trading centres throughout the District; these offer free services and medication. Maasai also buy drugs from shops for curing simple ailments such as colds, headaches and malaria. Nestel (1985) reported that up to 70% of children had been inoculated, although full courses of vaccination were much less common. More than two-thirds of people sampled sought modern medical attention when seriously ill. Nonetheless, the traditional healers (*laibons*) and herbalists still play an important medical role.

Education

Maasai are increasingly aware that they live in a changing world, that the lives of their children will be very different from their own. They stress the importance of education to the child's general ability to cope with the wider environment; as they deal more and more with non-Maasai, they realise that both literacy and a sound knowledge of Swahili is necessary (see Section 6.1: *Labour*).

The reason most commonly given for sending children to school, however, is the hope that they will find employment. Parents view a son's education as a good investment, citing cases of employed children sending money to their parents to buy cattle. Unfortunately, the prospects for employment for Maasai school-leavers seem limited and many remain in the ranches as pastoralists and traders.

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Chapter 4

The study area: Biophysical environment

P N de Leeuw

A knowledge of the land, livestock and people of the study area is needed to understand their interplay in shaping the livestock production system. Hence, this chapter deals with the biophysical environment (climate, grazing and water resources) of the study area as observed between 1981 and 1983. This is discussed further in the context of long-term trends in Chapter 10 (*The long-term productivity of the Maasai livestock production system*). Chapter 5 (*The study area: Socio-spatial organisation and land use*) centres on how people and their livestock use these resources.

This chapter begins with a general outline of the assets of the three group ranches in terms of land, people and livestock. This is followed by sections describing the landscape, soils and vegetation. The discussion of the characteristics of the climate, particularly rainfall, emphasises the differences between the semi-arid north and the arid south and the implications of these for the fodder resources and carrying capacity of the rangelands.

4.1 Land, people and domestic and wild herbivores

The study area comprised three group ranches, Olkarkar, Merueshi and Mbirikani, in eastern Kajiado District (Figure 4.1).

Olkarkar had higher densities of both people and livestock than the other two ranches (Table 4.1)[1]. As a result, the amount of land available per person and per livestock unit increased from north to south in the study area.

Wild herbivores add roughly 25 to 30% to the livestock biomass in the study area. Grazers, e.g. wildebeest and zebra, account for some 40% of the wild herbivore biomass, or some 10% of total livestock biomass (see Section 2.3.5: *Herbivore population*).

4.2 Landscapes, soils and vegetation

Landscapes

The distribution of different landscape units in the study area is shown in Figure 4.2. The characteristics of the units (their land-form, geology and vegetation physiognomy) are listed in Table 4.2.

The physiography of the whole study area is influenced by the Chyulu Hills, which bound the area to the east. The Chyulu Hills consist of an upper-level plateau rising to an altitude of 2000 m (unit 2), which is surrounded by lava flows (unit 3) and a mixture of smaller lava ridges, uplands and footslopes (unit 8).

To the north-west of the Hills volcanic uplands are prominent, rising to an altitude of about 1200

Table 4.1. *Land, people and livestock in three group ranches.*

	Olkarkar	Merueshi	Mbirikani
Size (km^2)	102	183	1350
No. of households	40	36	250
People	400	414	2 700
Cattle	6500	5270	41 500
Smallstock	6720	3170	19 500
Land availability			
ha/person	25	44	50
ha/household	255	508	540
ha/TLU[1]	1.7	3.9	4.3

[1]Tropical Livestock Unit (TLU) weighs 250 kg (cattle = 0.83 TLU in the north and 0.70 in the south; smallstock = 0.1 TLU; data from mid-June 1982).

Stock populations refer to census estimates of resident populations in June 1982 for Olkarkar and Merueshi, and to aerial survey counts of all stock in December 1982 for Mbirikani (King et al, 1985). The latter were used because census estimates for this ranch as a whole were not available.

1. The human and livestock populations shown in Table 4.1 apply to years of average rainfall only and not to drought years. During the minor drought in 1982, most of the people and livestock left Mbirikani (for details, see Section 5.3: *Water utilisation, grazing patterns and stocking rates*). Even the northern ranches, which in normal years have a fairly sedentary population, experienced emigration during the severe drought of 1984 (Grandin et al, 1989).

Figure 4.1. *Map of the study area.*

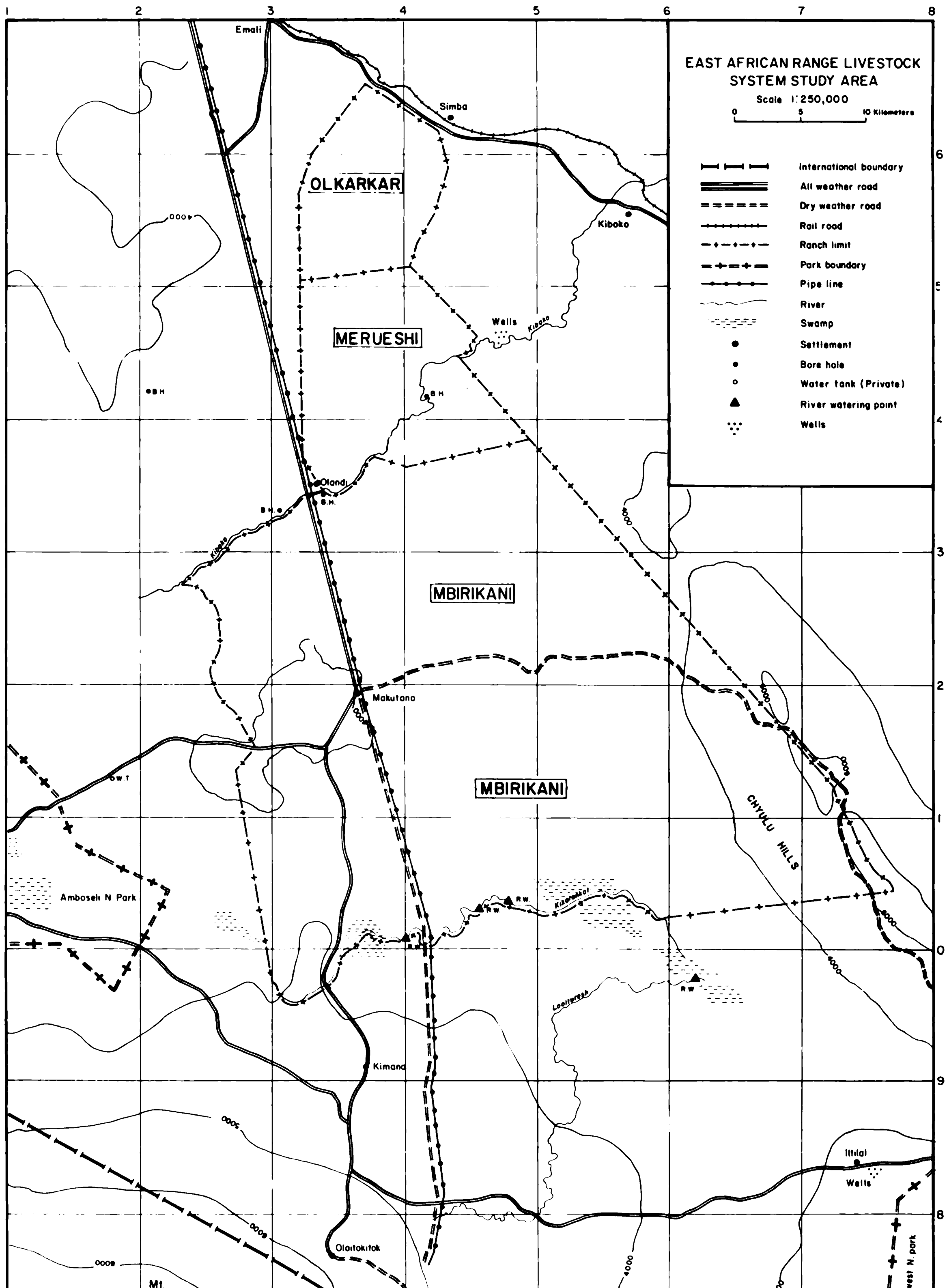
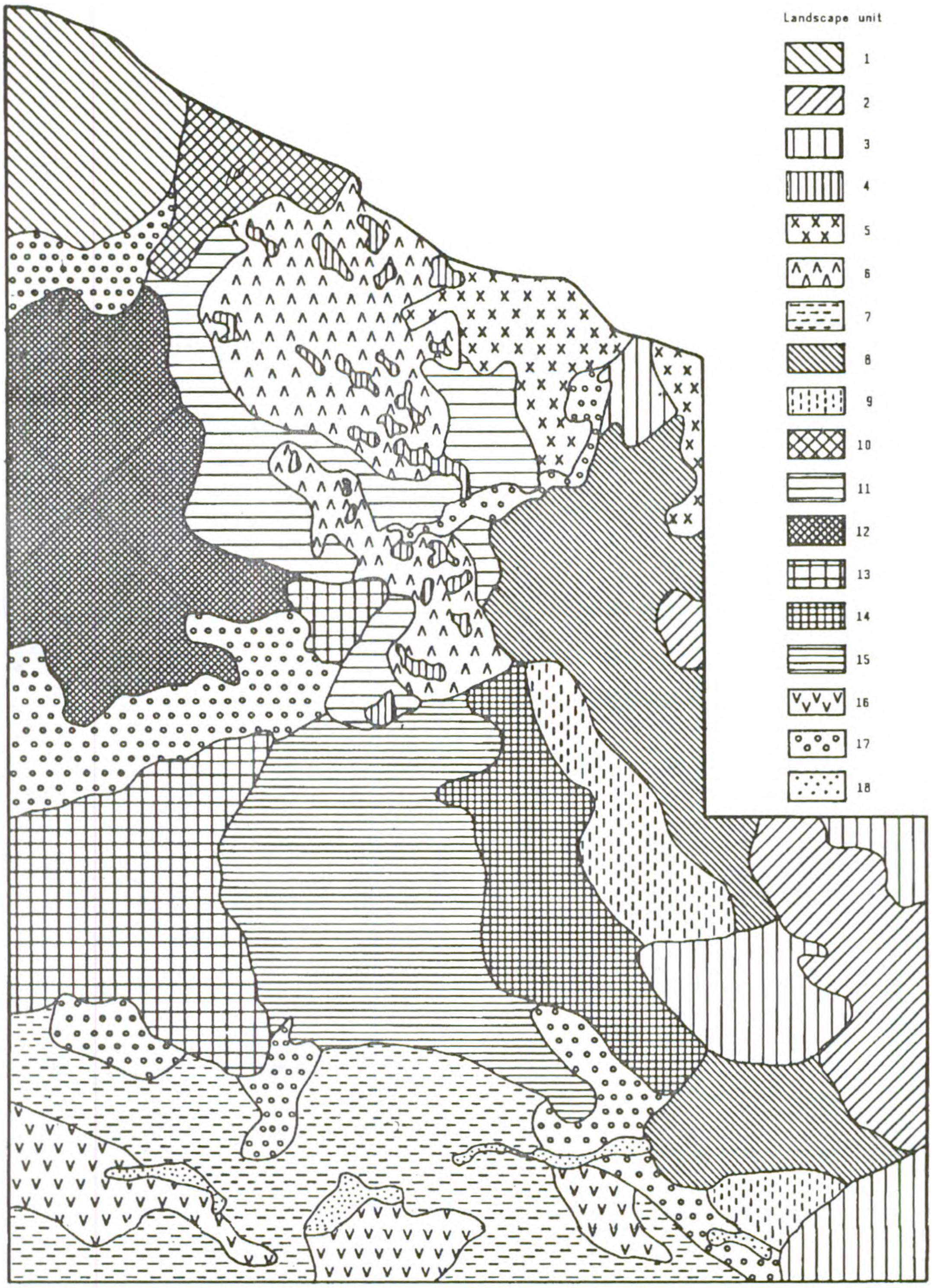


Figure 4.2. *Distribution of landscape units in eastern Kajiado District. The units are described in Table 4.2.*



m (unit 6) with cones and hills another 100 m above the rolling surface (unit 4). These uplands are the principal landscape in Olkarkar and continue into the northern and eastern part of Merueshi Ranch. To the east of this area is another upland unit (unit 5), with soils developed over basement complex; this unit covers most of the adjacent Kiboko Ranch.

Table 4.2. *Landscape units and their characteristics in eastern Kajiado District.*

Map unit	Land-form	Geology	Vegetation	Location[1]	Area %	Area km²
1	Hills	Basement complex (gneiss)	Bushland, woodland and thickets	NW, Olgumtus mountain	4.1	150
2	Upper slopes	Volcanic (Recent)	Sub-montane grasslands	Chyulu Hills	5.4	200
3	Lava flows	Volcanic (Recent)	Lava forest	Chyulu Hills	4.3	160
4	Cones	Volcanic (Pleistocene)	Bush- and grassland	North and Central	2.2	80
5	Uplands	Basement complex	Bushed grassland	NE, Kiboko	2.7	100
6	Uplands	Volcanic (Pleistocene)	Open and bushed grasslands	Olkarkar and Merueshi	6.5	240
7	Uplands	Volcanic (Pleistocene)	Bush- and woodland	South	10.8	400
8	Plains	Volcanic (Recent)	Open and bushed grass-lands, patches of lava forest	Chyulu Hills, SE Mbirikani	9.5	350
9	Plains	Volcanic (Recent)	Grassland	SE, Mbirikani	3.3	120
10	Plains	Volcanic (Pleistocene)	Grassland	NW, Poka	1.6	60
11	Erosional plains	Basement complex (with volcanic ash)	Grasslands	Central (Kiboko, Merueshi, Mbuko)	5.4	200
12	Erosional plains	Basement complex	Bush- and woodland	NW	8.7	320
13	Erosional plains	Basement complex	Bushed and wooded grass-land	SW	6.5	240
14	Erosional plains	Basement complex (with volcanic ash)	Open and bushed grassland	E Mbirikani	4.9	180
15	Erosional and piedmont plains	Basement complex and colluvium	Bushed grassland	S Mbirikani	10.3	380
16	Piedmont and lacustrine plains	Colluvial and alluvial deposits	Wooded grassland and woodland	South	3.8	140
17	Floodplains and bottom-land	Alluvial deposits	Grassland	Various	8.9	330
18	Swamps	Alluvial deposits	Grassland	South	1.1	40

[1]See Figure 4.2 for location of landscape units.
Source: Touber (1983).

To the south and west of these uplands are erosional plains over gneissic basement complex (units 11 and 12); these extend south along the western boundary of Mbirikani (unit 13). These flat or slightly undulating plains are bounded in the south by another series of volcanic uplands (unit 7), which are studded with small irregular outcrops of basaltic boulders. This unit forms the southern boundary of Mbirikani and extends south to the foothills of Kilimanjaro.

In the central part of Mbirikani, erosional plains form a lower-lying trough (1100–1150 m; units 14 and 15), merging with the Chyulu foothills to the east. The Kiboko river flows north-eastwards through these plains. In the south, the plains are broken by the Kikarankot River and its associated swamps (unit 18) and lacustrine plains (unit 16). The floodplains and bottomlands that flank these river systems are shown as unit 17.

Soils

The diverse physiography of the study area has resulted in a wide range of soils, most of which are deep and fine-textured. On the volcanic uplands and plains the soils range from stony Cambisols on the upper slopes to dark, cracking Vertisols in bottomlands and valleys. In the Chyulu Hills the main soils are Lithosols on lava flows, Andosols on coarse ash deposits and deep Luvisols on the flatter plains. Soils overlying gneissic basement complex are generally sandy, well drained and susceptible to erosion. The plains in the central, driest part of Mbirikani feature dark clays with vertic and saline-sodic properties (Touber, 1983).

Vegetation

Treeless grassland covers more than 40% of the study area (Table 4.3), including large parts of Olkarkar and Merueshi (unit 6) and almost all of the eastern part of Mbirikani (units 9, 14 and large parts of unit 15).

Table 4.3. *Density of woody cover in the study area.*

Physiognomy	Woody cover (%)	Per cent of total area
Open grassland	0–2	42
Wooded and bushed grassland	2–20	20
Bush- and woodland	20–40	30
Dense woodland and forest	>40	8

Derived from Touber (1983).

Woody cover is found on units over basement complex, such as the northern plains and uplands (units 5 and 12). The southern fringe of Mbirikani is also somewhat more wooded; bushland is largely confined to the basalt outcrops on the volcanic upland (unit 7), but there are extensive *Acacia tortilis* woodlands on the lacustrine plains (unit 16). There are also patches of acacia woodlands along the Kiboko river. Dense forest occurs only on lava flows in the Chyulu Hills.

Many woody species have been identified in the area (see, for instance, de Leeuw and Chara, 1985; Touber, 1983; Kemei, 1982), but the predominant species in most parts of zones V and VI are *Acacia mellifera, A. tortilis, A. nubica, A. ancistroclada, A. nilotica, Commiphora riparia, C. africana* and *Balanites aegyptiaca*. Less drought-tolerant species (e.g. *Combretum, Grewia* and *Premna*) are confined to zone IV and occur mostly in unit 1.

The species composition of the herbaceous layer is fairly uniform across the study area, despite the diversity of the landscapes and soils. Four principal grassland communities were distinguished, based on the dominant genera (*Chloris, Digitaria, Pennisetum* and *Sporobolus*), but many species occurred widely (Table 4.4). Data from permanent transects in the Kaputiei area showed the same tendency of uniform species composition across sites (Njoka, 1984).

Although perennial grass species made up most of the grazable biomass in most landscape units, annual grasses and forbs were important but variable components of the herbaceous layer. *Eragrostis cilianensis, E. tenuifolia, Dactyloctenium aegyptiaca, Aristida adscensionis* and *A. adoensis* contributed substantially to the biomass in good rainy seasons, as did a plethora of annual herbs (de Leeuw and Chara, 1985; Njoka, 1984).

Several grassland types also included dwarf shrubs and perennial herbs, many of which are important browse plants for sheep and goats (de Leeuw and Chara, 1985; Kamau, 1986). These shrubs and herbs were more common on sandy soils over basement complex than on heavy soils and were more abundant in intensively grazed areas. Thus, such perennials were commonest in units 5, 11, 12 and 13 and in overgrazed portions of unit 15 along the pipeline in Mbirikani.

It is difficult to assess the extent to which the species composition of the herbaceous layer affects the grazing potential of the different landscape units. The productivity of the different grassland types was much confounded with rainfall events (i.e. localised showers or storms) and with past use (see Section 4.5: *Water resources* and Section 5.3: *Water utilisation, grazing patterns and stocking rates*). However, species composition influenced the grazing habits of domestic stock. This was demonstrated by Semenye (1987) who, over three seasons in 1983, recorded the forage species selected by grazing cattle in five locations in the study area. He found that, across seasons and locations, *Chloris roxburghiana, Digitaria macroblephara* and *Pennisetum mezianum* together made up 50 to 70% of the animals' diet. This appeared to be related to the abundance of the species in the study area (Table 4.4). Kibet (1986) made similar observations at the National Range Research Station, Kiboko.

4.3 Climate

The study area straddles the semi-arid and arid zones (zones V and VI: see Section 2.1: *Agroclimatic zones and livestock-carrying capacity*). The northern ranches and the eastern part of Mbirikani are situated in the semi-arid zone; the remainder of Mbirikani is in the arid zone. Most of the study area is classified as "Lower Midland Ranching Zone", where rainfed cropping will succeed only in seasons in which rainfall is exceptionally good, i.e. above average and/or well distributed (Jaetzold and Schmidt, 1983).

Rainfall is distinctly bimodal throughout eastern Kajiado. The "first rains" fall from October to December and the "second rains" fall from March

Table 4.4. *Perennial grass composition of four grassland types.*

Species	North: Plains/uplands (6 + 10[a])	North: Uplands (11 + 12)	Bottomlands (7)	South: Uplands (9)	South: Plains (15)	Per cent selected in grazing diet[b]
Aristida keniensis	x	x	x	–	x	6
Bothriochloa insculpta	–	x	x	–	x	2
Cenchrus ciliaris	xx	xx	–	–	xx	2
Chloris roxburghiana	xx	xxx	x	x	xx	20
Chrysopogon aucheri	x	–	–	xxx	x	3
Cynodon dactylon	x	x	x	–	x	–
C. plectostachyus	x	x	x	–	x	7
Digitaria macroblephara	xxx	xx	x	x	x	16
D. scalarum	–	–	–	x	–	–
Enneapogon macrostachys	x	–	–	–	–	–
Eragrostis superba	x	–	–	xx	–	–
Eustachys paspaloides	x	–	–	xx	–	–
Ischaemum afrum	–	–	xx	–	–	1
Lintonia nutans	–	–	xx	–	–	–
Pennisetum massaicum	x	–	–	–	–	–
P. mezianum	xx	–	xxx	–	xx	19
P. stramineum	–	–	–	–	xx	–
Sporobolus fimbriatus	xxx	x	–	xx	–	6
S. ioclados	–	–	–	–	xx	–
Themeda triandra	x	–	–	x	–	–

– = rare or absent; x = occasional; xx = common; xxx = abundant.

[a]Landscape units: see Table 4.2 and Figure 4.2.

[b]Adapted from Semenye (1987).

to May. There is a short dry period during January and February and a long dry season from June to early October. The growing season in the study area thus runs from October to May, with a hiatus of variable duration in January and February.

Annual potential evaporation is about 1950 mm, giving a moisture index of 0.31 for the mean annual rainfall of 616 mm at Makindu, a meteorological station in zone V near the study area. Daily potential evaporation ranges from a peak of about 6.0 mm in January and February to a low of 4.5 mm for June and July in the long dry season. Mean maximum temperatures for these two periods are 30°C and 26°C respectively and the mean minima are 19°C and 14°C. Absolute minimum temperature can go as low as 8°C (Musembi, 1986).

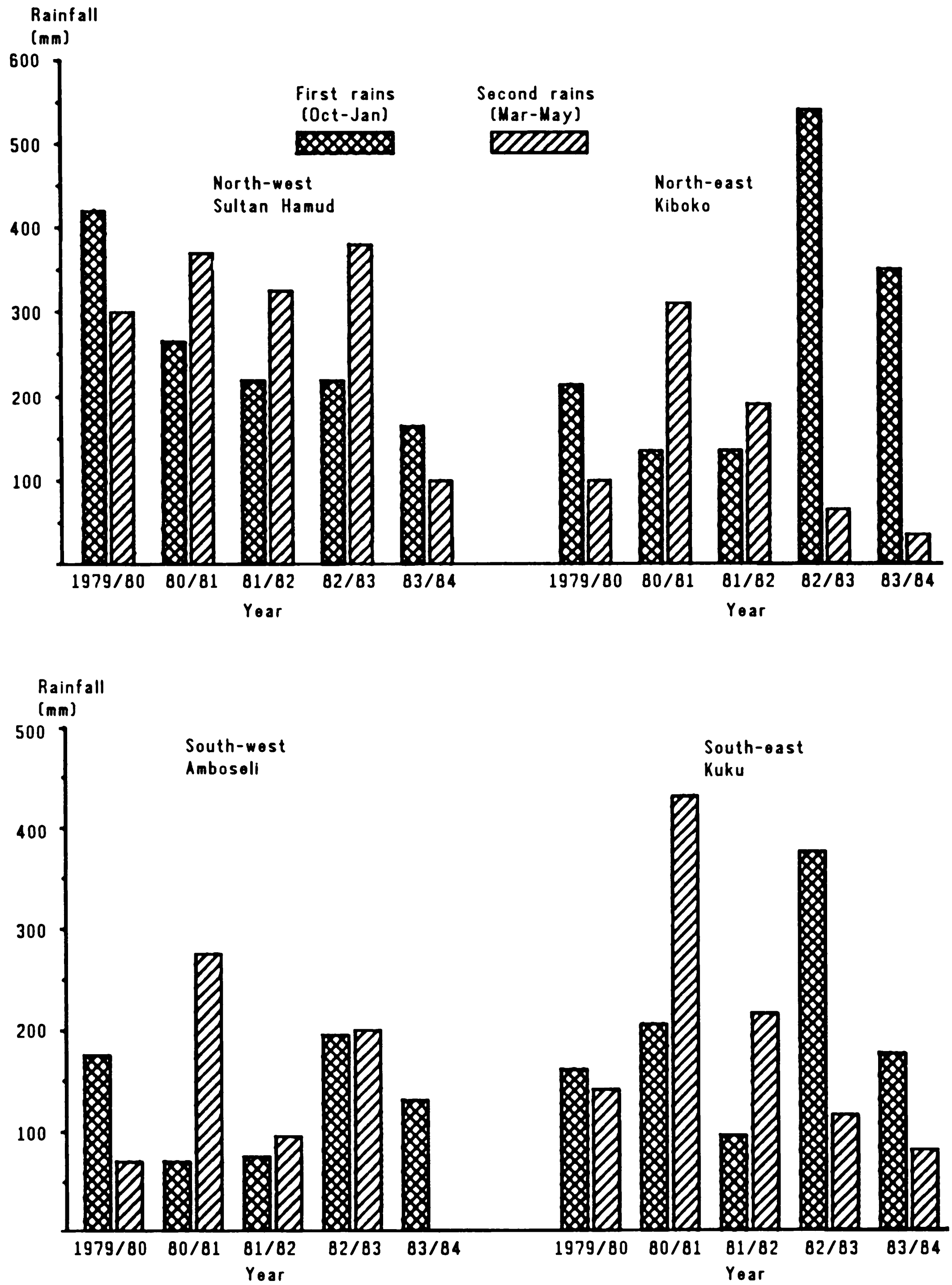
Figure 4.3 illustrates the patterns of rainfall in the study area between 1979 and 1984. The steep north-south rainfall gradient is evident.

Rainfall was above average in much of the study area for most of the late 1970s. In the northern part, climatic conditions remained close to normal through 1983, while the south experienced a minor drought for most of 1982; this was terminated by good rains in late 1982. A second, major drought affecting the whole study area started early in 1984 after a very short rainy season in late 1983 and very little or no rain in early 1984.

4.4 Rangeland production

The general relationships between herbage production and carrying capacity were discussed briefly in Chapter 2 (see Section 2.1: *Agroclimatic zones and livestock-carrying capacity*). It was noted that amount and distribution of rainfall are the prime factors determining herbage production, but that availability of herbage is strongly influenced by grazing pressure in previous seasons. The following sections elaborate on these relationships, in particular as they apply to the forage supply of the study area.

Figure 4.3. *Seasonal rainfall at four sites in eastern Kajiado District, 1979–84.*



4.4.1 Biomass yield, rainfall and growing season

Relationships between seasonal rainfall and biomass yield have often been used to predict forage availability. Deshmukh (1984) calculated an average ungrazed yield of 8 kg DM/ha per mm of rainfall for some major grassland types in eastern and southern Africa. Braun (1973) and Sinclair (1979) recorded average yields of 4 to 6 kg DM/ha per mm in the Serengeti Plains. Data given by Potter (1985) indicate yields of 4 to 7 kg DM/ha per mm, increasing with rainfall, for *Themeda* grasslands of the Athi Plains (de Leeuw and Nyambaka, 1988). Van Wijngaarden (1985) recorded similar yields in Tsavo National Park. The Tsavo study also demonstrated the importance of soil type and plant cover. Yields were 30 to 55% greater on deep, well drained sandy clays than on shallow gravely soils, and increased threefold as grass cover increased from 20 to 80% (van Wijngaarden, 1985; de Leeuw and Nyambaka, 1988).

Other workers have related biomass production to estimates of daily growth during the growing season. Bille and Heemstra (1979) estimated a growth rate of 30 kg DM/ha per day in the ILCA study area, while Braun (1973) in the Serengeti Plains found that daily growth rate increased from 15 kg DM/ha in short grasslands to 32 kg DM/ha in vegetation types with tall grasses. Data from Potter (1985) showed daily growth rates of 20–30 kg DM/ha for rainfall of 300–400 mm per season, decreasing to 10–15 kg DM/ha per day for rainfall of 150–250 mm per season. Daily growth rates based on Potter's (1985) data have been used to estimate long-term forage supplies (see Section 10.1.1: *Fodder resources*). Primary production in the three group ranches was surveyed several times between 1980 and 1984.

In 1980–81 standing biomass was measured on all three group ranches at the end of three dry seasons (October 1980, March 1981 and October 1981) and at the end of one rainy season, in June 1981 (Bille and Chara, 1981). Standing biomass was generally less than 0.5 t DM/ha at the end of the dry seasons except in river valleys and for grassland over Vertisols, where yields reached 1 t/ha. The response to the rains in early 1981 was low. In the northern ranches, standing biomass averaged about 0.7 t/ha in June 1981, ranging from 0.4 to 1.1 t depending on the level of overgrazing and soil type. The lower rainfall in the south was reflected in less standing biomass on Mbirikani than on the northern ranches.

Allowing for the amount of herbage removed by grazing, Bille and Chara (1981) estimated net primary productivity at 800–900 kg DM/ha, about 2–3 kg/ha per mm of rain or 15 kg/ha per day for a growing season receiving 250–350 mm rainfall. These growth rates are lower than those quoted above, which the authors attributed to the high grazing pressure on the ranches: at least one third of Olkarkar and half of Merueshi was seriously overgrazed, which resulted in low plant cover and consequent poor response to rainfall.

The good rains in late 1982 (first rains of 1982/83) resulted in considerable herbage growth throughout the study area. In the north, standing biomass in ungrazed swards increased in November 1982 from about 1.0 to 1.7 t DM/ha and reached 3.4 t in late January 1983 (Table 4.5). Similarly, in the south (eastern Mbirikani), standing biomass rose from about 1 t DM/ha in early November to 1.9 t DM/ha in early 1983 (Table 4.5); showers in February pushed yields up to nearly 3 t/ha in April. In response to these rains, plant cover in Mbirikani increased quickly. Dense cover (over 60%) was recorded in the north-east along the foothills of the Chyulu Hills, along the river valleys in the south and south-east and along the Kiboko River in the north-west. Regeneration of plant cover was much poorer in central Mbirikani because it had been overgrazed and because of the prevalence in that area of sodic and saline soils.

Table 4.5. *Grazable standing biomass in northern and southern parts of eastern Kajiado District, 1982/83.*

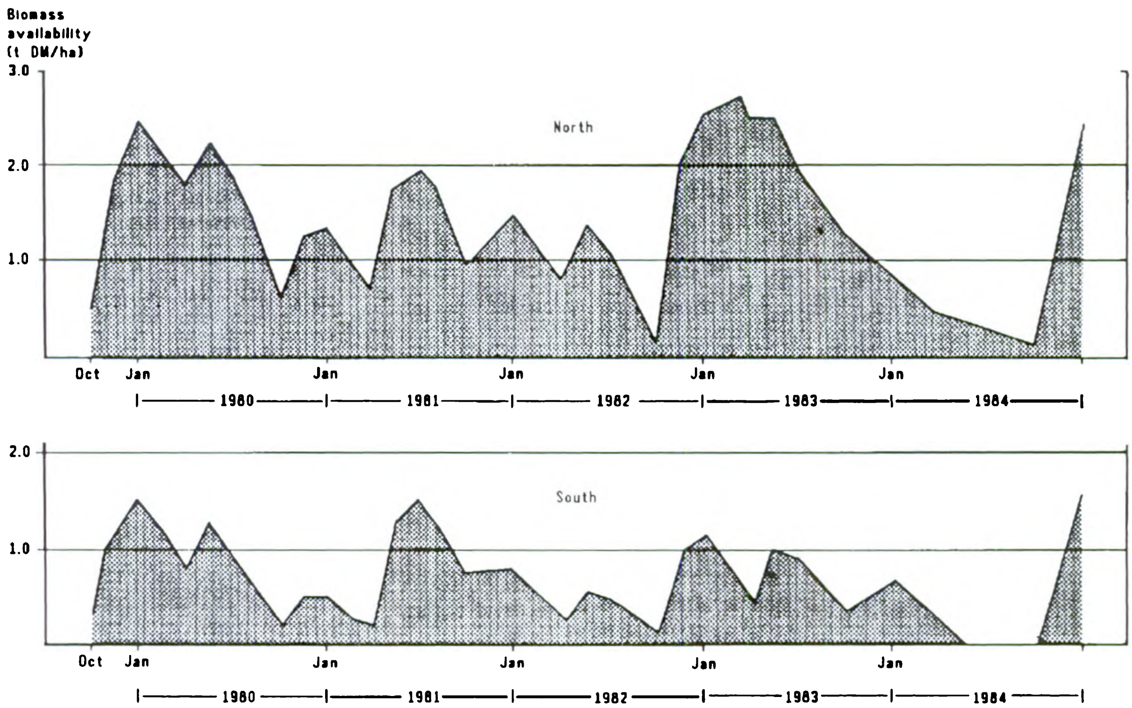
	North			South		
		Grazable biomass (kg DM/ha)			Grazable biomass (kg DM/ha)	
Period	n	Mean	SE	n	Mean	SE
Early November 1982	14	960	170	9	940	100
Late November 1982	6	1710	210			
Late January 1983	16	3370	210	13	1850	270
Late April 1983				13	2870	360

SE = standard error.
n = number of samples.

Similar patterns of herbage growth were recorded after the rains in late 1984 that broke the 1983/84 drought. More than one third of the 180 plots sampled had more than 2.5 t DM of standing biomass per hectare. Regression of standing biomass on plant cover indicated yields of 3 t DM/ha at 80% plant cover, similar to values observed by van Wijngaarden (1985) for a seasonal rainfall of 250 mm.

A profile of herbage availability was constructed for the northern and southern parts of the study area. The amount of forage available in the north (northern Olkarkar) rarely fell below 1 t DM/ha except towards the end of the long dry season of 1982 and during the 1983/84 drought

Figure 4.4. *Seasonal trends in biomass availability in the northern and southern parts of the study area, 1980–84.*



(Figure 4.4). Yields were generally much lower in Mbirikani than in Olkarkar (Figure 4.4); the high yields shown in Table 4.5 were mainly confined to the eastern part of the ranch, where soils were more fertile and grazing pressure was low.

4.4.2 Forage quality

Forage supply was monitored using aerial surveys and ground sampling. The latter, carried out between January 1982 and June 1983, involved determination of both amount and quality of standing biomass. These studies were complemented by comprehensive analyses of the nutrient content of extrusa from oesophagally fistulated cows grazing with local herds over three seasons in 1983, between February and October, in five grazing locations covering all three group ranches (Semenye, 1988).

Crude protein content

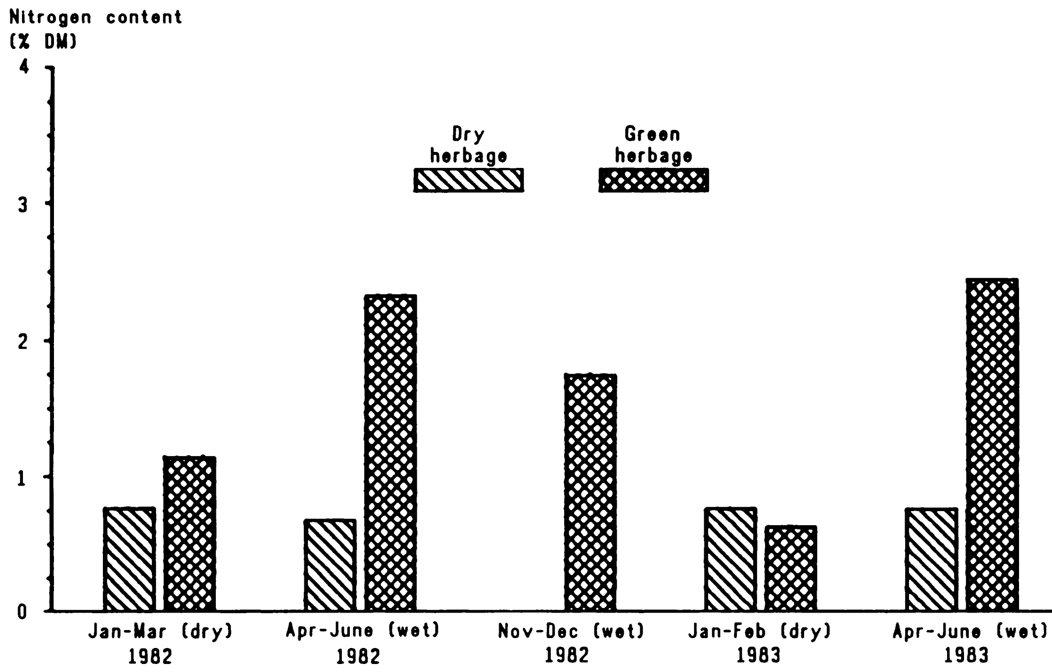
During the growing season, mean crude protein content of clipped and grazed herbage ranged from 11% in the first rains to 7.5% during the second rains. Contents of up to 16% were measured in new regrowth with yields of less than 0.5 t DM/ha (Figure 4.5). Crude protein content fell by about 1% a month as the herbage matured and bulked up, falling to 4–6% in dry grass and litter.

In all seasons the crude protein content of leaves was higher than that of stems and leaf sheaths (Semenye, 1987). Leaves formed 70–80% of the diet of grazing cows during the growing season and 40% of the diet during the dry season.

Protein content was closely linked with the amount of standing biomass. During growing seasons in which rainfall was good (e.g. 1982/83) leaf protein content fell from about 10% when there was 1 tonne DM of standing biomass per hectare to about 5% in mature stands of 2.5 t DM/ha. Thus, the good rains in late 1982 (first rains of 1982/83 growing season) resulted in there being in January–February 1983 a large amount of standing biomass that contained only 4.5% crude protein.

The crude protein content of extrusa from fistulated cows differed markedly between ranches. During the second rains of 1982/83, cows in north-east Olkarkar consumed a diet containing 13.0% crude protein compared with 8.5% crude protein in the diet of cows in south-west Mbirikani. This difference was due in part to better rainfall in the north of the study area leading to a flush of herbage growth, but was also related to differences in

Figure 4.5. *Nitrogen content of green and dry herbage over five seasons, January 1982 to June 1983.*



soils and species composition of the herbaceous layer. On average, herbage growing on deep basalt soils contained 40% more crude protein than herbage growing on soils over basement complex; unfortunately, interactions with season and differences in sampled standing biomass do not allow a firm conclusion (Semenye, 1988).

Digestibility

In vitro digestibility changed much less between seasons than did crude protein content. During growing seasons, ingested leaf herbage had an average digestibility of 54%, with short-lived peaks of up to 65% in very young growth. Late in the dry seasons digestibility fell to 46%. At other times, when both mature, dry herbage and green herbage were present, extrusa were between 45 and 50% digestible, depending on the degree of selection animals practised (Semenye, 1988). As expected, in vitro digestibility was closely correlated with crude protein content ($r = 0.86$). Thus, since these two factors are the main determinants of the nutritive value of range forage, subsequent discussion refers to crude protein content alone as an indicator of nutritive value.

Mineral content

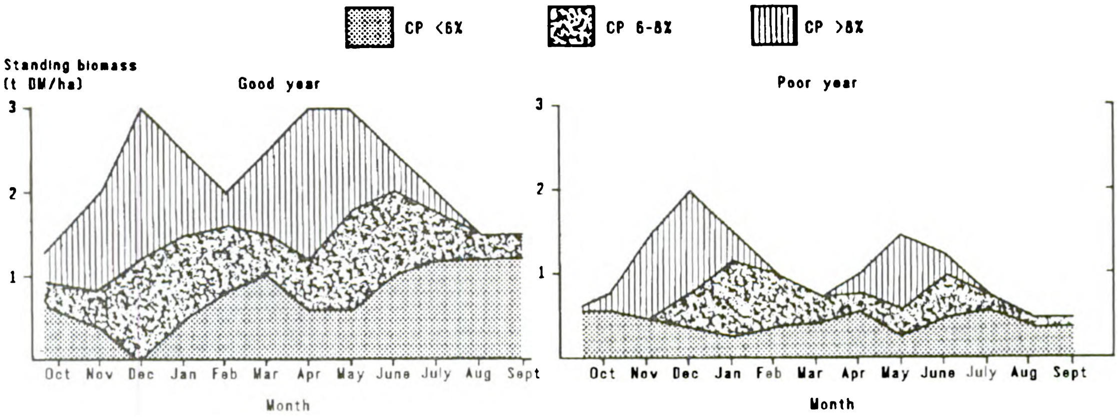
Mineral contents of extrusa from fistulated cows were generally above minimum required levels for cattle (Semenye, 1988), although copper content was marginal at one sample site at 4.2 ppm. In whole-plant samples phosphorus content ranged from 0.25% in dry herbage to 0.50% in green growth (de Leeuw, unpublished data), well above the minimum of 0.18% required by cattle for growth. As with other nutritive characters, P content was highest in plants grown on volcanic soils.

Seasonal trends

These data on nutritive values of forage were used to analyse the forage supply situation further. Two additional data sets were compiled by estimating monthly quantity and quality for good and bad years. The first set provided average digestibility and crude protein content by month. To illustrate the variability between year-types, the parameters are given for a fairly good and a poor rainfall year, roughly indicative of the grazing conditions in the north and in the south of the study area (Figure 4.6). Although differences between years are pronounced, the annual curves follow similar trends. In a good year the herbage contains an average of 8% or more crude protein for 8 months, compared with only 5–6 months in a poor year.

At the onset of each rainy season there is a rapid increase in the amount of high-quality biomass concomitant with the rapid disappearance of old standing herbage left over from the previous season (Figure 4.6). As the rainy season progresses the crude protein content of the herbage declines and old standing forage continues to

Figure 4.6. *Crude protein content of standing biomass in a good and a poor rainfall year.*



disappear. At the end of the rains only medium- and poor-quality forage remains.

The supply of crude protein clearly differs markedly between year-types. In a good year supplies of good-quality forage exceed 1 t DM/ha for 6 months (November–January and March–May), compared with only 2 to 3 months in a poor year.

In conclusion, the nutritional status of Maasai cattle is strongly influenced by the duration of the alternating dry and wet seasons and the resultant fluctuations in forage quality and supply. Due to the relatively high fertility of the predominantly volcanic soils, mineral content of forage was quite high. Hence, shortage of forage seems to be more limiting than the quality of the forage available (see Section 10.2.1: *Stocking rate and herd size*).

4.4.3 Carrying capacity

The long-term carrying capacity of agroclimatic zones V and VI, within which the group ranches are located, has been estimated to be between 3 and 7 ha per 250 kg tropical livestock unit (Section 2.1: *Agroclimatic zones and livestock-carrying capacity*). However, such average estimates may not be very useful given the large between-year differences in grazing resources.

The carrying capacity of grazing land is determined from:

- the amount of forage available per unit area within a specified time period;
- forage requirements of the herbivore population by species;
- forage allowances in relation to animal requirements and to safeguards aimed at ensuring sustained range productivity;
- availability of forage to the herbivore population as determined by location or distance.

Forage availability

The amount of standing biomass at the end of a growing season was estimated for Olkarkar and Merueshi (Table 4.6). These estimates are lower than the yields given in Table 4.5 and Figure 4.4 mainly because the estimated yields were adjusted to allow for average plant cover on each ranch.

Table 4.6. *End-of-season standing biomass (kg DM/ha) in relation to growing season and rainfall, Olkarkar and Merueshi.*

	End-of-season standing biomass (kg DM/ha)	
Rainfall (mm)	Olkarkar[1]	Merueshi[2]
100	500	240
200	1000	480
300	1500	720

[1]Based on 50% plant cover and a rainfall use efficiency (RUE) of 10 kg DM/ha.

[2]Based on 30% plant cover and an RUE of 8 kg DM/ha.

Forage requirements

Assuming an average daily dry-matter intake of 2.5% of bodyweight (Boudet and Riviere, 1968; Minson and McDonald, 1987), each tropical livestock unit (TLU) will consume 6.25 kg of forage dry matter daily or 2.3 t DM annually.

Forage allowance

The rate at which herbage disappears is higher than animal intake because of wastage and trampling. Thus, forage allowance was set at 10 kg DM/TLU per day (3.6 t DM/TLU per year), i.e. a utilisation rate of 62.5%. The increase in daily allowance over forage intake is related to the 'proper-use factor', i.e. the maximum rate of utilisation for sustainable rangeland use. The most common 'proper-use factor' is a utilisation rate of 50% of standing herbage yield; this gives a herbage allowance of 12.5 kg DM/TLU per day or 4.6 t DM/TLU per year. Applying this 'safe' allowance to the stocking rate for Kajiado District as a whole (3.3 ha/TLU in 1983; see Section 2.3.5: *Herbivore population*) indicates the need for an average annual forage yield of 1.4 t DM/ha. A dry-matter disappearance rate of 10 kg DM/TLU per day gives a required yield of 1.1 t DM/ha per year.[2]

Accessibility of forage supplies

Factors that modify the actual amount of forage that is accessible to livestock include distance from water, disease hazards, palatability and type of species present (e.g. the proportion of woody species in the biomass) (see Section 5.3: *Water utilisation, grazing patterns and stocking rates*).

Safe stocking rate

The safe stocking rate was calculated from forage requirements over the long dry season as this is the most critical period in terms of forage supply. It was assumed that the amount of standing forage available for dry-season use is determined solely by the second rains (March–May), i.e. no forage is carried over from the first rains. The dry season usually lasts 5 to 7 months.

For a herbage allowance of 10 kg DM/TLU per day, safe stocking rate for Olkarkar varies from 1.0 ha/TLU when a good rainy season (300 mm) is followed by a 5-month dry season to 4.2 ha/TLU when a poor rainy season (100 mm) is followed by a 7-month dry season (Table 4.7). The total amount of stock that can be safely carried on the 10 000 ha Olkarkar ranch thus varies from 10 000 to 2400 TLU. The predicted yields of herbage for Merueshi ranch are about half those for Olkarkar (Table 4.6); the safe stocking rate for this 18 300 ha ranch thus ranges from 2.1 to 8.75 ha/TLU, or 8700 to 2100 TLU.

Table 4.7. *Minimum land requirement (ha/TLU) for Olkarkar in relation to seasonal rainfall and duration of subsequent dry season.*

	Dry-season length (months)		
Rainfall (mm)	5	6	7
100	3.0	3.6	4.2
200	1.5	1.8	2.1
300	1.0	1.2	1.4

In Olkarkar the long dry season lasts, on average, about 6 months and the second rains average about 200 mm. Thus, a dry-season stocking rate of 2 ha/TLU could be maintained in most years, but would have led to shortage of forage in 1980/81 (Bille and Chara, 1981) and towards the end of the long dry season in 1982[3]. In Merueshi the long dry season commonly lasts up to 1 month longer than in Olkarkar and rainfall in the second season averages 150 mm. Thus, a stocking rate of 4 ha/TLU would be safe in most years, but would have led to serious shortages of forage in 1980/81 and during the dry spell in 1982.

It is difficult to estimate the safe stocking rate for Mbirikani because much of the ranch is too far from the water pipeline (the main source of water)

2. The 'proper-use factor' is based on the concept that there is a certain rate of defoliation above which the sustained productivity of range vegetation is impaired. Van Wijngaarden (1985) in Tsavo National Park (350–500 mm rainfall) demonstrated that when more than 45% of the dry-season biomass was removed, perennial plant cover during the following rainy season was reduced, while below this level of removal, plant cover increased. In contrast Potter (1985), working in the somewhat higher rainfall area of the *Themeda* grasslands of the Athi Plains, showed that long-term productivity was not reduced even at a very high defoliation rate (cutting every 3 weeks at a height of 5 cm) or when grasslands were continuously grazed at a stocking rate of 2 ha/TLU. These contrasting observations have implications for assessing the long-term carrying capacity of the Maasai group ranches (see Section 10.2.1: *Stocking rate and herd size*, for long-term implications).
3. Sloane (1986) used the length of the growing season to estimate carrying capacity of rangelands in Kenya, but arrived at much lower values. For instance, for a growing period of 3 months, a stocking rate of 6 ha/TLU was allowed. This translates to a conservative utilisation of only 25% of the standing biomass as compared to 62.5% allowed in the present study. It appears that Sloane chose conservative values as long-term averages to provide sufficient margins for seasons of below-normal rainfall, to allow for the often large proportion of unpalatable species in the available biomass and for extensive areas of low herbage productivity (see Section 2.1: *Agroclimatic zones and livestock-carrying capacity*).

to be grazed (see Section 5.3.3: *Grazing patterns and stocking rates in the southern ranch*). Areas within reach of the pipeline have been seriously overgrazed. Rainfall during the second rains rarely exceeds 200 mm and was much less in 1982 and 1984. Thus, while in good years a stocking rate of 4–6 ha/TLU may be safe, more than 10 ha/TLU may be needed after poor rains.

4.5 Water resources

The most important structure supplying water to the study area is the pipeline that cuts through western Mbirikani and skirts Merueshi on the west (Figure 4.7). There are several public water outlets from the pipeline, some with storage tanks, but private outlets are increasingly important. During 1983–84 at least 15 private connections, some with storage tanks and most with water troughs, were installed between Makutano and Olandi over less than 15 km. In Merueshi at least three private installations had been completed by 1984. There is a second, smaller pipeline system around the Amboseli National Park. Other man-made water sources include boreholes along the Kiboko River and in the north-west of the study area.

There are several other permanent water sources serving the study area. Some have been improved by man. The most important of these is Simba Springs, which provides water to most of the stock on Olkarkar and Kiboko group ranches, similar springs near Kiboko town, and the man-made shallow wells in the Kiboko River on the border between Kiboko and Merueshi group ranches. The swamps that form the southern boundary of Mbirikani Group Ranch are also a permanent source of water. Those farthest west drain into Lake Amboseli; the rest drain into the Looltureshi River and thence into the Tsavo River.

Most of Merueshi lies within 5 km of a permanent water source, compared with only a quarter of Olkarkar. There is no permanent source of water in eastern Mbirikani and more than 60% of this ranch is more than 5 km from a permanent water source (Figure 4.7).

Two types of seasonal water source are important in the study area: pools in riverbeds and streams, and ponds. Pools are found in riverbeds following the flash floods that occur after heavy rainfall. Ponds are common in areas underlain by basement complex, such as Kiboko Ranch, Mbuko Ranch (west of the pipeline) and along the northern end of the Chyulu foothills. Six ponds were used in Merueshi in good rainfall seasons during the study period. Olkarkar has few ponds because of its volcanic geology. Ponds along the Chyulu Hills rarely fill up because the volcanic ash deposits are very porous and only very heavy storms leave standing water.

The availability of water is an important facet of the Maasai production system and water facilities and watering management are discussed further in subsequent chapters: in Chapter 6 (*Labour and livestock management*), the effect of the location of water points on residence and land utilisation patterns; in Chapter 7 (*Productivity of cattle and smallstock*), the relationship to labour and herding management; and in Chapter 11 (*The potential for improving the livestock production and welfare of the pastoral Maasai*), the possible improvements to the existing facilities.

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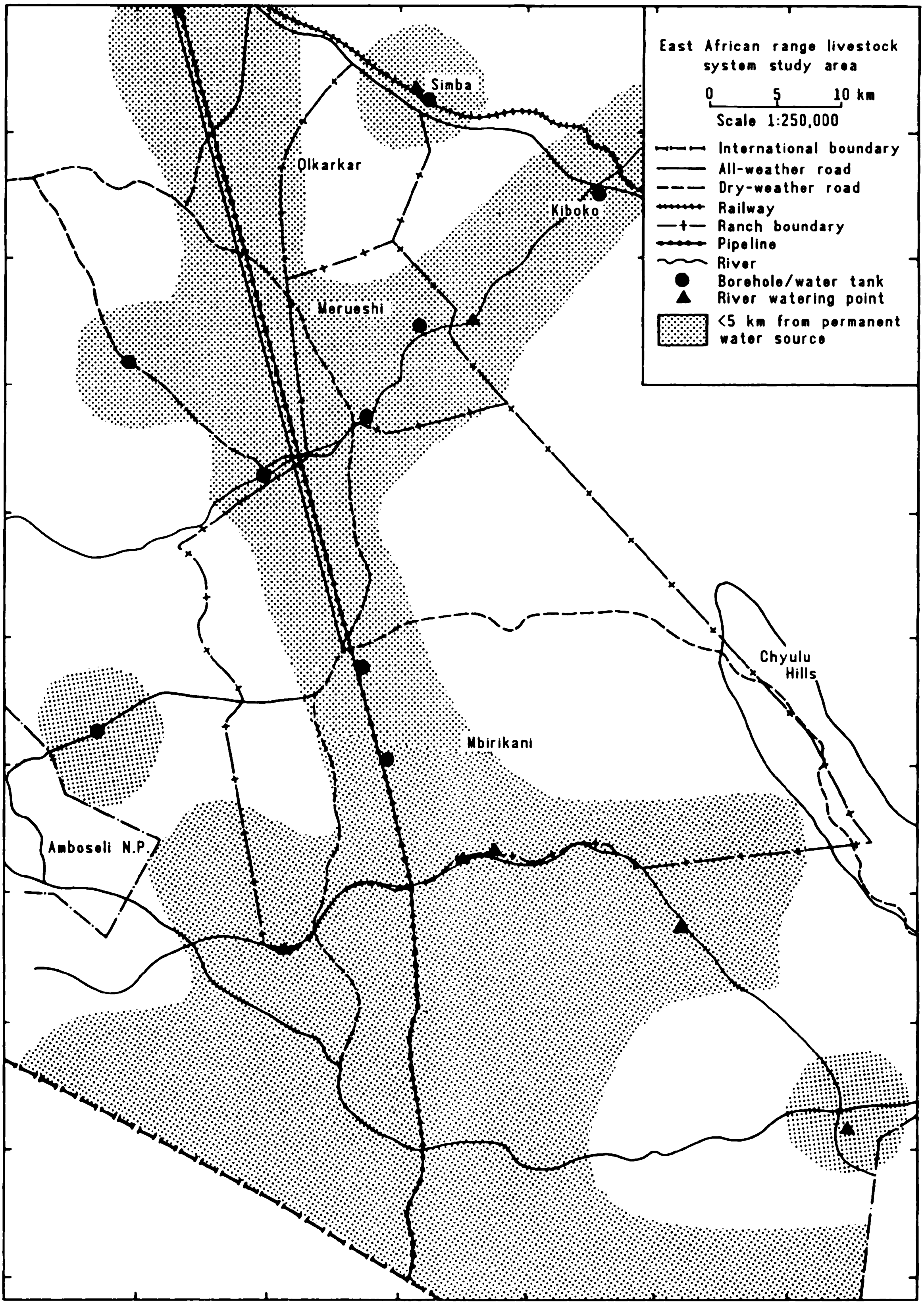
Figure 4.7. *Distribution of permanent water sources in the study area.*



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Chapter 5

The study area: Socio-spatial organisation and land use

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Two factors largely determine strategies for, and constraints on, livestock production in the study area: the group ranch to which the producer is affiliated and the wealth class of the household.

This chapter describes the socio-spatial organisation in the study site, including the household, the *boma* and the neighbourhood, and the interactions between residence patterns and resource utilisation.

The data presented were collected between 1980 and 1983, usually from sample households only, but sometimes from the whole population. Since household composition, livestock holdings, residence and herding patterns and the distribution of people and animals change over time, the numbers of livestock, households, *bomas* etc may not be consistent throughout. However, unless otherwise noted, the general patterns described pertain to the whole period under study.

5.1 The household and the *boma*

5.1.1 Household size and composition

In the northern ranches (Olkarkar and Merueshi) there was a clear correlation between wealth (measured in terms of Tropical Livestock Units per active adult male equivalent – TLU/AAME; see Section 1.3.2: *Producer heterogeneity and sampling design*) and household size and composition. Rich households had 80% more people than poor households, a smaller percentage of whom were from the nuclear family, i.e. the producer, his wives and children (Table 5.1). The organisation of households is more fluid in Mbirikani, which made it more difficult to determine household size and composition[1]. As a result, no clear relationship was found between wealth and household size. However, as in the northern ranches, rich households tended to have a smaller percentage of members coming from the nuclear family than did poor households.

Table 5.1. *Average household size and proportion of nuclear members in household by wealth class and ranch.*

Wealth class[1]	Olkarkar	Merueshi	Mbirikani
Poor	7.7 (80%)	9.0 (87%)	13.2 (82%)
Medium	9.9 (56%)	11.4 (66%)	10.2 (65%)
Rich	14.0 (62%)	16.2 (62%)	11.8 (63%)

[1]Rich = ≥13 Tropical Livestock Units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; poor = <5 TLU/AAME.

Forty per cent of all households had resident mothers, step-mothers or siblings of the household head. Married sons remained with their fathers in 17% of all households, most commonly in richer households. A quarter of households had dependants who were not members of the nuclear family[2]; these are people who are incorporated into the household because they have insufficient resources to be self-supporting. In general, the wealthier the household the more dependants it had. Dependants represent a fairly broad spectrum of relationships to the household head. There

1. For example, it was common in Kisongo section (which includes Mbirikani) to find brothers who did not separate their families and animals after the death of their father, although each had his own inheritance. However, as each had the right to make decisions and to separate, they were defined as separate households.
2. For the 24 dependency relationships for which information is available, the following is the distribution: six brother's families, four sister's families, four other agnatically related families, three returned married daughters, three mother's kin, one wife's kin, two other in-laws, one a father's friend (the dependency relationship was inherited).

were more dependants in Olkarkar than in other ranches, but the reason for this is not known.

Forty per cent of households borrowed children to help with herding or domestic tasks.[3] The number of children borrowed did not differ between Olkarkar and Merueshi or among wealth classes, but poor households lent more children than did rich households (1.6 vs 0.4 children). Lending of children was not well recorded on Mbirikani.

Maasai households traditionally joined with others, living together in a single *boma*, for various domestic and livestock management tasks, especially herding. There is an increasing trend toward individualisation in residence and production, especially among the Kaputiei in the north of the study area. In 1981 there were several single-household *bomas* on Olkarkar and Merueshi, but only one on Mbirikani (Table 5.2).

5.1.2 *Boma* size and composition

Bomas in Maasailand traditionally comprised 6 to 12 households (Jacobs, 1965; Njoka, 1979), but

Table 5.2. *Residence types of sample households by wealth class and ranch.*

Wealth class[1]	Residence type	Olkarkar	Merueshi	Mbirikani	Total
Poor	Alone	0	2	0	2
	With others	8	4	6	18
Medium	Alone	2	5	0	7
	With others	5	5	10	20
Rich	Alone	3	3	1	7
	With others	6	3	7	16
Total	Alone	5	10	1	16
	With others	19	12	23	54

[1]Rich = ≥13 Tropical Livestock Units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; poor = <5 TLU/AAME.

boma size has declined rapidly in the past 20 years[4]. By 1980, no *boma* in Merueshi had more than three households (Table 5.3), although 45% of households in Olkarkar and 60% of households in Mbirikani were in *bomas* of 4 or more households. In 1980 the mean number of households per *boma* was 2.7 on Olkarkar and 1.8 on Merueshi, which are in Kaputiei section, compared with 3.5 in Mbirikani, which is in Kisongo section. Between 1980 and mid-1983 the pressure for subdivision of Olkarkar ranch resulted in several *bomas* splitting (Grandin, 1987) and the mean number of households per *boma* on this ranch fell to 1.8. On Merueshi the number of households per *boma* fell slightly to 1.6 in mid-1983, while on Mbirikani *boma* size remained essentially unchanged (3.5 in 1980 and 3.6 in 1983).

More households were sedentary in Kaputiei section than in Kisongo section. In 1981 more than 90% of Kaputiei household heads were living in their *emparnat* (the area where their fathers and grandfathers had lived), and the mean age of *bomas* was more than 3 years. In Kisongo, only 46% of household heads were living in their *emparnat*; the mean age of *bomas* was about 1 year.

In 1980 Maasai were still using a wide range of relationships to join *bomas* (Table 5.4). Producers in Olkarkar used a wider range of relationships than did those in the other ranches but close agnates tended to remain together when *bomas* subsequently divided, while less-closely related households left. In Merueshi, the trend to live with agnates was already well established. In Mbirikani, about half the households joined brothers, the other half joined friends.

As *boma* size declined in the north, so too did cooperation in herding and other routine management activities. This and other local implications of sedentarisation and individualisation of production are discussed in more detail in Section 5.2.2 (*Neighbourhoods and reserved grazing areas*) and Chapter 6 (*Labour and livestock management*).

3. The arrangement may be a short-term emergency measure, but is more often a long-term one, with the child staying in the household of the borrower until marriage, in which case the borrower assumes the responsibility to feed, clothe, and help with required ceremonies (circumcision, marriage).
4. Although decline has been a long-standing process, it is clear that in Kaputiei the biggest decrease in *boma* size and the emergence of single-household *bomas* came after the establishment of the group ranches. These phenomena seem related to the desire to stake a claim should subdivision of group ranches occur, and to a lesser extent, to increasing individualisation of production (see Section 3.3.7: *Pressure for subdivision of group ranches*). Group ranches in the Kisongo area are much newer; subdivision is not an issue in that area, and *bomas* on the whole are larger and thus more diverse.

Table 5.3. *Distribution of* boma *size on Olkarkar, Merueshi and Mbirikani group ranches, 1980.*

Households per boma	Per cent of households by *boma* size			Per cent of *bomas* by size category		
	Olkarkar	Merueshi	Mbirikani	Olkarkar	Merueshi	Mbirikani
1	16	21	4	42	39	13
2–3	39	78	36	33	61	46
4 or more	45		60	25		40
Total	33	33	53	12	18	15

Table 5.4. *Relationships used in joining* bomas *on Olkarkar, Merueshi and Mbirikani group ranches*[1].

	Per cent of total recorded by ranch		
Relationship	Olkarkar	Merueshi	Mbirikani
Clan	30	5	2
Close agnate[2]	17	64	51
In-law	17	11	
Friend	17	21	47
Other	17		

[1]For 1980; based on the single closest relationship to any other household in the *boma*.

[2]Father, brother, father's brother etc.

5.2 Residence patterns

5.2.1 Introduction

Producers select a neighbourhood (and a *boma*) that best meets their goals, the needs of their animals and the preferences of their family. Herds need access to water and pastures, while families like to be near water, shops, schools and friends. The relative importance of these needs and desires in determining where to settle varies considerably with scale of production. For example, poor producers require less grazing than rich producers and are thus more likely to base their decision on where to settle on proximity to water and schools. They may, however, have to settle where there is a kinsman willing to help support them. In contrast, availability of grazing is of primary concern to richer households; finding sufficient grazing in a daily orbit is a qualitatively different problem for 500 cattle than for 50 cattle.

The most important short-term considerations in choosing a place to live are:

- Proximity and freedom of access to water for human and animal consumption, the quality and the reliability of the supply and the labour necessary to extract and transport the water.
- Proximity to good grazing, the degree of competition from other livestock and wildlife, and the type of the terrain and fodder available between the *boma* and the water point.
- Availability of reserved grazing areas
- Proximity to schools and, occasionally, outlets for milk sales.
- Previous relations with potential neighbours.

Longer-term considerations differed between the north and the south of the study area because of differences in the mobility of households. Despite their high mobility, Mbirikani producers try to maintain a residence in their *emparnat*. In the north, the desire to stake a land claim and to choose a place one would like to settle permanently are more important considerations. In the north, for establishing a new *boma*, choice is largely circumscribed by the prior existence of other *bomas* and *olopololis*.

5.2.2 Neighbourhoods and reserved grazing areas

Neighbourhoods

Residential locations were close to permanent water sources on all three ranches (Figures 5.1 and 5.2). On Olkarkar, all five neighbourhoods were within 7 km of Simba Springs, leaving almost half the ranch without human settlement. On Merueshi, seven of the eight neighbourhoods were within 5 km of a water source: four were close to the pipeline on the western side of the ranch, three were in the north-east corner of the ranch and relied mainly on the shallow wells and boreholes associated with the Kiboko River. Of the nine neighbourhoods in Mbirikani six were close to the pipeline, while the other three depend on the Kikarankot River.

Neighbourhoods in Olkarkar comprised an average of three *bomas*, eight households, 86 people and almost 900 cattle and 850 smallstock. This is similar to the size of individual *bomas* in Maasai areas of Tanzania in the 1950s (Jacobs, 1965). Density of people and livestock varied in relation to proximity of the neighbourhood to amenities, grazing and water. Neighbourhoods also differed in wealth of households living there: for example, most poor households in Olkarkar were in neighbourhood 2 (Figure 5.1), which is close to water, shops and a school. Although the

Figure 5.1. *Neighbourhoods, reserved grazing areas and water sources on Olkarkar and Merueshi group ranches.*

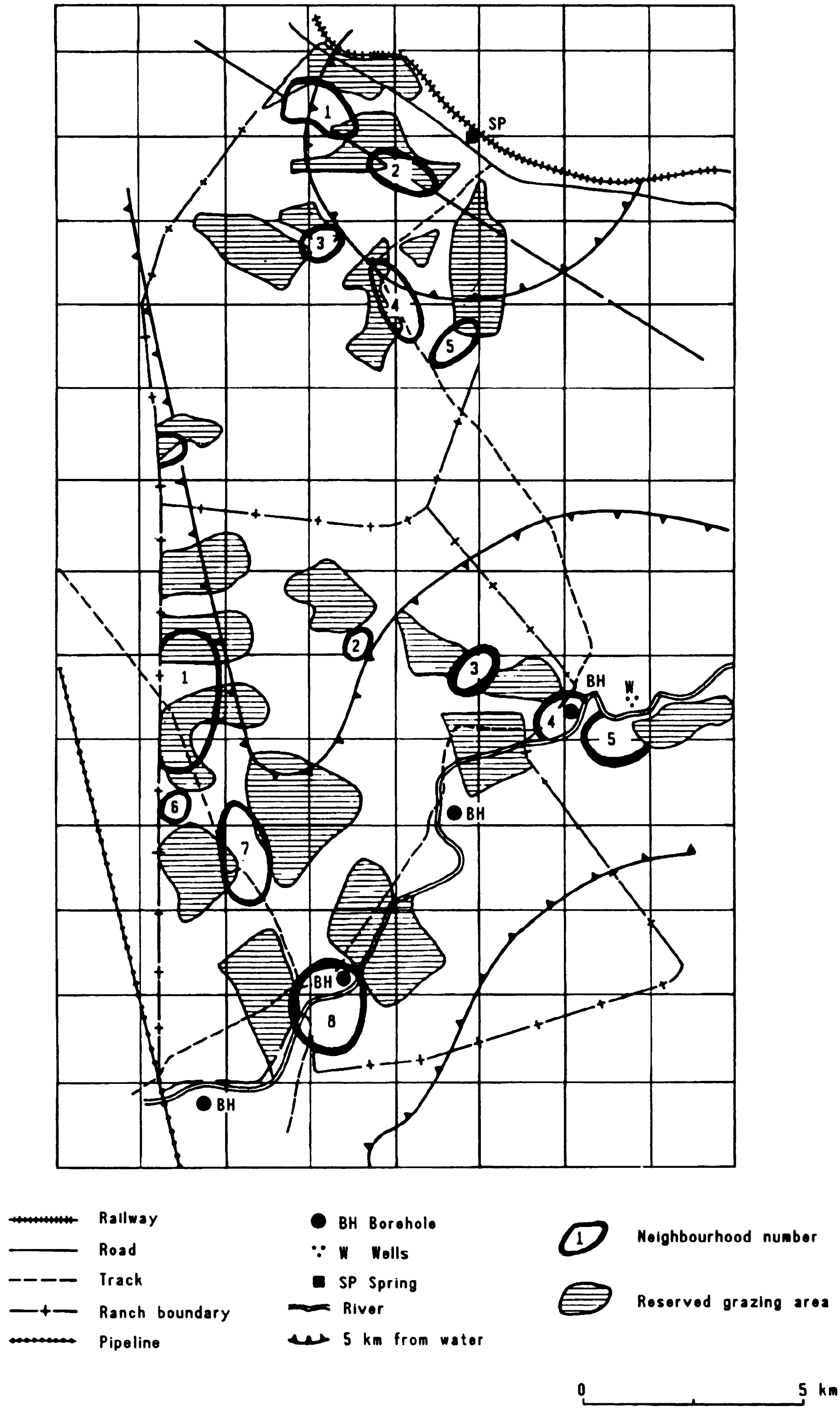
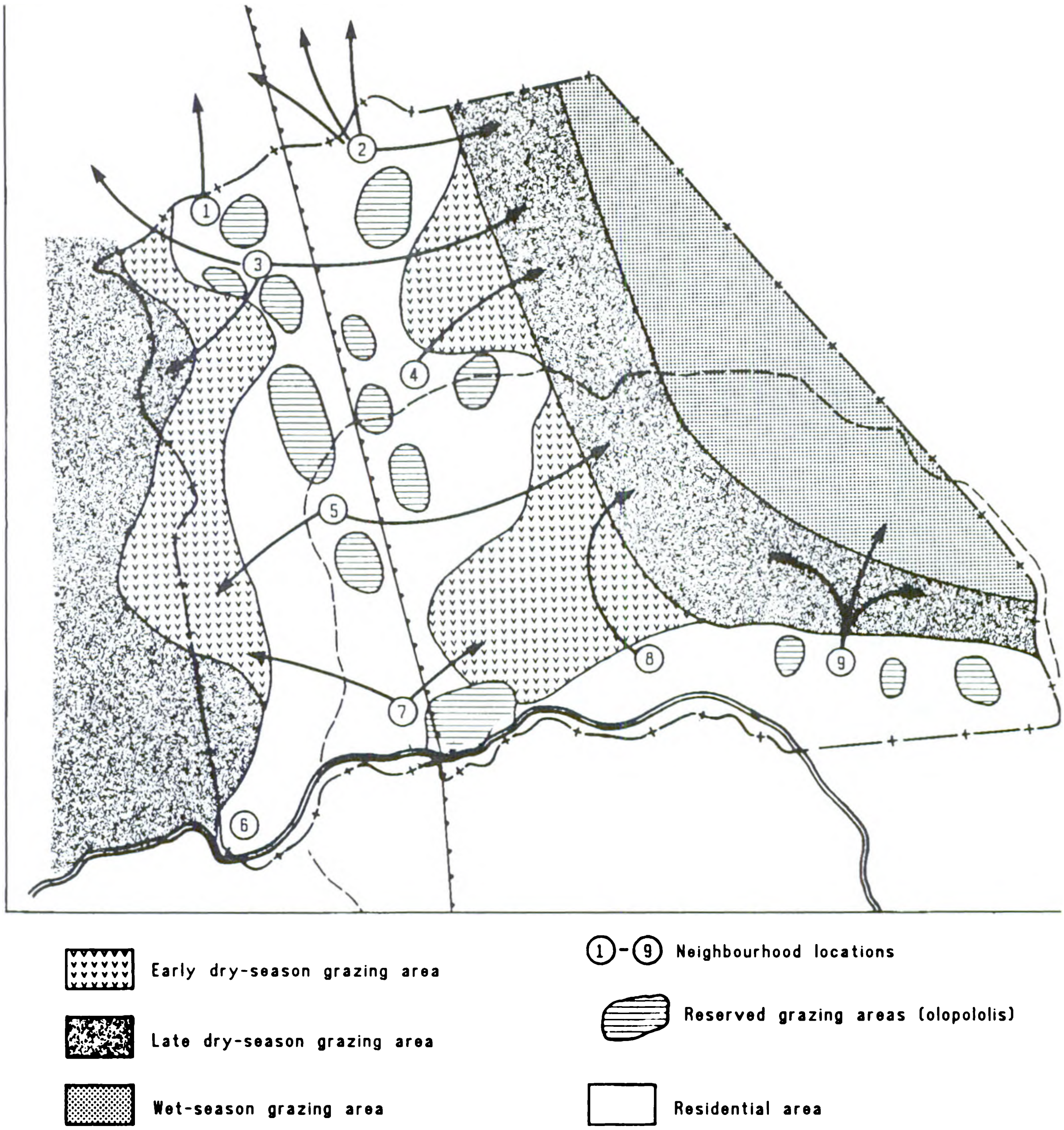


Figure 5.2. *Neighbourhoods and traditional grazing management on Mbirikani Group Ranch.*



number of households per *boma* fell considerably in Olkarkar during the study period. This had relatively little effect on the population of neighbourhoods because most households stayed in the same neighbourhood. The distribution of *bomas* did, however, change, from closely clustered to more scattered as the new *bomas* established their own reserved calf pastures.

Neighbourhoods in Merueshi were smaller than those in Olkarkar, with an average of roughly 60% as many households, people and stock (Tables 5.5 and 5.6). This was due in part to the greater dispersion of neighbourhoods in Merueshi but also in part to the greater desire for autonomous production and breakdown of traditional ties on this ranch. Mbirikani's neighbourhoods were much larger than those in the northern ranches, averaging nearly 8 *bomas*, 21 households and 248 people (Table 5.7).

Proximity to water had a marked effect on the number of livestock per household in Olkarkar neighbourhoods. Households in the neighbour-

Table 5.5. *Characteristics of neighbourhoods on Olkarkar Group Ranch, 1980*[a].

	Neighbourhood						
	1	2	3	4	5	Total	Mean
Bomas	4	3	2	3	3	15	3.0
Households	11	11	4	3	10	39	7.8
People	136	91	65	48	88	428	86
Cattle	1553	413	673	1091	720	4450	890
Smallstock	1302	710	714	590	947	4263	853
Olopololis[1]	2	2	2	3	1	10	2

[a]Excludes one *boma* with two households which is part of a neighbourhood in another group ranch.
[1]*Olopololis* are reserved calf pastures.

Table 5.6. *Characteristics of neighbourhoods on Merueshi Group Ranch, 1980*[a].

	Neighbourhood									
	1	2	3	4	5	6	7	8	Total	Mean
Bomas	3	1	3	3	3	1	3	3	20	2.5
Households	5	1	5	5	6	2	4	4	32	4
People	53	52	65	55	52	9	78	63	427	53
Cattle	361	654	802	752	471	216	864	120	4240	530
Smallstock	498	319	652	654	546	50	534	410	3663	458
Olopololis	3	1	1	2	1	1	1	2	12	1.5

[a]Excludes four households that took up residence in adjacent ranches in late 1980.

Table 5.7. *Characteristics of neighbourhoods on Mbirikani Group Ranch, 1980.*

	Neighbourhood										
	1	2	3	4	5	6	7	8	9	Total	Mean
Bomas	9	5	15	12	8	10	3	4	3	70	7.8
Households	25	12	49	32	24	17	6	13	8	186	20.7
People	300	144	588	384	288	204	72	156	96	2232	248
Olopololis	3	1	2	2	2	–	1	2	2	15	1.7

Note: An average household in Mbirikani has 12 people. Livestock data for the entire group ranch were never collected, because of the size of the area and the mobility of its stock and people.

hood closest to water (neighbourhood 2) owned on average only 40 cattle, whereas those in the neighbourhoods farthest from water (neighbourhoods 3, 4 and 5) each owned some 150 cattle and 130 smallstock. Neighbourhoods in Merueshi were generally close to a water source and thus the effect of proximity to water on the number of livestock per household was less clear. There was no livestock census for Mbirikani as a whole.

Reserved grazing areas

The Maasai have long set aside pastures near residential areas for the exclusive use of calves and weak animals. These areas of reserved grazing are known as *olopololis*. Establishment of *olopololis* is controlled by the council of elders in each neighbourhood.

In 1982 there were 13 *olopololis* in Olkarkar, with an average area of 162 ha and covering 20% of the ranch (Table 5.8). Ten of them were each used by a single *boma*, seven of them each by a single household. However, three *olopololis* retained the attributes of a neighbourhood *olopololi*; one was used by 11 households in six *bomas*, the second by seven households in three *bomas* and the third by 10 households in three *bomas*. The last lay partly inside Kiboko group ranch and was used also by a household in that ranch.

The 13 *olopololis* in Merueshi had an average size of 350 ha and accounted for 25% of the ranch

Table 5.8. *Characteristics of reserved grazing areas (*olopololis*) on Olkarkar, Merueshi and Mbirikani group ranches, 1982.*

	Ranch		
	Olkarkar	Merueshi	Mbirikani
Number	13	13	15[a]
Area			
mean (ha)	162	350	570
range (ha)	47–403	155–800	200–1600
% of ranch area	20	25	5

[a]Includes one *olopololi* servicing a primary school.

(Table 5.8). Nine of them are each used by only one *boma*, while none was used by more than three *bomas*. Seven of the *olopololis* were each used by only a single household. Each *olopololi* was used by an average of two households; none was used by more than four households.

Mbirikani group ranch had 15 *olopololis* covering about 5% of the ranch (Table 5.8). The *olopololis* were large, averaging 570 ha, and were each used by an average of four *bomas* and 11 households. Two were each used by only one *boma*, but none was used by a single household.

The changes in the use and management of *olopololis* in the study area are demonstrated by those occurring in Olkarkar between 1979 and 1983 (Grandin, 1987). In 1979 Olkarkar had nine *olopololis*, only one of which was controlled by a single household (Table 5.9). Four were controlled by residents of a single *boma*, comprising a total of 12 households. The remaining four were shared by more than one *boma*, and approximated neighbourhood control.

By 1983, the number of *olopololis* had increased to 15. Most of the increase was in single-household *olopololis*. Although there were still four single-*boma olopololis*, the *bomas* each comprised only two households headed by full brothers. Three of the *olopololis* shared by more

Table 5.9. *Changes in the number of* olopololis *and their use on Olkarkar Group Ranch, 1979–83.*

			Users		
		Per cent of ranch area	Single household	Multiple household	
	No.			1 *boma*	> 1 *boma*
1979	9	13[a]	1	4	4
1983	15	20	7	4[b]	4[c]

[a]Estimated.

[b]All of these consist of two full brothers only.

[c]Three of these are neighbourhood *bomas*, while the other includes two *bomas* of two brothers and two of their sons.

than one *boma* were shared by many households and could still be classified as neighbourhood *olopololis*. The fourth was now shared by two *bomas* formed when two brothers had separated after the death of their father, each establishing his own *boma* but sharing their father's *olopololi*.

The proliferation of *olopololis* in the northern ranches was related more to their use in establishing rights over land than to their value as a management tool. Hence, the size of the *olopololis* bears no necessary relationship to the needs of the "owning" household or households.

In conclusion, between 1979 and 1983 there was a proliferation of single-household *olopololis* in the northern ranches. This has implications for livestock management, in particular because many producers are using their *olopololi* to feed stock other than calves.

5.3 Water utilisation, grazing patterns and stocking rates

The distribution of water points in the study area was outlined in Chapter 4 (see Section 4.5: *Water resources*). This section discusses the use of these sources in Olkarkar and Merueshi, and describes the use of different water sources and the patterns of livestock movement in Mbirikani.

5.3.1 Water utilisation in the northern ranches

Simba Springs is the only permanent water source in Olkarkar and 79% of all visits to water points were to the Springs (Table 5.10). In contrast, there are several permanent sources of water in Merueshi, resulting in more varied patterns of use. Neighbourhoods in the north-west (1, 6 and 7; see Figure 5.1) went mostly to the pipeline (60% of visits). Neighbourhoods in the north-east exploited the shallow wells in the Kiboko riverbed (60% of visits). Neighbourhood 8 used the nearby borehole. The single household in neighbourhood 2 used both the pipeline and the shallow wells. Seasonal sources were used mostly in the rainy seasons and were more important in Olkarkar than in Merueshi, where ponds were used in the western and central portion, and river pools were used in the south. In a normal year these sources accounted for 30% of total use by the neighbourhoods in their vicinity.

Aerial surveys in the dry periods in February and June 1982 showed that more than half the cattle and three quarters of the small ruminants on the two ranches were within 5 km of one of the

Table 5.10. *Utilisation of watering sources on Olkarkar and Merueshi group ranches, June 1981 to April 1983.*

	Per cent of all visits to water points	
	Olkarkar	Merueshi
Permanent		
Simba Springs	79	
Pipeline	2	30
Boreholes		16
Wells	1	29
Seasonal		
Ponds	6	20
Rivers	12	5

permanent sources of water (King et al, 1985). Concentrations of stock in the eastern parts of the ranches were higher in June than in February. There were considerable eastward movements of stock within Merueshi, and there was an influx of livestock from Mbuko ranch. Several herds from Mbirikani and Kimana ranches grazed in Merueshi and the adjacent Chyulu foothills in the north-east.

5.3.2 Grazing patterns and stocking rates in the northern ranches

Daily movements to grazing of herds belonging to sample households in the two northern group ranches were recorded every 2 weeks between July 1981 and June 1983. Grazing pressure was based on the total livestock population resident in each ranch in mid-1982. It was assumed that unsampled households within each cluster were practising the same grazing management and movement patterns as their sampled neighbours. Thus, for each cluster the ratios between total stock and sampled stock were calculated, separately for cattle and smallstock. These ratios were derived from the initial survey in 1980–81, which included livestock populations of both sampled and unsampled households (ILCA, 1981).

Based on herd and flock structure data from King et al (1984), total cattle of each household were subdivided in 65% adult cattle, 25% weaners and 10% suckling calves. Similarly, it was assumed that grazing flocks comprised 80% of the total, the remainder being lambs and kids. As suckling stock were kept around the *boma* and did little grazing, they were excluded from the analysis (see Semenye, 1987; de Souza and de Leeuw, 1984).

Weights were assigned to each class: 250 kg for adult cattle, 120 kg for immatures and 25 kg for smallstock. From these weights, total grazing mass of livestock in each ranch was calculated. Frequencies of visits by each household to grazing areas were multiplied, first with the appropriate stock number by class for each and then by the ratio between sampled and total households by cluster. These weighted frequencies produced the grazing pressure by location and by aggregating grazing locations for each zone.

Grazed livestock in Tables 5.11 and 5.12 refers only to the resident livestock within each ranch territory; herds grazing in other ranches or immigrant herds have not been included in the calculations of grazing pressure. There is, however, considerable grazing across the boundaries into Poka and Kiboko ranches and ranch territories have been enlarged somewhat to allow for this movement (Figure 5.3).

Grazing locations within each ranch were aggregated into six grazing zones in Olkarkar and

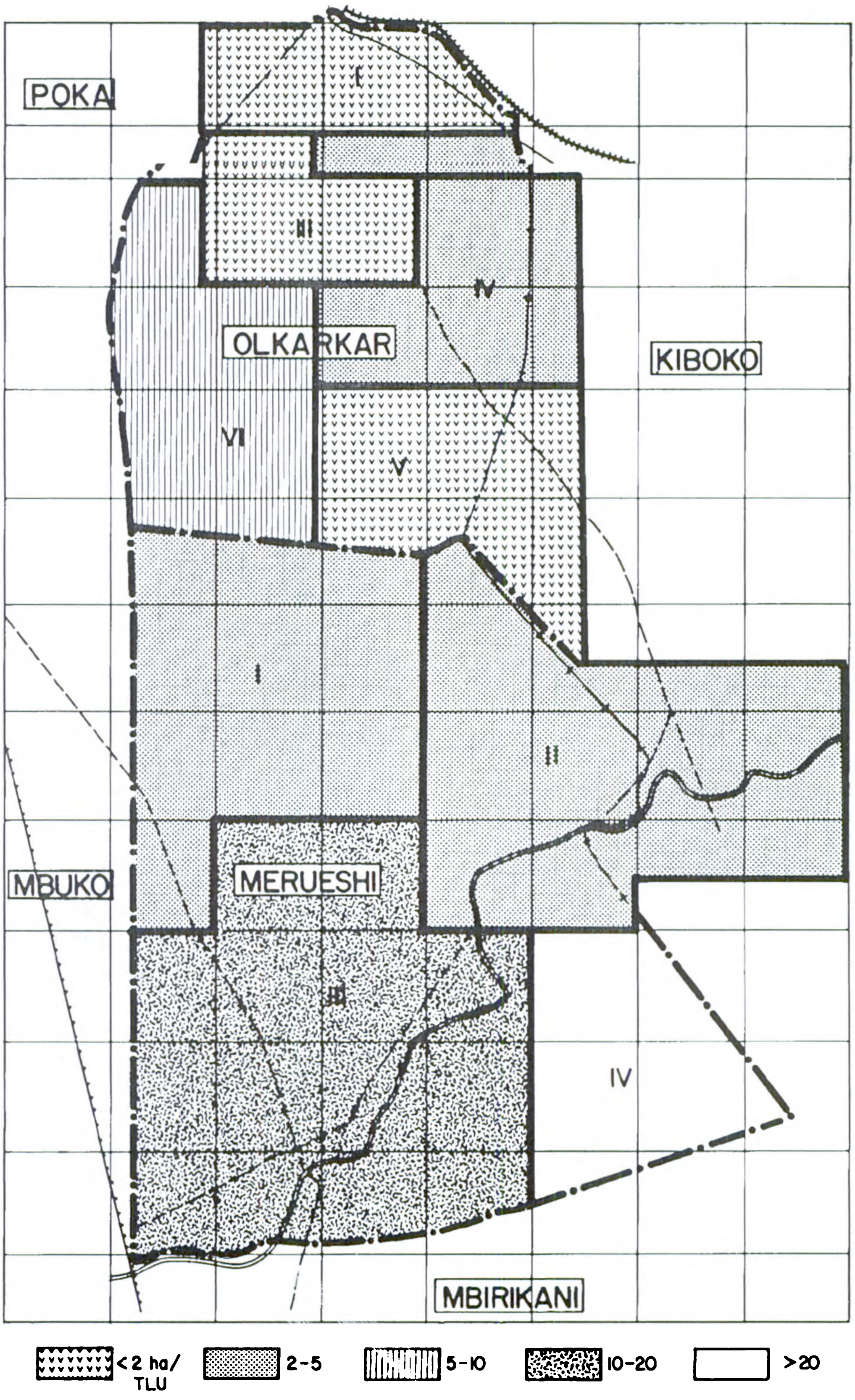
Table 5.11. *Grazing pressure by grazing zone on Olkarkar Group Ranch.*

	Zone						
	I	II	III	IV	V	VI	Total
Area (% of ranch)	15	12	11	18	15	29	100
Livestock (% of total TLU)							
owned	34	11	15	40			100
grazed	30	12	15	12	22	9	100
Grazing pressure							Mean
kg/ha	234	119	161	90	174	34	119
ha/TLU	1.1	2.1	1.6	3.2	1.4	7.4	3.5

Table 5.12. *Grazing pressure by grazing zone on Merueshi Group Ranch.*

	Zone				
	I	II	III	IV	Total
Area (% of ranch)	22	29	38	11	100
Livestock (% of total TLU)					
owned	24	48	28		100
grazed	32	50	16	2	100
Grazing pressure					Mean
kg/ha	100	90	21	7	57
ha/TLU	2.5	2.8	12.1	35.2	9.8

Figure 5.3. *Stocking rates on Olkarkar and Merueshi, 1981–83.*



four grazing zones in Merueshi (Figure 5.3). As would be expected, the distribution of these zones was similar to that of neighbourhood clusters (see Figure 5.1).

On Olkarkar, stocking rate declined radially away from Simba Springs. Within the northern part of the ranch livestock biomass was fairly evenly distributed, although grazing pressure was highest in zone I and zone V, the main grazing areas for the richer households in neighbourhoods 1, 4 and 5 (Figure 5.1). These two zones accounted for 30% of the ranch and more than half its total livestock biomass (Table 5.11). The five zones in which neighbourhoods were located (zones I to V) accounted for 71% of the ranch and had an average stocking rate of 1.6 ha/TLU. Zone VI was less used because it is far from both Springs and the pipeline and because its vegetation consists largely of coarse tall grasses.

The utilisation of grazing resources in Merueshi was different from that in Olkarkar, because *bomas* were mainly located along the ranch periphery and reserved grazing areas were more evenly distributed (Figure 5.1). There was high grazing pressure in zones I and II which cover 50% of the ranch but accommodated 82% of all stock; this converts into an overall stocking rate 2.7 ha/TLU (Table 5.12, Figure 5.3). This high pressure was in contrast to the low grazing use in zone III. Although the five households resident in this zone owned 28% of the ranch livestock, they herded their animals within zone III itself for only half the study period. There are several interconnected reasons for this mobility. About 80% of the cattle in zone III were owned by one household (1100 head in 1982) and this herd would overgraze the zone if it grazed there permanently. Grazing pressure in zone IV was low because there were no settlements there, it was relatively far from water and was regarded as a fall-back area during dry periods. It was heavily grazed during the 1983–84 drought (Grandin et al, 1989).

From this analysis, it is evident that Merueshi was much more lightly stocked than Olkarkar; about 5 ha/TLU as compared with 2 ha in Olkarkar. Although historic reasons may have played a part, it is argued that this difference in the overall utilisation rates reflected the differences in grazing resources between the two ranches. On average the plant cover in Olkarkar is much denser than in Merueshi. On Olkarkar most of the land consists of undulating uplands over volcanic rock, which supports a relatively dense cover with desirable grasses, some of which are resistant to repeated grazing (see Figure 4.2 and Table 4.2). Only a small part, mainly in the east, has soils over basement complex, on which much more open grass communities are found. In Merueshi the more productive rangelands cover less than half the ranch and are concentrated mainly in the north and the east. This good cover contrasts with the sparse vegetation in the SW portion of the ranch (see Section 4.2: *Landscapes, soils and vegetation*). This resource gradient running approximately from the north-east to the south-west is reinforced by the rainfall gradient along the same direction (see Section 4.3: *Climate*).

5.3.3 Grazing patterns and stocking rates in the southern ranch

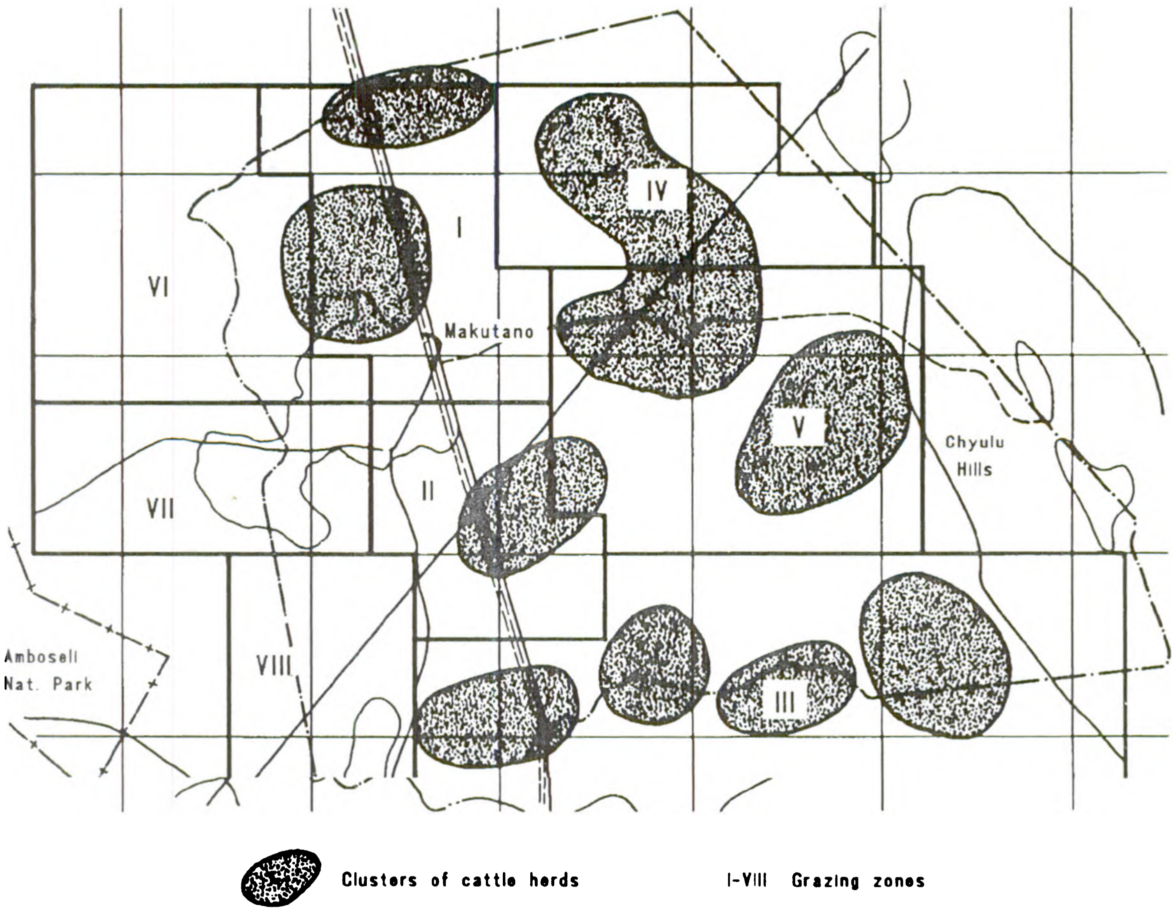
Traditionally, the Kisongo Maasai have divided their land into well-defined residential and grazing areas. The residential areas and the permanent *bomas* are usually as close as possible to permanent water and about half the ranch area was designated residential land; it also contained the neighbourhoods, all *olopololis* and stretched 5–10 km in width on either side of the pipeline and the Kikarankot River with its associated swamps.

Figure 5.2 shows the distribution of the different grazing areas. The arrows denote the sequence in which areas were used through the dry season. The source of the arrow is the neighbourhood and the head of the arrow marks areas for grazing in the late dry season. At a distance of 5–10 km from the neighbourhood sites there were areas earmarked for grazing in the early dry season, while further away there was a belt for use later in the dry season. At the margins of the early dry-season zone temporary camps were often constructed 10 to 15 km away from the pipeline and herds were put on a 2-day watering regime.

While grazing rights and use are well recognised for the residential areas and their *olopololis*, user rights became more fluid with increased distance. The *bomas* that were associated with these areas of deferred grazing did not have exclusive usufruct rights but they collectively decide when livestock may enter an area for grazing. In times of good rainfall these final dry season areas would not be entered before the next rains fell. Ideally, rains would be sufficient to fill surface pools in the most distant wet season areas, allowing cattle to proceed there, and thus preserve the grazing in the residential areas and in the *olopololis*. This grazing system was in operation when most herds were resident within the boundaries of the ranch and rainfall was normal.

However, this traditional system described above has been disturbed in the western part of

Figure 5.4. *Distribution of cattle herds on Mbirikani in February 1982.*



Source: Aerial surveys (see King et al (1985) and Peacock (1984)).

the ranch primarily because of the construction of Risa water tank just outside the western boundary of the ranch. This area is located west of the pipeline and stretches across the somewhat arbitrary western boundary and the traditional dry season areas of the western part of Mbirikani ranch. Before the construction of the water tank, cattle moved westwards and southwards from the residential areas along the pipeline. As the dry season progressed, herds would go closer to the seasonal Kiboko River, eventually crossing it and grazing west of it. When the rains came cattle would water either at the river or further west at one of the many water pools north of Amboseli Park. After the Risa water tank was built, permanent *bomas* were constructed nearby and the new occupants of this area developed a north-eastward pattern of grazing. Their cattle thus met and competed for grazing with cattle moving westwards from the neighbourhoods along the pipeline. If the temporary waterholes north of Amboseli were full and allowed grazing to continue into the dry season, then the area north-east of the Risa water tank was not under severe pressure. If the rains are poor, herds moved outwards from the permanent sources of water (pipeline and Risa tank) early in the dry season, which led to early competition between the two opposing movements of cattle.

Although rainfall during 1981 was somewhat below average, it may be considered a fairly typical year. In April 1981 the rains caused the formation of surface water pools in many parts of the ranch so that grazing was possible close to the Chyulu Hills (Figure 5.2). The livestock distribution showed little change from June to August and remained stable until the end of the dry season. The first rains in November and December 1981 were low and localised which caused the clumping of herds and flocks in several areas, a situation that continued to February 1982 (Figure 5.4). Thus, throughout most of 1981 stock relied on the northern stretch of the pipeline (between Makutano and Olandi), and the swamps along the Kikarankot River and the boreholes along the Kiboko

River. Several herds grazed in Mbuko and Merueshi territory, while during June to August 1981 a few herds used the Risa tank close to the Amboseli National Park. In November 1981 there was a sudden move from rangelands east of the pipeline to the western boundary of the ranch because good rainfall had filled the shallow waterholes there. Thus, during 1981 75% of the sample cattle herds remained within the ranch territory.

Smallstock were managed differently from cattle in that they stayed mostly within 5 km of the pipeline. Three flocks joined the cattle herds around Risa tank. Like cattle, smallstock made little use of areas in the south-west, except for a few flocks which went first to a tributary of the Kikarankot river in August 1981 and then moved to the *Acacia tortilis* woodland east of Kimana again relying on pipeline water.

While during 1981 most livestock remained within the boundaries of the ranch, the low rainfall in late 1981 and the even poorer rains in early 1982 caused wholesale shifts of the livestock population to grazing land outside the ranch, both towards the south and to the north. Patterns of herd movement and the population estimates were derived from aerial surveys for three distinct periods in 1982 (King et al, 1985). As was done for the northern ranches, Mbirikani ranch was subdivided into grazing zones that follow as closely as possible the traditional grazing areas: zones I, II and III represent the residential areas whereas the other zones (IV to VIII) coincide with the dry season grazing areas to the east and the west of the pipeline (Figure 5.5).

Even though in February 1982 these movements had already started, dispersal within the ranch still corresponded to the dry season distribution shown in Figure 5.4. Over half the cattle were still relying on the pipeline but use of its southern section was much greater than in the previous year. From February onwards the exodus got underway properly. Most herds went first to the swamps, either those near the southern pipeline section or to the Chyulu foothills relying on the water points in the eastern swamps using a 2-day watering regime; about 20% (of the 42 000 head estimated during the aerial survey) followed the latter strategy. As a result of the exhaustion of the fodder supplies surrounding the swamp zone, herds moved further to the southwest and by mid-June 57% were grazing in Kuku Ranch using either the remaining water pools along the Loolturesh river or the wells near Iltilal (14%). Towards August 1982, these pools were drying out and the reliance was shifted to the wells.

Smallstock followed an itinerary similar to cattle except that they moved gradually southwards along the pipeline and then moved straight into Kuku Ranch and the Iltilal well zone without stopping in the swamp zone. As a result, the western and central partsof Mbirikani were almost entirely evacuated. Only 11 000 cattle and 1300 smallstock remained along the northern pipeline and its adjacent grazing area in the north-east. As some 140 households have their permanent *bomas* in zone I, it was calculated that about eight cattle per household remained behind. These represented mainly lactating cattle and their calves to feed the resident family members. In the residual areas around the swamps (zone III) another 6000 cattle and 3000 smallstock remained.

Good rainfall in late October and November 1982 not only produced abundant new forage (see Table 4.5), but also filled most of the ephemeral ponds and riverbeds on the ranch, encouraging the return of herds and flocks. By late December, all but 7% of the livestock population had come back within the ranch, but some had not reached their permanent *bomas* along the pipeline. Nevertheless, 70% of all cattle and 65% of all smallstock were counted within the three residential zones and in zone I cattle had already reached a density of close to 50 TLU/km^2 or 2 ha/TLU (Figure 5.5). The remainder was dispersed over the dry season areas in particular in the areas to the west; this is in contrast to the distribution in February 1982 when grazing pressure was high in the east. The eastern area (zones IV and V) accounted for only 11% of the cattle and 8% of the smallstock.

The effect of these stock migrations on the overall stocking rates of the ranch is shown in Table 5.13. While in February and December cattle numbers were similar indicating that by December 1982 most herds had returned, in June only 40% of the cattle and less than 30% of the smallstock remained on the ranch. This proportion was even lower between June and November (Peacock, 1984). During February and December the average stocking rate of domestic herbivores was between 5.1 and 5.4 ha/TLU, while in June the rate dropped to 12.7 ha/TLU. The distribution of herbivores over the grazing zones showed that in February high stocking rates occurred along the southern end of the pipeline (zone II) and in the residential areas North of the swamps and rivers (zone III). Grazing pressure was also high in the north-east (zone IV) indicating that many herds were on a 2-day watering regime (Figure 5.5).

It appears that grazing strategy of maximum dispersal and the resultant distribution was much influenced by the influx of wildebeest and zebra at

Figure 5.5. *Stocking rates on Mbirikani in February, June and December 1982.*

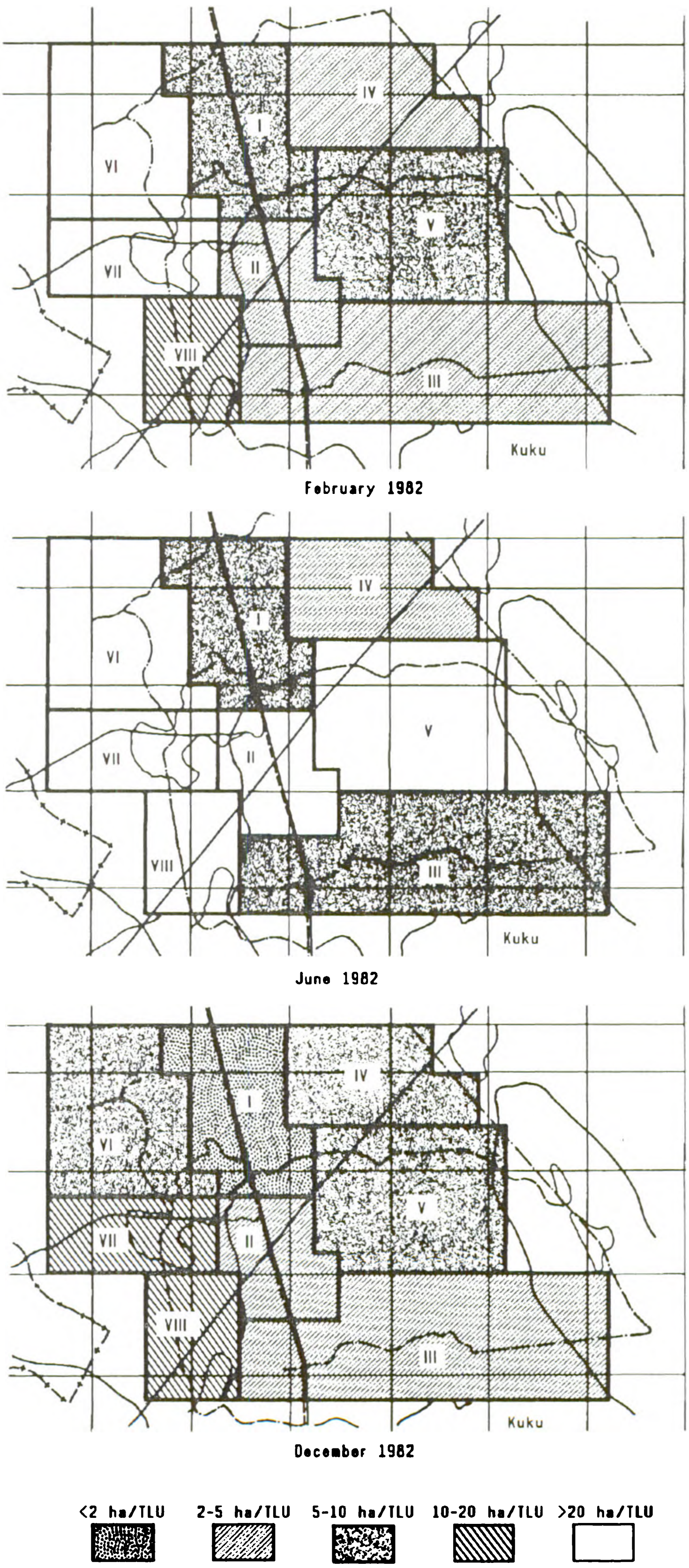


Table 5.13. *Seasonal herbivore populations and stocking rate on Mbirikani Group Ranch, 1982.*

	February		June		December	
	Number ('000)	Per cent of total TLU	Number ('000)	Per cent of total TLU	Number ('000)	Per cent of total TLU
Cattle	43.7	93	18.0	88	43.6	77
Smallstock	17.0	5	6.2	4	22.6	5
Wildebeest	0.5		1.7		4.9	
		2		8		18
Zebra	0.5		0.5		6.0	
Total						
'000 head	61.7		26.4		77.1	
'000 TLU	33.6		14.8		41.0	
Stocking rate (ha/TLU)	5.3		11.6		4.2	

the start of the rains. While in February and June these two species accounted for respectively 2 and 8% of the total herbivore biomass, this proportion rose to 18% in December 1982 (Table 5.13). More importantly, over 80% of all wildlife were found in the residential areas along the pipeline and its adjacent dry season area in the east. In zones IV and V, 42% of the total herbivore biomass consisted of wildlife and they competed heavily for the available forage resources and were instrumental in keeping away cattle from the eastern dry-season zones.

This account shows that during good rainfall seasons and their aftermath, Mbirikani herds and flocks stayed within the ranch resulting in stocking rates in residential areas that are well beyond the carrying capacity. This necessitated rigorous grazing control that encouraged dispersal of stock towards less heavily utilised areas. Concomitantly, it requires the adoption of 2-day watering regimes. It is also clear that swift movements to grazing lands with ephemeral water ponds whenever they fill is an essential part of the same strategy, as it further assists in alleviating the grazing pressure in the areas closer to permanent water.

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Chapter 6

Labour and livestock management

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The first section of this chapter deals with allocation of labour to different tasks, and mechanisms used to overcome labour shortages. The main focus is on herding arrangements, as herding uses more labour than any other activity in the Maasai production system. The second section deals with livestock management practices including watering and grazing operations, care of young stock and animal health care.

6.1 Labour[1]

6.1.1 Introduction

This section first describes the culturally accepted age/sex divisions of responsibilities and labour. It then presents recorded labour inputs. This is followed by estimates of the number of workers required for an independent operation, and the actual amount of labour available by household, *boma* and ranch. Ways in which labour is recruited are described.

6.1.2 Division of responsibility and labour in livestock production

The Maasai have strong, culturally prescribed norms for the division of responsibilities and labour between age groups and sexes. This division must be understood to appreciate properly the system as it functions at present and to identify possibilities for intensification. All too often studies report physical labour inputs only, ignoring aspects of control of labour and decision-making. The general description of responsibilities and tasks below represents the **ideal**; the actual division of labour and time spent by task are discussed under Section 6.1.3: *Actual labour inputs.*

Men

Adult married men are primarily managers and supervisors. It is their responsibility to gather the necessary information on range conditions, water availability and marketing. They make the initial decision on residence location, decide on herd movement and splitting, on the watering location, the daily orbit of grazing and who will do the herding. They tell the herder where to go and often accompany the herd to make sure that it follows the intended orbit. Men usually oversee watering to ensure that animals are watered in an orderly fashion and are not pushed away by someone else's animals.

When water points need maintenance or repair, men organise it and pay for it if it is done by hired labourers. Men organise the functioning of dips and perform most of the dipping. If animals are sprayed by hand this is usually done by younger men (often with the help of women, who carry the water), but older men are often there to supervise. In the evening, men inspect animals as they return home to make sure none are lost, to determine whether animals have grazed enough, whether any are about to give birth or are sick. When an animal goes missing, men constitute the search party. Men buy and administer veterinary drugs and perform castrations and other minor veterinary procedures. They also decide when and which animals should be slaughtered or sold, although they may consult other family members.

Some farming occurred in the study sites. This is primarily the responsibility of men, but much of the actual work is done by hired labour in the north and by both men and women in the south.

Political affairs, both traditional and modern, are entirely in the hands of men. In recent years they have required considerable amounts of time, largely because of the formation and management of group ranches.

Adult women

Women make all major domestic decisions, including those relating to childcare, food preparation, collection of water and fuelwood and house-building and maintenance. They also take part in livestock management. Each woman takes care of the cattle and smallstock allocated to her sub-household. Women care for very young stock, which spend the day around the *boma*.

1. Section 6.1 is based on Grandin (1983) and Grandin (1988).

They make sure young animals have ample suckling time, supply fodder to young calves and occasionally supply water to sick animals in the *boma*. Women inspect the animals of their sub-household to make sure all have returned from grazing and are in good health. Problems are brought to the attention of the household head.

Women do the milking and have the right to the milk of their animals. They make most decisions about milk offtake, although these may be scrutinised by their husbands. Women foster orphaned calves and smallstock and remove ticks from the teats of their animals by hand. Women own the skins of stock allocated to them and make leather from them.

In households that engage in cropping, women may help with planting and harvesting. In southern Mbirikani, women prepare land for irrigated agriculture, while the men do the irrigation.

Women sometimes assume men's responsibilities. This occurs mainly in households of young men in Kaputiei, who prefer to live and manage their animals alone even when they are involved in activities such as trading which take them away from the *boma* for considerable periods of time. Their wives must then assume many of their daily responsibilities.

Children

Much of the routine work of the Maasai household is carried out by children, who do almost all of the herding and much of the work around the *boma*. Children become involved from when they are 3 or 4 years old, helping with such tasks as carrying kids and lambs into or out of the house and watching animals around the *boma*. This fulfils three functions: it helps protect the animals from predators, it trains the children as future herders and it keeps the children occupied so their mothers can do other jobs.

At 6 or 7 years old a child becomes a full-time herder, beginning with smallstock. Herding smallstock is a demanding job as smallstock wander and are easily lost or taken by predators. Children start herding calves at 8 or 9 years old. This is less arduous than herding smallstock and children welcome the change. By the age of 11, children, particularly boys, begin to herd older cattle, initially as apprentices to an older herder. Normally cattle herding is a supervisory activity as animals know the way and set the pace. Herders follow the animals, keeping them from straying and watching for predators.

Girls tend to do more smallstock and calf herding and less cattle herding than boys. Cattle herding is considered too arduous for girls, particularly if distances walked are long. If girls herd calves or smallstock, they usually return to the *boma* in time to help with young-stock management, preparations for milking and domestic tasks.

Children who attend school are expected to herd on weekends, which increases the labour supply and keeps them in training. Poorer households educate as many children as labour needs and finances will allow, while richer households tend to choose only one or two boys to educate.

After circumcision girls are ready for marriage, and their labour will soon be lost to the household; boys become *moran* (warriors) and are then nominally free from routine labour[2]. However, they may be called upon to help with herd-splitting, and watering in severe dry seasons. When herds are split, *moran* commonly manage the distant camps, particularly in Mbirikani where herd-splitting is common and *moran* are older. In the north, *moran* are younger and herd-splitting is less common (see Section 6.1.5: *Labour sufficiency*). In addition, *moran* help with spraying and dipping, with maintaining water points and are the chief source of the limited amount of hired labour used.

6.1.3 Actual labour inputs

The actual annual labour inputs were based on a time allocation study in Olkarkar[3]. The recorded division of labour between children and adults and between males and females as a percentage of each livestock management task is shown in Table

2. This relative idleness of *moran* is much criticised by national authorities who, using standards from other cultures, believe that adolescent boys and young men should be more productively occupied. The Maasai, on the other hand, view this period as an important time of socialisation, of establishing contacts and of learning about areas beyond the immediate vicinity of one's home. A boy moves from the influence of the purely domestic arena to the wider socio-political sphere during this period.
3. Data were derived from a 14-month time allocation study, during which the activity of each member of the household was recorded at random times twice a month. Through this series of "snap-shots", accurate estimations of total labour inputs are possible (Grandin, 1983; Johnson, 1978). The data presented are aggregates by each age/sex group within each wealth class averaged over one year; they are not an indication of what any given individual does on any given day.

6.1. The category "children" includes those from about 6 years of age until marriage. As many *moran* lived away from home and as most girls married soon after circumcision, this category comprised mainly children between 6 and 15 years old.

Table 6.1. *Division of labour by sex and age in Olkarkar (as a percentage of each task)*[1].

	Children[2]		Adults	
Task	M	F	M	F
Watering supervision	15	5	74	6
Herding	48	44	3	5
Dipping/spraying		5	74	21
Other livestock work	17	23	33	27
Milking	1	18	0	81

[1]From time allocation data.

[2]Children 6 years and above.

Children did almost all the herding (92%), while men supervised most of the watering, dipping and spraying (74%). All age/sex classes participated in other livestock work, primarily the tasks in and around the *boma*, while women did most of the milking (81%), with some assistance from older girls.

Inputs to livestock management were also measured in terms of people's total time allocation, i.e. the average number of hours spent daily on various activities (Table 6.2). Observations covered a 14-hour day from 0600 to 2000 hours. Children spent 4–5 hours a day herding and about 1 hour on livestock work around the *boma* and other livestock work. Girls spent 2.5 hours on domestic activities, to which boys contributed very little. Boys spent more time in school than girls, and also had more leisure time.

Men spent an average of 5.5 hours a day on livestock-related work. More than 2 hours a day of their time was unaccounted for, during which they were away from the *boma* but for which no activity was recorded. In Olkarkar men often went to Simba town after watering their stock to meet friends or attended formal group ranch or age-set meetings. Men spent more time visiting and at ceremonies than any other group of people, but spent little time on domestic chores. Business activities, mainly livestock trading, accounted for almost 10% of men's time.

Women spent an hour and a half a day on livestock management, just over an hour on milking and about 6 hours on domestic chores. Many domestic activities (e.g. cooking and child-care) were done simultaneously and at least one woman remained in the *boma* to watch children and young stock during the day.

Table 6.2. *Time spent on various activities by household members of different sex/age groups, Olkarkar*[1].

	Mean time spent on each activity (hours/day)			
	Children[2]		Adults	
Activity	Male	Female	Male	Female
Watering supervision	0.3	0.1	2.0	0.1
Herding	4.5	5.0	0.4	0.4
Dipping/spraying	0.0		0.3	
Boma livestock work	0.7	1.2	2.1	0.8
Other livestock work	0.3	0.1	0.7	0.1
Subtotal	5.8	6.4	5.5	1.4
Milking		0.4	0.0	1.2
Water/wood		0.2		1.3
Cooking	0.1	0.2	0.2	1.4
Other domestic work	0.4	1.7	0.1	3.6
Subtotal	0.5	2.5	0.3	7.5
Business[3]	0.3	0.1	1.2	0.2
School	1.5	0.5		0.0
Social activities	0.8	0.2	1.6	1.1
Other activities	4.7	3.6	3.0	3.0
Unknown	0.5	0.7	2.3	0.7
Subtotal	7.8	5.1	8.1	5.0

[1]Mean values based on time allocation study.

[2]Children 6 years and above.

[3]Includes trading and other income-generating work.

Table 6.3 shows the average number of hours devoted to livestock management per day by each age/sex group in poor, medium-wealth and rich households. Girls did more livestock work than boys in rich and medium-wealth households, in which boys spent more time in school than did girls. In poor households boys and girls spent roughly equal amounts of time in school and inputs to livestock management did not differ by sex. Women spent much less time on livestock-related activities than did children and men. Poor households spent about 24 hours a day on livestock management, while rich households spent about twice as much (Table 6.4). However, the latter owned more than nine times as many livestock units and hence spent only one quarter as many hours per livestock unit as poorer households. This was partly due to "economies of scale" (especially in herding and watering), and partly to

Table 6.3. *Time spent on livestock management by adults and children in poor, medium-wealth and rich households, Olkarkar Group Ranch.*

	Mean time spent on livestock management (hours/day)			
	Children		Adults	
Wealth class[1]	Male	Female	Male	Female
Poor	4.3[a]	4.3[a]	4.5	0.8
Medium	7.5[a]	7.9	4.6	1.8
Rich	5.7[a]	6.9	6.9	1.6

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[a]Children in these groups spent a mean of approximately 1.5 hours a day at school.

Table 6.4. *Total time devoted daily to various livestock-related tasks by poor, medium-wealth and rich households, Olkarkar.*

	Time devoted to livestock management (hours/household per day)		
	Wealth class[1]		
Task	Poor	Medium	Rich
Watering	2.4	3.0	4.6
Herding	13.5	18.7	29.1
Dipping	0.3	0.6	0.6
Boma livestock work	6.6	7.5	10.9
Other livestock work	1.3	1.8	2.7
Total hours	24.1	31.6	47.9
Livestock units (TLU)	29	62	272
Total hours/TLU	0.8	0.5	0.2

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

less intensive *boma* management in rich households than in medium-wealth and poor households.

6.1.4 Labour requirements for critical tasks in livestock management

Although labour requirements vary by wealth status and location, it is useful to assess minimum requirements for an independent operation through critical task analysis (Torry, 1977; Dahl, 1979; Sperling, 1984; Grandin, 1983). In the study sites, observations and interviews indicated that the most time- consuming livestock management tasks are herding, watering and care of livestock in the *boma*. Of these, shortage of labour for herding is the main constraint in the study sites, whereas in other pastoral systems the amount of labour needed for water extraction may limit livestock production (Cossins and Upton, 1987).

Herding

The amount of labour needed for herding depended on the division of livestock into herding groups. Livestock holdings are commonly divided onto the following categories for herding:

- Adult and immature cattle of both sexes
- Older suckling calves (often combined with resting bulls, sick and weak adults)
- Adult and immature sheep and goats
- Young calves, kids and lambs around the *boma*.

In Mbirikani the cattle herd was commonly further split into:

- A wet herd: lactating cattle left in the home *boma* to provide milk to women and children;
- A dry herd: dry cattle, steers and immatures which are moved to distant grazing.

Herds in the north were split only in severely dry periods.

Adult and immature cattle, older calves and smallstock required full-time herders, while young animals remained around the *boma* often under the care of small children with supervision from women. Thus a **normal** operation required a minimum of three herders per day. However, as the herding day lasts 10–12 hours (see Section 6.2.3: *Herd management and behaviour*), and children are not expected to herd for more than 2 days in every 3 (3 out of every 4 days at most) five children are needed, although it is possible to manage with four. Households with extremely large herds (500 or more head) may divide the adults from the immatures (this requiring an additional daily herder) or they may use several children simultaneously or a young adult male for herding. When herds are split to go to distant grazing, as is common in Mbirikani, at least two additional herders are required, making a total of six or seven herders.

Watering

Labour requirements for watering were low compared with other pastoral systems (Cossins and Upton, 1988; Swift, 1981; Helland, 1977). The amount of labour required for watering depended primarily on the water source (see Section 4.5: *Water resources*). For most watering facilities (boreholes, pipelines, surface water), a single adult per herd was necessary to ensure that animals were not pushed away prematurely. However, in Merueshi, extracting water from the wells in the dry riverbed at Ilkilunyeti required a lot of work: water is scooped up and poured into a trough by one person who stands in the shallow well, while a second person supervises the movement of animals (see Section 6.2.2: *Watering management*).

Livestock work at the *boma* and milking

Livestock work at the *boma* included inspecting and treating animals, putting suckling young with their dams and separating them after suckling. The return of the animals to the *boma* marked the busiest time of the day. Almost everyone over the age of four was occupied in some task. As a minimum, livestock work at the *boma* required two women, one to take care of children and young stock at the *boma* while the other is away from the *boma* to fetch water and firewood.

Milking occurred mainly between 0600 and 0700, before cattle left for grazing, and between 1830 and 2000, after they returned. Women prefer to milk by daylight but often milk in the dark in the dry season. Milking can be done by the same two women involved in other livestock work at the *boma*.

In summary, an ideal **minimum** labour force in the north consists of five herders, a male manager/supervisor and, preferably, two female milkers/domestic workers. Herd splitting in the south requires two more herders, one extra male manager and one more female manager/domestic worker. In addition, each unit needs access to other workers of various age/sex categories for less common tasks (e.g. dipping/spraying).

6.1.5 Labour sufficiency

Most households commanded a total labour force of 6–10 people, although poor households on Mbirikani had more than 12 workers and rich households on Merueshi had more than 17 workers (Table 6.5). Most households on the northern ranches (Olkarkar and Merueshi) had enough male managers but too few herders (Table 6.6). The pattern was similar for Mbirikani assuming no herd-splitting, but less than half the households had enough labour to allow herd-splitting.

Since few households on Mbirikani have enough labour to split their herds, households on this ranch have maintained closer social ties, larger *bomas* and greater co-operation in livestock management than those on the northern ranches. Households in Merueshi showed the highest labour self-sufficiency, and this was reflected in their more individual mode of residence and production (see Chapter 5: *The study area: Socio-spatial organisation and land use*). Finally, it should be noted that rich households require more than the minimum number of workers be-

Table 6.5. *Mean number of workers in poor, medium-wealth and rich households on Olkarkar, Merueshi and Mbirikani group ranches.*

	Number of workers		
Wealth class[1]	Olkarkar	Merueshi	Mbirikani
	Herders		
Poor	3.9 (8)	4.2 (6)	8.2 (6)
Medium	2.9 (7)	4.5 (12)	4.5 (8)
Rich	5.5 (9)	9.0 (3)	5.0 (9)
	Adult women		
Poor	1.8	1.7	2.8
Medium	2.3	2.2	2.1
Rich	3.3	5.7	3.3
	Male managers		
Poor	1.0	1.0	1.3
Medium	1.1	1.3	1.0
Rich	1.3	3.0	1.2

Numbers in parentheses are numbers of households.

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Table 6.6. *Self-sufficiency in labour by wealth class and ranch.*

	Percentage of households self-sufficient			
			Mbirikani	
Wealth class[1]	Olkarkar	Merueshi	No splitting	Splitting
	Herders			
Poor	38	50	83	50
Medium	0	33	50	25
Rich	56	67	33	33
	Adult women			
Poor	50	67	83	33
Medium	70	75	50	25
Rich	89	100	100	56
	Male managers			
Poor	100	100	100	33
Medium	86	100	100	38
Rich	77	100	100	44

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

cause they split their large herds and flocks, and hence their level of self-sufficiency, particularly with regard to herders, is probably slightly overestimated.

6.1.6 Labour recruitment for herding

Most households in the study area had too few people to run an independent operation, particularly with regard to labour for herding. The extent of the labour shortfall was mainly determined by the stage of the domestic cycle of the household (see Section 3.2: *Maasai social structure*). "Young" households, i.e. those that are newly independent, have relatively inexperienced managers and few of their own children of herding age. "Mature" households have more experienced adults and more children for herding. "Extended" households retain married sons, their wives and children, thus combining experienced, older adults with energetic younger ones and children of all ages. "Declining" households are those in which married daughters and sons have left; these eventually cease to exist following the death of the household head or their incorporation in a younger unit.

Households with surplus labour can move towards more autonomous production, try to improve the quality of their livestock management, increase other activities (education, leisure) or contract their household labour supply to others. Households with too little labour can adopt a variety of strategies to overcome it depending on the severity of the shortage, its expected duration, and the opportunities open to the producer (given his wealth, social network etc). A major criterion affecting the decision, especially in the north, is whether the producer is willing to sacrifice autonomy through joint herding or whether he wants to herd individually. Essentially, the most important ways that a household can increase its labour supply are by:

- joining with other households in cooperative herding and watering
- expanding the household by marriage, taking in impoverished dependants or borrowing a child, usually from close relatives (see Section 5.1: *The household and the* boma)
- hiring labour for herding (a recent development).

Clearly these are not mutually exclusive alternatives; many households used a combination of these methods. Table 6.7 characterises these ways of increasing labour in terms of how long it takes for the worker to become available and old enough to contribute; how long the worker is expected to stay; the control the producer has over the worker; the social obligations entailed by using that worker; and the regular monthly cost of the worker (maintenance in the case of family members, a salary and maintenance for hired workers).

In terms of flexibility and social and financial costs, cooperative herding is the best way to increase labour supply and this was the traditional norm. The primary cost, decrease in management autonomy, was offset by frequent movements and consequent changes in herding partners. As a compromise, cross- *boma* herding emerged recently in Olkarkar, in which producers who have their own *bomas* and *olopololis* regularly herded their adult cattle with producers from neighbouring *bomas* but herded their calves and smallstock individually.

The percentage of sample households that used these various means of marshalling labour is shown in Table 6.8. In general, households on Merueshi were less involved in labour acquisition or joint herding than those on either of the other ranches, reflecting their greater degree of self-sufficiency in labour. Hiring labour is a recent development, found only in Olkarkar and in less than

Table 6.7. *Characteristics of ways in which herding labour was recruited.*

Type	Time to develop	Duration	Control of worker	Social obligations	Monthly cost
Cooperative herding	Short	Variable	Low	Medium	None
Expanded household					
Marriage (own/sons)	Very long	Very long	High	High	Medium
Dependant household	Short	Long	High	High	Medium
Borrowed child					
Short term	Short	Short	Low	High	Low
Long term	Short	Long	High	Medium	Low
Hire	Short	Variable	High	Low	High

Table 6.8. *Percentage of sample households recruiting labour through various means, Olkarkar, Merueshi and Mbirikani group ranches.*

	Percentage of households[1]		
Type	Olkarkar	Merueshi	Mbirikani
Cooperative herding	79	29	79
Expanded household			
Son's family	21	18	18
Dependants	58	36	41
Borrowed children	38	27	38
Hire	8	0	0

[1]Many households used more than one labour type, so totals far exceed 100%.

10% of the households. Those hired were usually young men from poor households hired by rich households as herders. Hiring of labour increased during the drought of 1984, and is likely to increase with further individualisation of production and decreased social cohesion.

As expected, labour-deficient households in Olkarkar and Mbirikani herd co-operatively; in Merueshi some households with insufficient labour and all labour-sufficient households herd alone (Table 6.9). On the whole, more poor households than rich households herded co-operatively, no matter what their labour availability. Overall, households herding cooperatively had 4.2 herders while those herding alone had 7.5 herders.

Households that herded cooperatively sent proportionately more children to school than those herding alone, particularly on the northern ranches (Table 6.10).

6.1.7 Cooperative herding arrangements

Cooperative herding groups differ in their duration and their "symmetry" i.e. the extent to which each household contributes labour versus the extent to which they benefit from that labour. Some herding groups are short-term ad hoc arrangements (during periods of high mobility or emergencies due to illness). Most, however, are usually more stable, lasting at least a season and commonly several years in the north. Herding groups range from symmetrical to highly asymmetrical. The latter often involve households of different wealth ranks, the poorer household providing much more labour relative to its livestock holdings than does to richer household. In such an arrangement, the poor herdowner sacrifices the management of his own animals (as they will be in a much larger

Table 6.9. *The effect of labour sufficiency on the occurrence of cooperative herding on Olkarkar, Merueshi and Mbirikani group ranches.*

		Households herding cooperatively			
		Low labour sufficiency (0–4 herders)		High labour sufficiency (>4 herders)	
Ranch	Wealth class[1]	%	No.[2]	%	No.[2]
Olkarkar	Poor	100	5	100	3
	Medium	86	7	0	0
	Rich	100	4	40	5
Merueshi	Poor	67	3	0	3
	Medium	50	8	0	4
	Rich	0	1	0	2
Mbirikani	Poor	100	1	80	5
	Medium	100	4	25	4
	Rich	100	6	25	3

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[2]Total number of households in wealth class/labour sufficiency category.

Table 6.10. *Percentage of children attending school by herding pattern and wealth class, Olkarkar, Merueshi and Mbirikani group ranches.*

	Percentage of children attending school			
Wealth class[1]/ herding pattern	Olkarkar	Merueshi	Mbirikani	Weighted mean
Poor				
Alone		14	31	17
With others	30	44	24	30
Medium				
Alone	11	20		17
With others	29	40	17	27
Rich				
Alone	7	25	6	12
With others	26		15	21
Total				
Alone	8	20	11	16
With others	28	42	19	26

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

herding group with greater delays at watering, more competition for forage etc) but benefits from the labour of others and, more importantly, from the patronage of the rich herdowner. The rich herdowner receives the additional labour he needs with little sacrifice in management, but accumulates informal obligations to the poorer household.

6.2 Livestock management practices

6.2.1 Introduction

In general, Maasai grazing and watering management practices were aimed at:

- minimising distances between the night *boma*, the water point and grazing locations, for the benefit of both the herded animals and the herders
- avoiding predator attacks and other losses, in particular of smallstock
- ensuring animals arrived at the water point and night location at the appointed times
- providing the best possible grazing for each stock class.

To achieve these goals herders selected specific water points, where animals were watered at a predetermined frequency, and a daily grazing orbit that included one or more grazing locations (see Section 5.3: *Water utilisation, grazing patterns and stocking rates*).

6.2.2 Watering management

Distribution and types of watering facilities varied considerably among the three ranches (see Section 4.5: *Water resources*), and this influenced the frequency with which animals were watered. In general, the further a producer lived from water, the more likely it was that he practised alternate-day watering. Thus, alternate-day watering was much more common in Olkarkar and Mbirikani than in Merueshi (Table 6.11). It was also more common in dry periods than in wet periods, when ephemeral ponds or pools in riverbeds provided additional water points. Smallstock were watered less frequently during the rains than during dry periods because the Maasai believe that the green herbage available during the rains provides much of the water the animals need. The relationship between watering regimes and *boma* location was discussed in Chapter 5 (*The study area: Socio-spatial organisation and land use*) and the implications of watering frequency for milk production will be discussed in Chapter 7 (*Productivity of cattle and smallstock*).

Table 6.11. *Percentage of herds of adult cattle and young cattle and flocks of smallstock that were watered daily, every second day, every third day or infrequently, Olkarkar (Olk.) and Merueshi (Mer.) group ranches.*

Watering frequency	Adult cattle		Young cattle		Smallstock	
	Olk.	Mer.	Olk.	Mer.	Olk.	Mer.
Daily	56	84	56	79	23	39
Every 2nd day	43	15	42	19	56	34
Every 3rd day	1		2		9	9
Infrequently		1		2	12	18

6.2.3 Herd management and behaviour

As noted in Section 6.1.4 (*Labour requirements for critical tasks in livestock management*), cattle were usually divided into two groups for herding: adult cattle, comprising lactating and dry cows as well as the older heifers and steers; and all young stock from the ages of 4 to 24 months, most of which were weaned. The largest producers occasionally created a third herding group, of older immatures, to reduce the size of their adult herd. When the animals were taken to distant pastures, resulting in their being away from the *boma* for several days or longer, lactating cows and their calves were kept at home to provide milk for remaining household members. Such herd- splitting was very common in Mbirikani and many herds remained split for most of the minor drought from February to November 1982 (see Section 5.3.3: *Grazing patterns and stocking rates in the southern ranch*).

Sheep and goats were herded together. Flocks included both adults and the young that were mature enough to cover the daily orbit. The proportion of young animals in the flock was usually much higher in the long dry season than during rainy seasons because of the highly seasonal pattern in lambing and kidding (see Section 7.2.3: *Reproductive performance*).

The mean size of herding units, derived from four aerial surveys, ranged from 85 to 120 head of cattle and from 80 to 105 head of smallstock (King et al, 1985), but some of the largest producers had herding groups of 400–700 adult cattle. Such larger groups were herded either by adults or by more than one child. In addition, joint herding, which was common in Olkarkar and Mbirikani, increased the size of herding groups (see Section 7.1.4: *Reproductive performance*).

Throughout the study period, cattle herds and smallstock flocks were followed to record their activities during the herding day. Two different methods were used: these are described in de Leeuw and Peacock (1982) and in Semenye (1987)[4]. During 1982 and in early 1983, cattle herds were followed for 25 days. Herds in five locations were followed for a total of 61 days in 1983, covering the short dry season (February–March), the end of the rainy season (May–June), and the latter part of the long dry season (September–October) (Semenye, 1988a). Flock behaviour was recorded only in Mbirikani for a total of 30 days in 1982/83 following the methodology of de Leeuw and Peacock (1982).

In an analysis of Maasai herd and flock activities in relation to watering regimes, seasons and resources, consideration has to be given first to the system of herding employed by Maasai producers. Herding was mostly done by children, who acted mainly as observers and rarely influenced animal behaviour directly. Herd activity patterns were largely determined by the lead cows or old steers. However, the grazing orbit was determined by the herdowner's decisions on when the herd should depart and whether, when, and where it was to be watered. These decisions determined the distance to be walked, the amount of time spent at the water point and therefore how much time was left for grazing. Thus although the herdowner did not participate in the actual herding, he accompanied the herd out of the *boma* and met it at the water point at a predetermined time; he ensured that animals were watered in an orderly fashion and got enough time to drink.

Daily grazing management was quite uniform across ranches, sizes of production unit and seasons. Cattle were normally herded from dawn to dusk, the period when the animals were at least risk from predators. Adult cattle left the *boma* between 0630 and 0730 except in good rainy seasons, when herd departure was sometimes delayed until about 0800. Ordinarily, herds rarely returned before 1815 and most entered the *boma* between 1830 and 1915. Hence the length of the herding day was quite uniform at about 11 to 12 hours, with little influence of ranch or season[5]. Calves and immature cattle usually left about 1 hour after the adult cattle and returned earlier.

Since the length of the herding day was quite constant, it follows that the time available for grazing depended on the amount of time spent trekking and watering. Actual time spent on watering was usually low (about half an hour a day) and did not vary much between the different types of water point. The difference in time spent on different activities between watering and non-watering days was mainly that a larger proportion of time was spent on walking (without grazing) on watering days. On dipping days the herd commonly left the *boma* 1 hour earlier than usual; almost 6 hours were spent on dipping, watering and walking, leaving only 6.7 hours for grazing.

How the remaining hours were used depended largely on the herd, as did the partitioning between actual grazing, walking during grazing, resting and ruminating. Cattle spent an average of 48 minutes ruminating during the day (72 minutes in the dry season and 24 minutes in the wet season) and about 2 hours at night (Semenye, 1988b).

The amount of time available for grazing was generally between 6.7 and 9.5 hours a day. Grazing can be subdivided into three parts: forage harvesting or actual grazing, walking in search of forage and walking between periods of harvesting. Actual grazing time varied less than the available grazing time, indicating that animals compensated for loss of available grazing time by increasing the proportion of time available that was spent actually grazing. Actual grazing time was similar to that recorded by Semenye (1988b), who found an overall mean of 6.2 hours a day, ranging from 5.7 hours in dry periods to 6.6 hours in periods when green forage was available.

Although trekking time ranged from 0.4 to 2.9 hours a day, the total distance covered was much less variable (12 to 15 km). The extent of the grazing orbit was determined by two factors: the

4. The method described by de Leeuw and Peacock (1982) used continuous recording of group behaviour; percentages of the group engaged in the various activities were noted each time a change in group behaviour occurred. Speed was recorded in order to calculate distances travelled, while details of the grazing orbit (species composition, terrain etc.) were noted at regular intervals. The advantage of the method is that only one recorder is needed and problems of animal selection are avoided. The method employed by Semenye (1987) was based on recording the activity of three sample animals at 5-minute intervals. Supplementary data were derived from a vibracorder attached to the animal which logged grazing time over a 6-day period.
5. In several West African agropastoral systems the grazing day was much shorter during rainy seasons than during dry seasons (van Raay and de Leeuw, 1974; Bayer, 1986). This is usually associated with a high demand for labour for cropping during the rainy season. Maasai have no such demands and therefore can keep the grazing day constant across the year knowing that cattle need as much or more time to graze during rainy seasons as in dry seasons.

distances walked between the *boma*, the grazing area and the watering-point, and the distance moved during grazing. Animals that had trekked further to grazing tended to move less during grazing than did those that had walked a shorter distance to grazing.

The activity profiles of smallstock in Mbirikani were fairly similar to those of cattle. Herding days were slightly shorter (7.5 to 10 hours, compared with 10 to 12 hours for cattle) because smallstock were usually allowed out of the *boma* after the adult cattle herd had left. They also returned earlier from grazing staying and stayed near the *boma* until they were kraaled at dusk. Grazing orbits of smallstock were much shorter than those of cattle, hence smallstock spent less time walking than did cattle, with the result that their total and actual hours spent on grazing were similar to those of cattle. In contrast to cattle, sheep and goats grazed for fewer hours during green periods than during dry periods (de Souza and de Leeuw, 1984).

6.2.4 Calf management

Maasai calf management has two components, both of which are geared to avoiding losses rather than promoting fast calf growth[6]. First, milk offtake was carefully controlled to maintain a safe balance between the needs of the calf and human consumption (see Section 7.1.7: *Milk offtake and lactation yield*). Second, calves were very gradually adapted to grazing.

The Maasai believe that the amount of milk that a calf needs varies with the age of the calf. During the first 3–4 days after birth the calf was allowed almost all its dam's milk. Ideally, dams were milked only once a day for several weeks postpartum; calves were allowed to suckle during and immediately after milking and were then separated from their dams. The norm in Maasailand is for the woman to milk the two left teats, leaving the two right ones for the calf. However, in times of need the woman may strip three teats. Once the health of the calf seems well assured the intensity of milking increased.

Calves were penned in well-protected enclosures until they were 1 month old. From 1 month until 3 months old, they were tethered in the shade and occasionally taken out to graze. During the dry season women sometimes cut grass and carried it home for calves; the more severe the dry season, the more important this became. At 3 to 4 months old, calves were taken to reserved grazing areas (*olopololis*), which usually had a better herbage cover than unprotected areas and were usually close to the homestead and on the way to the water point so that the trekking distance to water was short.

The amount of milk required by older, grazing calves depended on the availability and quality of fodder and water, which in turn were largely determined by season and proximity of the household to water sources, respectively. Calves from homesteads near water were watered at an earlier age and were subsequently watered more frequently than calves from homesteads further from water (see Section 7.1.7: *Milk offtake and lactation yield*). In general, calves were not weaned forcibly but continued to have access to their dams at milking, and also when milking had stopped, for as long as the dam was willing to suckle them. Usually, natural weaning occurred when the dam was in calf again (see Section 7.1.3: *Breeds and weights*).

6.2.5 Management of young smallstock

Young smallstock require particular care. Women build roofed enclosures for them, either as part of the main house or as a separate structure. In Mbirikani, and sometimes in Merueshi, young lambs and kids were kept in small enclosures whereas most Olkarkar producers allowed them to roam freely around the *boma*. Very young lambs and kids were often kept in the house, even in the daytime, as they are particularly vulnerable to cold. At peak periods of lambing and kidding children and women helped match dams with their lambs and kids; extra attention was given to twins. Women saw to it that young kids and lambs were brought to their dams for suckling in the morning and in the evening. A recalcitrant dam is held so the young can suckle. At approximately 3 months old, lambs and kids join the smallstock flock and are herded together with their dams or sometimes with young calves. As with cattle, weaning was gradual. Since adults and young were herded together, suckling continued when out grazing and stopped whenever the dams ceased to lactate

6. In times of drought, this goal may be sacrificed in order to take care of immediate family needs. A few "sacrifice" animals may be left with women and children when the bulk of the herd moves. These are milked until the death of the dam or its calf.

or became pregnant again. Maasai usually castrated their smallstock around weaning time or sometimes when they were still suckling.

6.2.6 Animal health care

This section describes the preventive measures producers take against cattle and smallstock disease. The specific diseases are discussed in relation to cattle and smallstock mortality in Chapter 7 (Section 7.1.5: *Mortality*; Section 7.2.4: *Mortality and disease incidence*).

Cattle were supposed to be vaccinated twice a year against foot-and-mouth and any other diseases specified by government order. Vaccines were administered by the government veterinary services. Ticks were mainly controlled by hand-spraying or dipping livestock with acaricide, although some, mainly poor producers, removed ticks by hand. Producers stated that their aim was to control tick burden rather than tick-borne diseases. Many producers stated that cattle should be dipped or sprayed fortnightly and tried to do so, particularly when the tick burden was high. Actual frequency was affected by shortages of cash, acaricide and labour, and by dip breakdowns and ranged from weekly when tick burden was high to infrequently. During the study period cattle were dipped an average of 13 times a year on Olkarkar and 16 times a year on Mbirikani (Peacock, 1984).

Because of the problems with dips many producers changed to hand-spraying their cattle in small enclosures. Although this is less effective than dipping, it is cheaper and easier to organise, since each producer can decide on his own schedule, acaricide type and strength (de Leeuw and ole Pasha, 1987).

Most livestock owners were familiar with the common veterinary drugs and bought them from wherever they were available, including veterinary officers, chemists, pharmaceutical companies and the open market. Injectable tetracycline and trypanocidals were the most commonly used drugs and were used by most households. Most owners owned syringes and needles, which they cleaned but did not sterilise. Anthelminthics were used occasionally. The Maasai have traditional

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Chapter 7

Productivity of cattle and smallstock

P N de Leeuw, P P Semenye, C P Peacock and B E Grandin

7.1 Cattle productivity

7.1.1 Introduction

The major parameters that determine the productivity of a cattle herd are:

- the reproductive performance of the breeding females
- mortality
- growth rates from birth to maturity
- division of milk between calves and people.

Although overall mortality and growth are important determinants of herd performance it is the cow–calf unit that drives the system, in the short-term because of the milk supply and in the long-term because it is the number of calves, their survival and growth that determines the sustained viability of the herd. As a consequence, this study focused on this herd component.

This chapter presents herd composition data by age and sex categories and data on calving rate, calf mortality, calf growth and milk yield and offtake. In the final section these parameters are used in calculating the productivity index of the cow–calf component of the herd.

7.1.2 Herd composition

The structure of 41 herds across the three group ranches was recorded at the beginning of the study (1981–82). In total, over 5000 cattle were classified by age, sex, management category[1], breed and weight. The results of the analysis were published by King et al (1984).

Table 7.1 shows herd structures for the three wealth classes. All herds had a preponderance of females (65–70%). Larger producers had proportionally fewer females but a larger proportion of immature steers.

There was little difference across ranches in the proportion of cows (35–37%) or of total males (32–34%), although the composition of the latter varied: Mbirikani producers kept a larger proportion of immature steers (10%) than producers on the other ranches (5–6%). Olkarkar ranch had the largest proportion of mature steers (3.8% vs 0.9% and 1.5% on Merueshi and Mbirikani respectively).

The herds of 41 households were also stratified by weight-for-sex in five herd-size classes (Table 7.2). Herd size had a similar effect on herd composition to that of wealth class, in that the proportion of heavy steers increased with herd size, while there was only a small increase in the proportion of younger, lighter steers. The proportion of bulls in the herd declined with increasing herd

Table 7.1. *Cattle herd structures by wealth class, Olkarkar, Merueshi and Mbirikani group ranches, 1981.*

		Per cent of animals by class			
		Wealth class[1]			
	Age (years)	Poor	Medium	Rich	Mean
Males					
Calves	0–1	8.4	10.4	6.9	7.8
Young steers	1–2	11.4	7.1	11.2	10.4
Immature steers	2–4	4.2	4.2	10.0	8.2
Mature steers	>4	0.5	3.0	1.9	2.0
Bulls	>4	5.7	6.3	4.9	5.3
Total males		30.2	31.0	34.9	33.7
Females					
Calves	0–1	10.7	10.8	9.3	9.8
Heifers	1–4	18.4	23.5	19.9	20.5
Cows	>4	40.6	34.8	35.7	36.1
Total females		69.7	69.1	64.9	66.4

Columns do not sum to 100 due to rounding.

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Source: Derived from King et al (1984).

1. Management categories were: Females: calf, heifer, adult lactating and adult dry; Males: calf, replacement bull; Steers: weaner, immature, mature and large mature.

Table 7.2. *Relationship between herd size and herd composition, Olkarkar, Merueshi and Mbirikani group ranches, 1981.*

	Per cent of animals by class				
	Herd size (head)				
Age/sex class	1–40	41–80	81–150	151–300	>300
Bulls >100 kg	9	6	8	5	5
Steers 100–200 kg	7	6	7	9	8
Steers >200 kg	6	5	11	10	13
Total males >100 kg	22	17	26	24	26
Females 100–200 kg	9	12	13	16	14
Females >200 kg	48	43	43	40	44
Total females >100 kg	57	55	56	56	58
Ratio: Females 0–200 kg / Females >200 kg	0.4	0.6	0.6	0.7	0.6
Ratio: Females 0–100 kg / Females >200 kg	0.22	0.32	0.30	0.30	0.25
Per cent of households	24	24	23	16	13
Per cent of cattle	4	9	20	23	44

size. Since each producer prefers to have his own breeding bulls and replacements, these take up a larger proportion in the smaller herds. King et al (1984) found that the number of cows per bull increased from 11 in poor producers' herds to 14 in herds of rich producers.

Large herds (151–300 head) had the smallest proportion of breeding females (defined as those weighing more than 200 kg) but the highest young female/cow ratio and one of the highest calf/cow ratios. The low calf/cow ratio in small (1–40 head) herds might indicate a lower calving rate in these herds but it is more likely that they were forced to sell or exchange young female stock for cash or marketable steers from the rich and medium-wealth producers. There was little difference between ranches in the proportions of young females and breeding females or in the ratio between these classes.

7.1.3 Breeds and weights

About 95% of the 5000 cattle included in the weighing exercise were classified as Small East African Zebu; 5% were tentatively classified as mixed-breed (zebu with Sahiwal or Boran). Bulls of mixed blood were commoner on Olkarkar (55% of breeding bulls) and Merueshi (36%) than on Mbirikani, where very few were recorded. Hence the proportion of mixed-blood animals was greatest on Olkarkar. About 19% of calves in the livestock production study were classified as Sahiwal x zebu crossbreds (Semenye, 1987). The percentage of crossbred breeding bulls was higher in herds of poor and medium-wealth producers (23%) than in those of rich producers (15%).

Coat colours of cattle did not differ greatly between ranches, with 70–73% of the cattle having variegated coats. This contrasts with the findings of Finch and Western (1977), that the percentage of light-coloured cattle increased with increasing aridity; they hypothesised that this was because light-coloured animals are better adapted to heat stress and require less water than dark-coloured animals. Dark cattle may be better adapted to low night temperatures and, in view of the altitude (1200 m) of the study area, adaptation to this environmental factor may have been a more important selection criterion than heat tolerance.

Mean weights for the main management classes identified by King et al (1984) are given in Table 7.3. Mean weights of adult females were similar across herd sizes and ranches. As expected, mean steer weight increased with wealth class from 233±18 kg to 284±10 kg. Steers were heavier on Olkarkar (311±39 kg) than on Merueshi (235±18 kg) or Mbirikani (240±21 kg). Average weight of castrated weaners increased from 141±18 kg on Olkarkar to 208±9 kg on Mbirikani and average weights of female weaners from 140±18 kg to 195±9 kg. There were no differences in weight at weaning between ranches or wealth classes: calves were weaned at 100–120 kg, which corresponds to an average age of 12–14 months, indicating that Maasai prefer long lactation periods (see Section 7.1.7: *Milk offtake and lactation yield*).

Table 7.3. *Mean weights of weaner and adult zebu females, steers and bulls, Olkarkar, Merueshi and Mbirikani group ranches, 1981.*

	Mean weight (kg±SE)	
Sex	Weaners	Adults
Female	174±7[a]	251±4[a]
Steers	171±7[a]	262±13[a]
Bulls	164±10[a]	322±34[b]

[a]Small East African Zebu (SEAZ) only.

[b]94 SEAZ, 4 Sahiwal, 14 SEAZ x Sahiwal crossbreds and 2 SEAZ x Boran crossbreds.

Source: Derived from King et al (1984).

7.1.4 Reproductive performance

Seasonal distribution of birth

The Maasai do not control the breeding of their cattle and hence the reproduction of their cattle is primarily influenced by the bimodal rainfall regime and the resultant seasonality in feed supply. Ideally, calvings should be evenly distributed throughout the year to give a continuous milk supply. In practice, however, there are two major peaks in conceptions that coincide with the two rainy seasons (Figure 7.1). Monthly conception rate was highly correlated with monthly rainfall ($r = 0.93$). This conception pattern results in a calving peak from the end of the long dry season in September through November (31% of all births) and a larger peak from February through May (51%). Thus, while over 80% of calves were born during the 8 months when rainfall probability is relatively high, many cows were in the latter half of pregnancy during dry months in either the long or the short dry season.

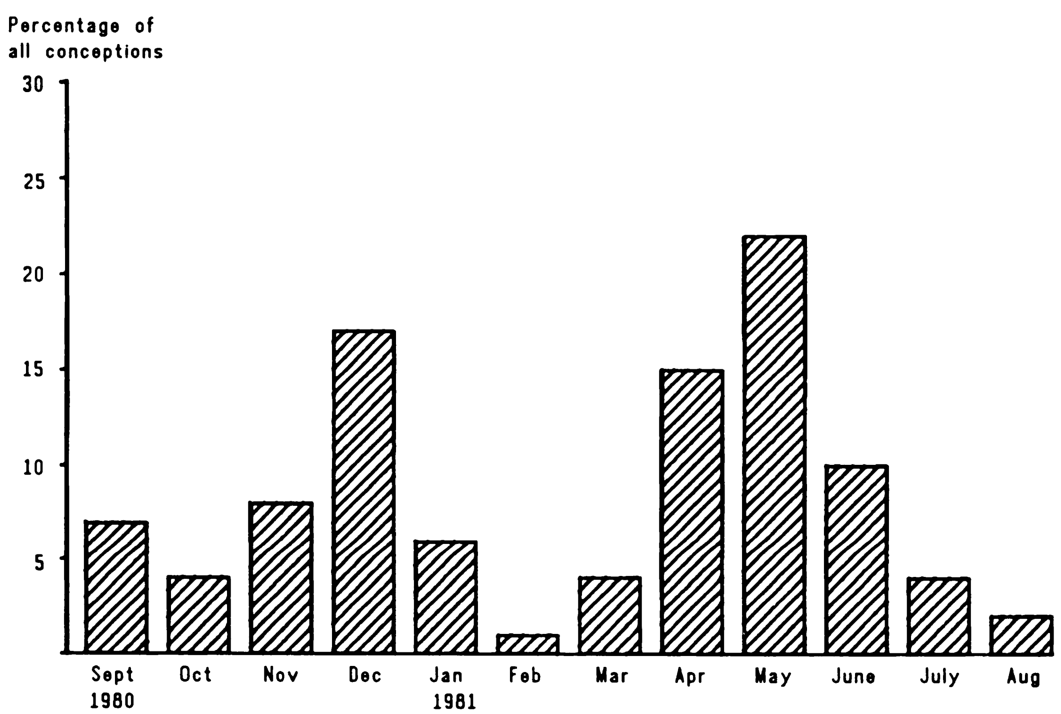
Calving rate

The average calving rate for the three group ranches was 58%, with Mbirikani showing the lowest (56%) and Merueshi the highest rate (61%). Although the time-span covered by the records was too short to provide long-term estimates of reproductive efficiency of cows, three trends were apparent, relating to:

- the effect of season of birth
- the effect of the length of the milking period
- the high variability in calving intervals.

A total of 196 cows calved during the dry season of 1981; these calved again, on average, 20.8 months later, whereas cows that calved during the rainy period from October 1981 to April 1982 gave birth 16.9 months later. These calving intervals represent calving rates of 58% and 71% respectively. These data suggest that in years with two consecutive good rainy seasons the calving rate could be as high as 75%, whereas if one season's rains failed the calving rate would drop

Figure 7.1. *Distribution of cow conceptions between September 1980 and August 1981.*



below 60%. Two consecutive poor rainy seasons would reduce calving rate to about 40% (see Section 10.1.2: *The herd-projection model*).

An analysis of records on 144 cows for which both the length of the milking period and the subsequent date of calving was known showed that the duration of milking had little effect on calving interval. When milking was prolonged by one month, the calving interval increased by only 3 days[2]; cows that were milked for 4 months calved after 20 months and those that were milked for 14 months calved after 21 months. Conception during early lactation was rare: only 7% conceived between 3 and 6 months after parturition. These findings seem to indicate that the stress of pregnancy and early lactation results in anoestrus, the duration of which is almost independent of the length of time over which the cows are milked. Calving intervals were, however, highly variable among the 144 cows: 43% calved again within 18 months, another 44% between 18 and 24 months after calving and the remaining 13% calved again after 2 years or more (de Leeuw and Wilson, 1988; Semenye, 1987).

7.1.5 Mortality and disease incidence

Calf survival rates were significantly lower on Mbirikani than on the other two ranches (Table 7.4). Calf survival was high up to 4 months of age due to the efficient management system that Maasai have adopted for young calves which are kept in and around the *boma* and rely exclusively on their dams' milk (see Section 6.2.4: *Calf management*). However, mortality during the first few weeks postpartum was poorly recorded and neonatal deaths were not included[3].

Mortality increased somewhat when calves were sent out to graze, in particular on Mbirikani where only 88% of calves survived to 7 months old. From 7 to 18 months survival was again surprisingly high, being equivalent to a mortality rate of 2–4% over 11 months (Table 7.4). Calf survival rate was also linked with dam age, calves whose dams were between 5 and 9 years old having the highest survival rates. The main causes of calf death were disease on the northern ranches and disease and malnutrition on Mbirikani (Table 7.5).

Table 7.4. *Survival rates of calves to 4, 7 and 18 months on Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Survival rate at age (months)		
Ranch	4	7	18
Olkarkar	0.99a	0.98a	0.94a
Merueshi	0.97a	0.96a	0.94a
Mbirikani	0.94b	0.88b	0.85b
Mean	0.97	0.94	0.91

Within columns, numbers followed by the same letter do not differ significantly ($P > 0.05$).
Total of 678 calves monitored.

Mortalities in older classes of stock were less systematically recorded but appeared to be mainly due to disease, injuries and predation on the two northern ranches. Mortality rates for cows were lower on Olkarkar and Merueshi than on Mbirikani (2% a year vs 10% a year). Fluctuations in herd mortality due to longer-term variations in forage supply are discussed in Chapter 10 (Section 10.1.2: *The herd-projection model*).

A general disease survey was carried out from June 1982 to May 1983. Brucellosis and leptospirosis are endemic in the area and were the most common diseases of cattle (Table 7.6). Brucellosis was also the most common disease in goats, whereas anaplasmosis was the most common disease in sheep. The majority of theileriosis cases occurred during an outbreak on Mbirikani follow-

Table 7.5. *Causes of calf deaths on Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Percentage of all deaths		
Cause	Olkarkar	Merueshi	Mbirikani
Disease	89	81	51
Injuries	7	4	
Malnutrition	4		40
Predators		4	6
Lost		11	3
Number reported	27	26	184

Source: Peacock (1984).

2. Wagenaar et al (1986) reported a similar, though more pronounced, effect of milking period on calving interval in pastoral herds in Mali: for every month increase in the milking period, the calving interval was lengthened by 13 days.
3. In some pastoral production systems 16% of pregnancies resulted in abortions, stillbirths or neonatal deaths. These causes thus accounted for over a third of all calf deaths up to 1 year old (de Leeuw and Wilson, 1988).

Table 7.6. *Incidence of major diseases in cattle, sheep and goats in the study area, 1983.*

	Disease incidence (% of animals tested)		
Disease	Cattle	Sheep	Goats
Brucellosis	15	1	7
Leptospirosis	18	0	0
Paratuberculosis	2		
Anaplasmosis	3	4	2
Theileriosis	4	1	1
Babesiosis		1	
Bovine otitis	3		

ing the drought-related movement of cattle to Kuku ranch further south where the main vector for the disease, *Rhipicephalus appendiculatus* (Brown ear tick), was present. Other diseases reported to be of concern to producers included malignant catarrhal fever, bovine otitis and helminthiasis in calves.

Thus, although several diseases were reported by livestock owners and diagnosed by the veterinary team during this extensive survey, their overall incidence was low. These findings suggest mainly sub-clinical infections and/or enzootic stability and tolerance, indicating low susceptibility to certain diseases and immuno-responsiveness to others. Passive (colostric) immunity provides young stock with their initial resistance to diseases; thereafter young stock build up and maintain immunity by being continuously exposed to the infectious agents. The inherent genetic resistance of the indigenous breeds is believed to play an important role (de Leeuw and ole Pasha, 1987).

7.1.6 Growth of young stock

The overall mean birth weight of calves was 19.2 kg. Calves born on Olkarkar and Merueshi were significantly ($P < 0.05$) heavier than those born on Mbirikani (20 kg vs 17.8 kg). Calves were born 2 kg heavier if the last trimester of gestation coincided with a rainy season than if it coincided with a dry period.

Up to the age of 7 months calves on the northern ranches gained weight faster than those on Mbirikani but between 7 and 18 months of age calves on Mbirikani had the higher growth rate (Table 7.7). The differences were, however, not significant.

About 19% of the calves were classed as Sahiwal x zebu crosses, most of which were on Olkarkar. At 4, 7 and 18 months these crosses were 6, 8 and 20 kg heavier than pure zebu animals ($P < 0.05$).

The effect of season of birth on subsequent growth was significant ($P < 0.05$) only up to the second month. Calves born in the first rains had slightly, but not significantly, higher rates of gain up to 7 months of age than calves born at others times of the year (Table 7.8). The lowest gains were recorded for calves born in the second rains (April–June); their poor performance was due to their entering the long dry season at an early age and their being exposed to poor grazing longer than calves born in other seasons.

Producer wealth class had no significant effect on calf growth rate.

On Olkarkar, calf growth differed significantly ($P < 0.05$) between producers within neighbourhoods, apparently in relation to *boma* location, which determined the distance to water, watering frequency and range resources available to the calves. Calves from *bomas* located 5 km from water with adequate grazing between the *boma* and the water point were 20 kg heavier at 7 months old than calves from *bomas* 10 km from water with only overgrazed land between the *boma* and the water point. Variability decreased with age as calves extended their orbit of grazing and relied

Table 7.7. *Daily weight gain and 7- and 18-month weights of calves on Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

		Weight gain (g/day) Calf age (months)			Calf weight (kg) at (age):	
	Number of calves	1–4	4–7	7–18	7 months	18 months
Olkarkar	140	238	184	199	67	134
Merueshi	143	218	198	204	66	134
Mbirikani	89	183	179	208	59	129
Mean		212	187	204	64	132

Table 7.8. *Effect of season of birth on daily weight gain and weight of 7-month-old calves, 1981–83.*

		Weight gain (g/day)			
		Calf age (months)			
Season of birth	Number of calves	1–4	4–7	1–7	Calf weight (kg) at 7 months old
Dry: July–Sept 1981	177	224	188	206	65
Wet: Oct–Dec 1981	98	233	206	213	66
Dry: Jan–March 1982	48	210	193	208	64
Wet: April–June 1982	49	182	162	172	63
Mean		212	187	200	64

Source: Adapted from Semenye (1987).

less on overgrazed areas around the *boma* and along cattle tracks.

7.1.7 Milk offtake and lactation yield

Milk offtake is determined by the interaction of two factors: potential milk offtake from lactating cows and milking strategy. Potential milk offtake was measured by Semenye (1987), who recorded milk offtake from 372 lactating cows once a week in the evening and the following morning. Information on components of milking strategies and their effect on actual milk offtake at the household level was collected subsequently through interviews with women and through re-analysis of the data after including those cows that were milked less often than twice every day (Grandin, 1988).

The availability of milk for consumption in Maasai households is governed by several factors. The potential supply of milk per household depends primarily on herd size, the proportion of lactating cows in the herd and the milk-production potential of each cow. Actual milk supply depends largely on the milking strategy of the producer. This determines how much milk the calf is allowed to suckle and how much is taken off for human consumption. Milking frequency and the amount of milk taken in a milking session are the main components of the milking strategy.

Rich producers milk their cows less often and extract less milk per session than producers studied by Semenye (1987); his yield data should thus be regarded as potential output.

Potential milk offtake

The Maasai have the overall production aim of maintaining a reliable supply of milk to the household throughout the year. This leads to prolonging milking for as long as possible. As the length of the milking period had little effect on the length of the calving interval, the longer the milking period, the greater the milking efficiency of a cow (Table 7.9). However, in a sample of 149 cows Semenye (1987) found that a quarter were milked for less than 6 months, while only 18% were milked for more than 12 months; the overall mean was 9 months. Short lactations were mainly due to the death of the calf and problems with milk let-down.

Table 7.9. *Milking period, calving interval and efficiency of milk production*[1].

Milking period (months)	Calving interval (months)	Efficiency[2] (%)
6	20.1	30
8	20.3	39
10	20.5	49
12	20.7	58
14	20.9	67

[1]Developed from the equation:
Y (calving interval) = 19.5 + (0.1 x milking period (months)) ($R^2 = 0.32$) (Semenye, 1987:245–248).

[2]Efficiency = milking period/calving interval.

The average daily milk offtake from cows that were milked twice daily was 0.94 litre. However, offtake varied from 0.65 litre/day in dry months to 1.20 litres/day in wet months. The effect of these differences on milk offtake from the herd was somewhat masked by the seasonality of calving and also by an increase in the proportion of milk taken from cows in early lactation. Milk offtakes given in Table 7.10 represent the means of two dry and two wet seasons, combining the sharp fall in the short dry seasons (February–March) and the much slower but more prolonged decline during the long dry season. The slower decline in milk offtake during the long dry season is mainly related to the relatively large proportion of cows in

Table 7.10. *Effect of season and stage of lactation on daily milk offtake.*

	Milk offtake (litres/cow per day)			
	Stage of lactation (months)			
Season	1–3	4–6	7–9	Mean
Rainy seasons[1]	1.16	1.13	1.02	1.09
Dry seasons[2]	0.92	0.76	0.73	0.79
Mean	1.04	0.95	0.88	0.94

[1]Means of two rainy seasons.

[2]Means of two dry seasons.

Source: Semenye (1987).

early lactation following the calving peak from March to May (see Figure 7.1).

Lactation yield

Total lactation yield (milk consumed by the calf plus that taken for human consumption) cannot be measured directly under field conditions and must be estimated from calf growth rates together with milk offtake. Daily lactation yield was estimated using growth rates of calves from 30 to 120 days old, during which period growth rate depends mainly on milk intake. Over this period, poor producers on Olkarkar extracted an average of 1.12 litres of milk daily from each milking cow, while calves each gained an average 16.7 kg. This weight gain indicates that each calf consumed approximately 150 litres of milk (Drewry et al, 1959). Thus the total lactation yield over the 90 days was 251 litres or 2.8 litres a day, of which 40% was taken off for human consumption.

Milking strategies and actual milk offtake by wealth class[4]

This section considers the amount of milk taken off for human consumption, which is a function of the potential supply and the needs of suckling calves and the family.

Maasai do not speak of milking cows; they speak of "milking calves". This underscores their understanding of the competition between calves and the family for the milk of the same cow. Maasai know the productive potentials of their animals and their life history. The condition of animals is monitored closely by both the woman who milks them and the head of the household. If a calf seems weak, or becomes ill, its dam will be milked less frequently and the amount of milk taken on each occasion will be reduced. However, Maasai believe that too much suckling can harm a calf; high-yielding cows are milked even if they are temperamental to prevent the calf from consuming too much milk and getting diarrhoea. The amount of milk required by older, grazing calves depends on the availability of forage and water, which was closely related to the season and the location of the homestead. Calves from homesteads near water were taken to water at an earlier age and were watered more frequently than calves from homesteads far from water.

After calf survival, the most important criterion used by a woman in determining how much milk to extract is the need of her family. The amount of milk needed depends on several factors, including the size of the family and its age/sex structure. Women seem to aim for a daily milk offtake of about 1 litre per person in the dry season and 1.5 litres per person in wet season. Seasonal variation in the diet was preferred by most people. However, seasonal variation in milk consumption was a necessity for poor households, whereas for rich households it is by preference.

The availability of other foodstuffs also influenced family needs for milk. In most of the study sites, local shops and markets normally afforded a regular supply of goods and hence the availability of cash governed the supply of other foods. In poor households women milked harder than in rich households, which had more cash available to purchase other foods.

Milk sales accounted for only 5% of milk offtake on Olkarkar and less on Merueshi. Almost no milk

4. The following section is based on Grandin (1988) and Grandin (unpublished data). The quantitative information was derived from formal questionnaires administered monthly regarding the number of lactating and milked cattle per sub-household and from fortnightly milk measurements on cows in the animal productivity study (Semenye, 1987). Although the latter data collection was not designed with household consumption in mind, the information can be used to estimate general patterns. Observations combined with informal interviews, mainly in Olkarkar, contributed substantially to the analysis. The available data suggest that patterns in Merueshi were quite similar to those in Olkarkar. Only general statements are possible in relation to Mbirikani because of the drought conditions pertaining on that ranch and the high mobility of both people and stock. There was no information on lactating cattle and what milk records were available were almost exclusively collected from the more accessible *bomas*.

was sold on Mbirikani. Demand was highly location specific, with sales made to nearby hotels or to locally resident workers (teachers, game park workers, etc). Thus milk sales did not have a marked effect on milk offtake.

Women did not always milk all their lactating cows. The percentage of cows usually milked generally declined with increasing herd size. Some cows were not milked at all (due to wildness, mastitis, low potential) or were milked for only part of the lactation. Rich households commonly delayed onset of milking and stopped milking earlier in the lactation than did poor households. Thus only some of the lactating cows contributed milk for human consumption at any given time. However, these "usually milked" cows were not necessarily milked every day or at every milking and hence the number of "actually milked" cows was often lower than the number of "usually milked" cows.

Unfortunately, few data are available on the percentage of "usually milked" cows that are actually milked on a given day and estimates were derived from observations and milk recordings. A single data point for households in Olkarkar for July 1982 (mid-long-dry season) indicated that poor households actually milked 95% of their reported "usually milked" cattle, while rich households milked only 70%. The single richest household milked only 58% of the "usually milked" cows. In the very wealthy households, a labour bottleneck at milking limits the number of cows milked; however, this is much less important factor than the need for milk in determining the number of cows milked.

Most households milked their animals twice a day, in the morning and in the evening. The richest households commonly milked their cows only once a day, while others occasionally milked only once a day. The offtake per cow from once-a-day milking was 50–60% that of twice-a-day milking (Semenye, 1987).

Several short-term circumstances commonly resulted in a cow remaining unmilked on one or more occasions. Milking was temporarily suspended if the cow or calf was ill or seemed to be in poor condition. Calves occasionally escaped from the calf-pen and spent the night with their dams, which were consequently not milked in the morning. Calves that were not penned before their dams returned from grazing often met their dams and suckled on the way. Such events were commonest in households with large herds, in which women did not need all the potentially available milk and could afford to be less careful in their calf management. Additionally, women who had more milk available than required took a lot of milk from a few cows rather than taking a little from all their cows, thus reducing the amount of work involved. Women tended to choose animals with younger calves as young calves are easier to handle than older calves and require less milk.

Lastly, actual milk offtake depended on how much milk was taken from each cow milked, which was determined by the number of quarters milked and the degree of stripping. Maasai women usually milked the two left teats, leaving the two right ones for the calf, but milked three quarters when family needs were high. The amount of milk taken from each quarter also varied. The amount of milk given by the cow per unit time decreases after the first few minutes of milking, at which point women with many lactating cows generally moved on to another cow, leaving the rest of the milk for the calf, while poor women coaxed out the last bit of milk.

The effects of wealth class on milking strategies and offtake in Olkarkar are shown in Table 7.11. Milk offtake per person was similar across wealth classes, but the percentage of cows milked, the proportion of cows milked twice a day and the amount of milk taken per cow all decreased with increasing wealth. An offtake of about 1.2 litres per person per day would seem to be the goal in Maasailand, but households with

Table 7.11. *Milk-offtake parameters for poor, medium-wealth and rich households on Olkarkar Group Ranch.*

	Wealth class[1]		
Parameter/household	Poor	Medium	Rich
Cattle per reference adult	4	7	23
Per cent of lactating cows usually milked	100	70	40
Per cent of lactating cows actually milked[2]	96	60	30
Per cent of cows milked twice a day	88	85	65
Daily milk offtake per cow milked (litres)	1.0	0.93	0.75
Total daily milk offtake (litres)	7.2	10.4	18.5
Daily offtake per reference adult (litres)	1.1	1.2	1.3
Actual/potential offtake (%)[3]	86	56	25

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[2]Estimated from milk recording observations.

[3]The potential is reached when all cows with suckling calves are milked twice a day.

Source: Adapted from Grandin (1988).

few cows were not able to meet that goal despite a relatively intensive milking strategy. Medium-wealth households met it but with slightly less intensive milking, whereas rich producers achieved this level of offtake using only about one quarter of their potential milk offtake (see Section 10.2.3: *Milk offtake*).

Residence and milk offtake in Olkarkar

Neighbourhoods varied markedly in their access to water and the quality and quantity of grazing between the *boma* and the water point. Frequency of watering of both cattle and calves was inversely related to distance from water, with concomitant effects on both milk production and calves' needs for milk. Most rich producers lived far from the water point to give themselves access to more and better grazing, while most poor producers lived nearer the water point as they had less need for grazing. Watering frequency also varied with neighbourhood. Households 2 km from water watered their stock every day; those about 7 km from water usually watered stock every second day. Distance from water had an effect on milk production and hence on the amount that could be taken for human consumption. Milk yields fell as distance of the *boma* from water increased, due to lower water intake, longer walking distance to water and reduced grazing times[5]. Although place of residence was confounded with wealth class, milk offtake was generally lower in households far from water points: e.g. on Olkarkar households 7 km from water had an average milk offtake of 0.78 litres per cow per day, compared with 1.02 litres per cow per day for households 2 km from water.

Seasonal fluctuations

Daily offtake per cow varied more between seasons than did the number of cows milked (Table 7.12). The number of lactating animals varied between seasons (see Section 7.1.4: *Reproductive performance*) but variations in the percentage of lactating cows that were usually milked (significant in the case of medium-wealth and rich producers) resulted in smaller seasonal fluctuations in the number of cows usually milked. The percentage of cows that were actually milked seemed to be lower during wet seasons than during dry seasons, particularly in the case of rich producers' herds.

7.1.8 Productivity index

Productivity indices combining cow reproduction, milk offtake per cow and calf viability and growth were used to examine the overall annual output of the cow–calf unit (Table 7.13).

These indices indicated productivity of 53–73 kg of calf/cow per year, or 21–28 kg of calf/100 kg of cow liveweight per year. This is somewhat higher than in other traditional production systems in similar environments in sub-Saharan Africa, in which indices range from 17 to 23 kg of calf/100 kg of cow (de Leeuw and Wilson, 1988).The productivity of Mbirikani was some 25% less than that of the two northern ranches, mainly because of a minor drought in 1982.

Although these indices provide useful overall yardsticks to measure system productivity, caution is needed in interpreting them because of possible differences in productivity between wealth classes. The effect of wealth class on the productivity indices was thus calculated for Olkarkar. Since there was no evidence that cow and calf survival or calving percentage differed between producer groups, it follows that only calf growth and milk offtake yield influenced the productivity index (Table 7.14). Calves in medium-sized herds were heavier at one year old than those in large or small herds and medium-sized herds had the highest productivity index. Large herds had the second highest productivity index when this was calculated using potential milk offtake but the lowest index when actual milk offtake (derived from Table 7.11) was used in the calculation. This is because rich producers used only about 25% of their potential milk offtake during the favourable conditions of the study period. The contribution of milk offtake to the productivity index is rather small as a result of converting milk offtake to a calf-growth equivalent. This does not reflect the true importance of milk in Maasai households.

Productivity varied much more between individual cows than it did between herds. The major differences were in calving rate and milk yield. In addition, "gift cows" of unknown parity had higher calf mortality and produced calves that weighed less at 12 months old than did cows in their fourth or fifth parity. Combining these differences in production parameters indicates that the productivity of a good cow may be 56% higher than that of a poor cow (Table 7.15).

5. Semenye (1987) has shown that milk offtake on the watering day was about 10% higher than on non-watering days.

Table 7.12. *Estimates of daily milk offtake in poor, medium-wealth and rich households by season, December 1981– February 1983, Olkarkar Group Ranch.*

Season	Wet	Dry	Wet	Dry	Wet
Period	Dec–Jan 1981/82	Feb–Mar 1982	Apr–May 1982	June–Oct 1982	Nov–Feb 1982/83
Poor[1]					
Daily offtake (litres/cow)	1.28	0.66	1.26	0.93	1.19
Cows usually milked	4.9	6.3	7.8	7.6	7.1
Per cent of cows actually milked[2]	96	98	90	96	95
Actual offtake (litres/household per day)	6.0	4.1	8.8	6.8	8.0
Medium-wealth[1]					
Daily offtake (litres/cow)	1.04	0.73	0.92	0.72	1.14
Cows usually milked	10.2	11.6	12.5	12.2	13.2
Per cent of cows actually milked[2]	80	86	80	92	75
Actual offtake (litres/household per day)	8.4	7.1	9.1	8.0	11.3
Rich[1]					
Daily offtake (litres/cow)	0.68	0.51	0.73	0.60	0.79
Cows usually milked	24.7	24.9	28.9	23.8	23.9
Per cent of cows actually milked	65	80	60	72	67
Actual offtake (litres/household per day)	10.8	10.2	12.7	10.2	12.7

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[2]Estimated from observations and milk recordings.

Table 7.13. *Productivity parameters and productivity indices for cattle on Olkarkar, Merueshi and Mbirikani group ranches*[1].

	Ranch			
Parameter	Olkarkar	Merueshi	Mbirikani	Overall
Cow survival (%)	98	98	90	95
Calving percentage	57	61	56	58
Calf survival (%)	95	93	87	92
Calf weight at 1 year (kg)	98	97	91	95
Milk offtake (kg/lactating cow per year)	250	294	227	257
Average cow weight (kg)	240	260	253	251
Productivity indices				
kg calf/cow per year[1]	68	73	53	65
kg calf/100 kg cow liveweight	27	28	21	25

[1]The index was calculated as:
(cow viability x calving rate x calf survival x calf weight at 1 year (kg)) + (cow viability x calving rate x (milk offtake (kg)/9))

Finally, it must be stressed that these calculations were based on data from only 18 months. Long-term herd productivity is discussed in Chapter 10, in which the productivity index is extended to indicate the productivity of the whole herd, rather than just the cow–calf component.

Table 7.14. *Productivity parameters and productivity indices for poor, medium-wealth and rich producers, Olkarkar Group Ranch.*

	Wealth class[1]		
Parameter	Poor	Medium	Rich
Calf weight at 1 year (kg)	89	108	102
Potential milk offtake (kg/cow per year)	290	275	260
Index: kg calf/100 kg cow	27	31	29
Actual milk offtake (kg/cow per year)	250	154	65
Index: kg calf/100 kg cow	26	28	24

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Table 7.15. *Minimum and maximum cow productivity parameters and resultant indices.*

	Minimum	Maximum
Cow survival (%)	98	98
Calving percentage	58	73
Calf survival (%)	86	93
Milk offtake, kg/cow per year	88	99
Calf weight at 1 year (kg)	225	290
Index (kg calf/cow)	57	89

7.2 Smallstock productivity

7.2.1 Introduction

This section focuses on the composition of sheep and goat flocks and their reproductive performance, mortality and growth. It does not consider other components of research on smallstock, such as the relationships between productivity, flock management, and rangeland resource utilisation. Some of these research topics have been reported in de Leeuw and Peacock (1982) and Peacock (1984) and were summarised in Chapters 5 (*The study area: Socio-spatial organisation and land use*) and 6 (*Labour and livestock management*). The socio-economic aspects of keeping smallstock are dealt with in Chapters 8 (*Livestock transactions, food consumption and household budgets*) and 9 (*An economic analysis of Maasai livestock production*).

7.2.2 Flock composition

Flock structures were determined using the same households as those for cattle herds (see Section 7.1.2: *Herd composition*). In total, some 2700 sheep and 2300 goats in 41 households were counted and classed according to sex, age and breed (King et al, 1984).

Sheep

The average composition of sheep flocks is given in Table 7.16. There were no significant differences between wealth classes or ranches in the proportion of females in the flocks, which averaged 67%. However, while the distribution of females among age classes was similar on Olkarkar and Merueshi, on Mbirikani over half the females were more than 30 months old (Figure 7.2).

Table 7.16. *Average sheep flock structure, Olkarkar, Merueshi and Mbirikani group ranches, 1981.*

	Percentage of flock by class		
Age (months)	Males	Castrates	Females
Young (0–15)	8	10	21
Mature (15–30)	2	5	20
Old (>30)	1	6	26
Total	11	21	67

Derived from King et al (1984).

The proportion of castrates decreased slightly from north to south (24 vs 20%), while rich households retained a larger proportion of castrates of more that 30 months old than did poor households (13 vs 8%) (Figure 7.3), indicating that poor producers sold male stock at an earlier age than rich producers. Olkarkar had the smallest proportion of young males and the highest proportion of young castrates, indicating the producers on this ranch castrated male sheep at an earlier age than did those on the other two ranches (Figure 7.3; see Section 8.2: *Livestock utilisation: Transactions for offtake and acquisition*). There was an average of 14 ewes per breeding ram, ranging from 12 on Mbirikani to 19 on Olkarkar, and from 11 in poor households to 16 in rich households.

Goats

The number of females and the age distribution in goat flocks was similar to that in sheep (Table 7.17). As with sheep, more than half the female goats on Mbirikani were 30 months old or older (Figure 7.4). The proportion of castrated males was similar on all ranches but old castrates accounted for half of all castrates on Mbirikani, compared with 16% on Olkarkar and 12% on Merueshi (Figure 7.4). The proportion of old castrates also increased with increasing household wealth, from

Figure 7.2. *Age classes of female and castrated sheep on Olkarkar, Merueshi and Mbirikani group ranches.*

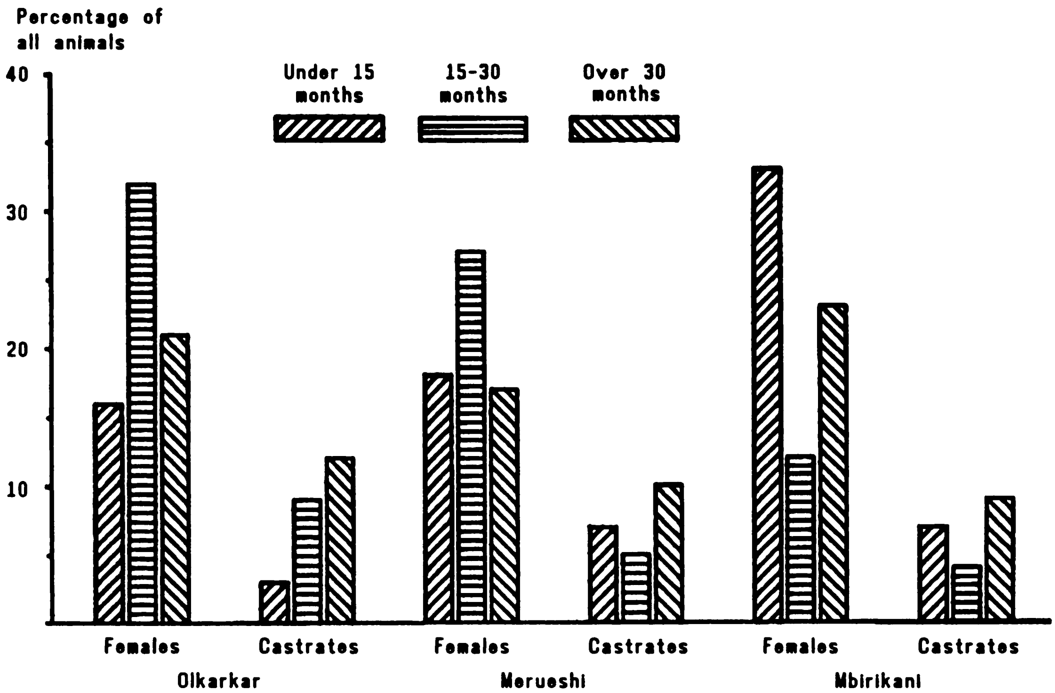
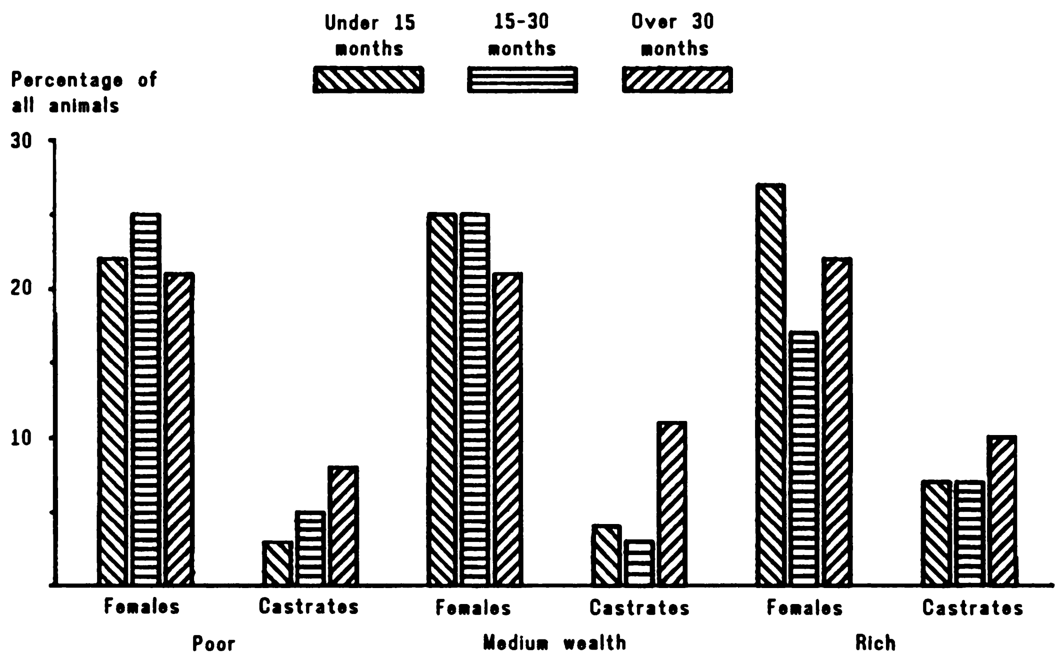


Figure 7.3. *Age classes of female and castrated sheep in flocks belonging to poor, medium-wealth and rich producers.*



less than 4% in poor households to almost 10% in rich households (Figure 7.5). The mean number of does per breeding buck was 26, ranging from 24 on Merueshi to 30 on Mbirikani and from 13 in poor households to 40 in rich households.

Males and castrates comprised more than 32% of the total flock in the study area, compared with only 5% for the Afar in Ethiopia, 23% for the Daju and the Baggara in the Sudan, 25% for the Bambara and 27% for the Fulani in Mali (Wilson, 1982;

Table 7.17. *Average goat flock structure, Olkarkar, Merueshi and Mbirikani group ranches, 1981.*

Age (months)	Percentage of flock by class		
	Males	Castrates	Females
Young (0–15)	7	9	18
Mature (15–30)	1	7	22
Old (>30)	1	8	27
Total	9	24	67

Derived from King et al (1984).

Peacock, 1984). In addition to the high proportion of males and castrates in the flocks, 51% of the castrated goats and 35% of the castrated sheep were over the optimum sale age (Peacock, 1984). Sales of small ruminants, especially by rich producers, can thus be doubled without impairing the reproductive capacity of the breeding flock (see Section 8.2: *Livestock utilisation: Transactions for offtake and acquisition*).

Breeds

The major sheep breeds were Red Maasai, Blackheaded Somali and some Dorpers and their crosses. The fat-tailed Maasai sheep was the predominant breed on the northern ranches (65–75%), while the fat-rumped Somali was the commonest breed on Mbirikani (65%). King et al (1984) found that Dorpers accounted for 20% of the sheep on Olkarkar and 8% on Merueshi, whereas Peacock (1984) stated that only a few Dorpers were observed in some richer Olkarkar households. Almost all the goats were of the Small East African breed.

7.2.3 Reproductive performance

The Maasai try to control breeding of their smallstock using breeding aprons and this results in a distinct peak of conception early in the long dry season, when the breeding apron was normally removed. However, lambing and kidding occurred throughout the year, albeit with 80% of births taking place between October and April (Figure 7.6), coinciding with the two rainy seasons.

Over the 2-year study period two-thirds of all births on Mbirikani occurred in the first year (1981/82). Lambing and kidding rates were low as the result of low and poorly distributed rainfall between June 1981 and November 1982 and a severe outbreak of Nairobi Sheep Disease in 1982/83 (see Section 7.2.4: *Mortality and disease incidence*). Between June 1981 and June 1983 only 24% of the sheep and 17% of the goats gave birth twice. These had mean parturition intervals of 12.3 months and 13.6 months respectively. This poor reproductive performance was confirmed by rapid surveys on Mbirikani between 1981 and 1984: 36% of the potential breeding females had not conceived at all; of those that did conceive, some 50–70% did so within 18 months, whereas another 20–25% had a parturition interval of over 2 years (Figure 7.7).

Figure 7.4. *Age classes of female and castrated goats on Olkarkar, Merueshi and Mbirikani group ranches.*

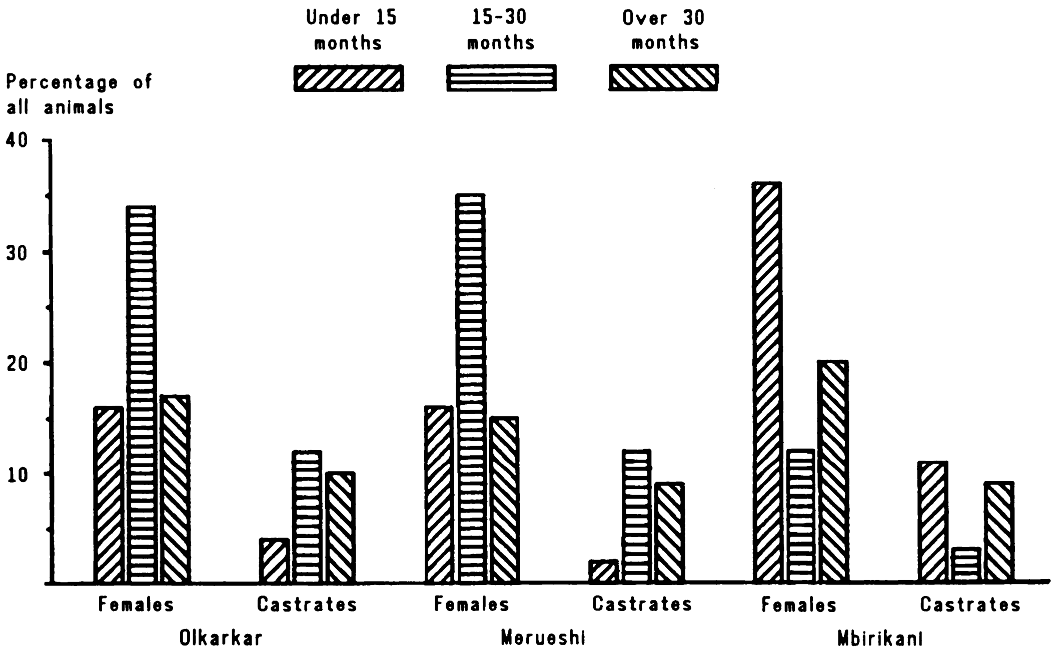


Figure 7.5. *Age classes of female and castrated goats in flocks belonging to poor, medium-wealth and rich producers.*

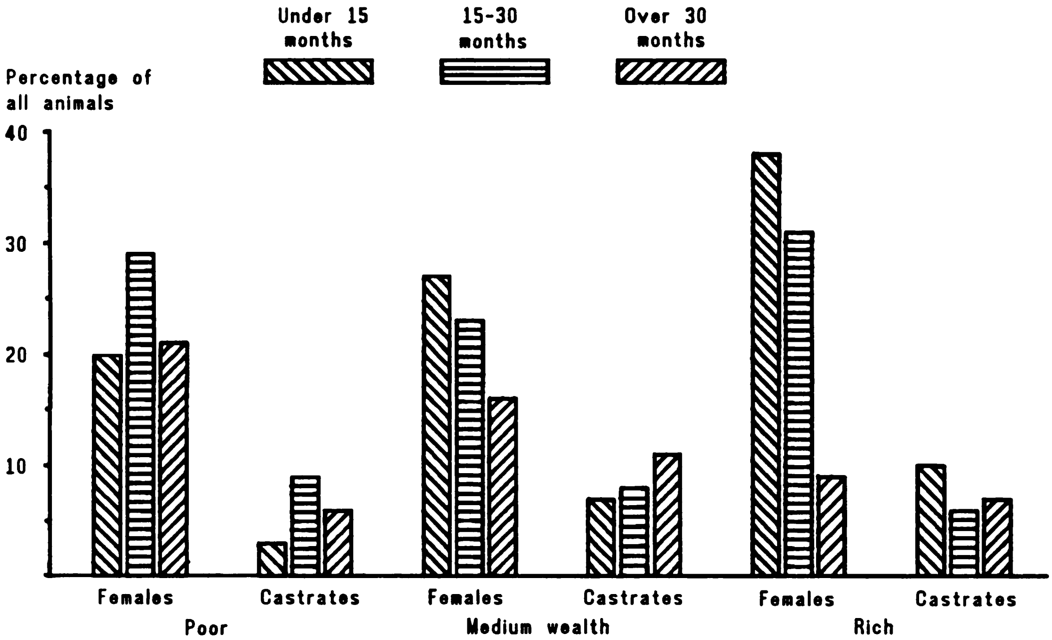
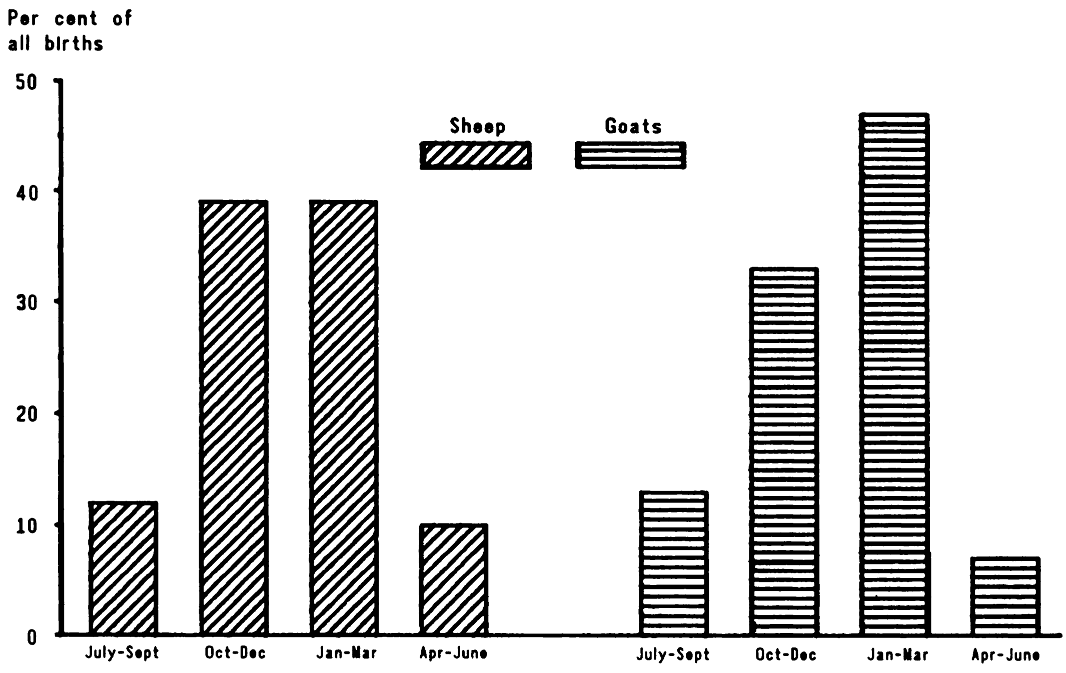
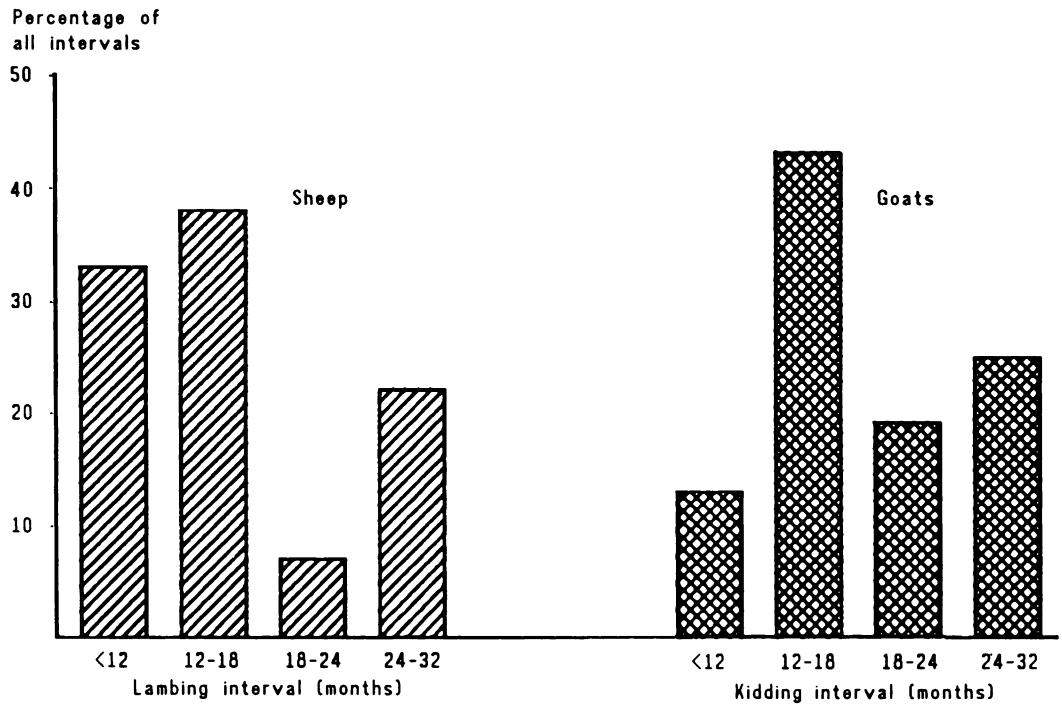


Figure 7.6. *Seasonal distribution of births of sheep and goats on Olkarkar, Merueshi and Mbirikani group ranches.*



The effect of nutrition during the mating season, particularly on goats, was demonstrated by differences in mating and subsequent birth rates in smallstock flocks on Mbirikani, some of which were moved to *Acacia tortilis* woodlands south of the ranch to feed on acacia pods during the long dry season in July–August. Comparison of the reproductive performance of flocks that remained on the group ranch and those that moved showed a near-five-fold increase in the percentage of goats that were mated and hence a six-fold increase in the percentage giving birth

Figure 7.7. *Frequency distribution of successive birth intervals in sheep and goats on Mbirikani, 1981–84.*



(Table 7.18). Pod feeding had less effect on sheep reproductive performance.

7.2.4 Mortality and disease incidence

Mortality rate up to weaning was lower for sheep (18%) than for goats (34%), although the difference was smaller at 18 months (57% vs 66%). The high pre-weaning mortality rate in goats was due in part to their larger litter size; about 15% of the goats produced twins, which were twice as likely to die before weaning as were single-born kids. Only 1% of sheep gave birth to twins. Preweaning mortality rates differed little between ranches but mortality rates from 5 to 18 months and from 0 to 18 months were markedly lower on Merueshi than on the other two ranches (Table 7.19). Mortality rates of goats also differed substantially between wealth classes (Table 7.20); apparently, households with many cattle took less care of their goats than did households with few cattle. Season of birth affected pre-weaning mortality rate in sheep but not in goats; lambs born in the long dry season had higher death rates than those born in other seasons (Table 7.19). Browse was a more important source of feed for goats than for sheep, and this was the most likely cause of the lower dry-season mortality of unweaned kids (de Leeuw and Chara, 1985).

Table 7.18. *Effect of feeding on acacia pods in 1983 on the reproductive performance of goats and sheep, Mbirikani Group Ranch.*

	Reproductive performance (% of breeding females)			
	Goats		Sheep	
	Pods	No pods	Pods	No pods
Mated	97	20	73	47
Conceived	80	20	54	47
Birth	79	13	54	44
Abortion	1	7	0	13

Source: Adapted from Peacock (1984), Table 5.4.2., page 245. See also de Leeuw et al (1986).

Table 7.20 shows the causes of death of young (suckling) and adult sheep and goats between August 1981 and February 1983, based on monthly interviews with producers. Disease was a major cause of pre-weaning death in both species and on all ranches. Predators accounted for a large proportion of deaths among young sheep and goats on Olkarkar and of young sheep on Merueshi, but were of little importance on Mbirikani.

The distribution of sheep mortality rates among households was uneven; on all ranches, 60% of the households had low mortality rates

Table 7.19. *Mortality rates of smallstock by ranch, wealth class and season of birth.*

	Mortality rate (%)					
	Sheep			Goats		
	Age (months)			Age (months)		
	0–5	5–18	0–18	0–5	5–18	0–18
Ranch						
Olkarkar	10	26	36	25	36	61
Merueshi	8	15	23	29	18	47
Mbirikani	10	34	44	32	35	67
Wealth class[1]						
Poor	10	20	30	9	23	32
Medium	7	13	20	23	17	40
Rich	7	14	21	40	13	53
Season of birth						
Oct–Dec	8	20	28	30	27	57
Jan–Mar	10	30	40	29	39	68
July–Sept	16	15	31	29	18	47

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Source: Adapted from Peacock (1984).

(0–10%), while another 7% had rates exceeding 50%, often on account of Nairobi Sheep Disease. The distribution of goat mortality rates was more even; 25% of households had mortality rates of less than 10%, whereas in another 25% death rates were over 60%.

Lambs and particularly kids suffered from scouring, often leading to dehydration, emaciation and death. Scouring was associated with coccidiosis, enterotoxaemia and enteric coli-bacillosis. Another likely cause was salmonellosis. Helminthiasis and coccidiosis were diagnosed frequently in smallstock. Strongyle eggs were found in 30% of faeces samples, and coccidial oocysts in 20%, during the general disease survey, while less than 2% of the animals examined had tapeworm and liver fluke. Enterotoxaemia was identified by post-mortem examination in three separate flocks in Mbirikani, in one of which 80% kid mortality was recorded. Pneumonia caused by *Pasteurella haemolytica* was also identified as a possible cause of death in lambs.

Tick-borne diseases, including theileriosis, babesiosis, Nairobi Sheep Disease, heart-water and anaplasmosis, were a major cause of adult mortality. However, three-quarters of all smallstock examined had low tick burdens. *Anaplasma* was the most common blood parasite in both sheep and goats. *Babesia* were commoner in

Table 7.20. *Causes of sheep and goat deaths on Olkarkar, Merueshi and Mbirikani group ranches, August 1981 to February 1983.*

	Percentage of deaths							
	Olkarkar		Merueshi		Mbirikani		Mean	
	Young	Adult	Young	Adult	Young	Adult	Young	Adult
Sheep								
Disease	39	3	50	89	78	81	52	63
Injury	5	16					3	6
Malnutrition	3	2	7		2	2	3	2
Predators	43	37	36	7	4	9	30	20
Lost	10	16	7	4	16	8	12	9
N	123	172	14	132	68	123	207	427
Goats								
Disease	54	41	75	61	88	70	76	54
Injury	2	16			1		1	8
Malnutrition	6	5	13	4	1	1	4	4
Predators	27	29	8	13	2	8	11	19
Lost	11	9	4	22	8	20	9	15
N	112	108	24	23	195	75	331	206

Source: Peacock (1984).

sheep, and *Theileria* parasites in both sheep and goats, on Olkarkar and Merueshi than on Mbirikani because of the greater incidence of ticks in the two northern ranches. Other causes of adult mortality were pregnancy toxaemia, particularly during the long dry season, and acute haemonchosis, which was commonest in goats. The study area has, in the past, suffered epidemics of Contagious Caprine Pleuro-Pneumonia but occurrence has been irregular and the last outbreak was reported in 1978.

The most important disease that affected adult sheep and goats during the course of the study was Nairobi Sheep Disease. The first outbreak occurred on Mbirikani in January 1983 and eventually subsided in June 1983; it also spread northwards into Merueshi and Olkarkar. Mortality and abortion rates were high, which, combined with the poor grazing conditions in Mbirikani during the 1982 mating period, caused extremely poor reproduction. In light of its large impact on the sheep and goat flocks in the area, a brief description of the course of the disease is given below.

The failure of the long rains in 1982 on Mbirikani caused households to move cattle, sheep and goats off the ranch; most households moved south into Kuku Group Ranch (see Section 5.3.3: *Grazing patterns and stocking rates in the southern ranch*). This ranch is on the edge of an area where Nairobi Sheep Disease is enzootic, centred on the foothills of Mount Kilimanjaro (Davies, 1978). There were no working dips in Kuku and most households had not taken their hand-spraying pumps or supplies of acaricide with them during their extensive migration.

Most households returned to Mbirikani following the good rains in November and December 1982. By January 1983 there were reports of a mysterious disease that was killing adult sheep and, to a lesser extent, goats. The outbreak was at its most severe during February and March and subsided by June 1983. Some 57% of sample households were affected. Mortality rates ranged from 16% to 100% in both sheep and goats, with a mean of 44% in sheep and 41% in goats. In three flocks, only sheep were affected. Some 30% of animals infected recovered. Most Maasai said that there were more abortions during that year than in other years, although the abortion rate (approximately 5–10%) was lower than might have been expected.

7.2.5 Growth performance

Lambs and kids

Growth rates differed markedly between species. Kids grew much more slowly than lambs up to 5 months old, in part because of the higher twinning rate of goats (Table 7.21). Single-born animals were heavier at birth and up to 5 months old than twins. The difference narrowed on 1-year-old animals as a result of high mortality among twins; surviving twins were usually the heavier animals.

Season of birth had a marked effect on subsequent growth rate. Lambs and kids born in the first rains were heavier up to 5 months old than those born in other seasons. Between November 1982 and February 1983, 8- to 12-month-old kids gained an average of 50 g/day, compared with a mean of 25 g/day in other seasons.

Growth rates of both sheep and goats were generally lower on Olkarkar than on the other two ranches (Table 7.21). This may have been related to the higher disease risk, less effective management, generally higher stocking rates and lower availability of browse on Olkarkar (see Chapter 4: *The study area: Biophysical environment*, and de Leeuw and Chara (1985)). The relatively high post-weaning weights of lambs on Mbirikani may have

Table 7.21. *Least squares mean weights of lambs and kids at birth and 3, 5, 12 and 18 months old on Olkarkar, Merueshi and Mbirikani group ranches.*

	Liveweight (kg) at age (months)				
	0	3	5	12	18
Lambs					
Ranch					
Olkarkar	3.4	9.4	13.0	18.8	27.5
Merueshi	3.1	10.3	13.9	20.5	28.5
Mbirikani	4.0	10.3	14.6	23.4	30.6
Overall mean	3.5	10.0	13.8	20.9	28.8
Kids					
Birth type					
Single	3.4	8.7	11.3	18.7	24.4
Twins	2.7	7.1	9.4	17.4	23.9
Ranch					
Olkarkar	3.1	7.7	9.7	15.5	19.4
Merueshi	2.9	7.9	11.0	20.0	26.5
Mbirikani	3.2	8.2	10.3	18.6	26.5
Overall mean	3.1	7.9	10.3	18.0	24.1

Source: Peacock (1984).

been due, in part, to the high proportion of Blackheaded Somali sheep on this ranch.

Adults

Weight changes of adult males and females were monitored in three Mbirikani flocks from April 1982 to June 1983. These flocks thus passed through the long 1982 dry season and the excellent rains from late October to January 1983. Final weights coincided with the end of the very poor rains in April and May 1983.

In general, rams maintained their weight through the 1982 dry season, whereas bucks made small but steady gains. In October 1982, at the beginning of the rains, rams weighed an average of 34 kg while bucks weighed 40 kg. At the end of the rains (January 1983) rams weighed 40 kg and bucks weighed 47 kg. Both rams and bucks then maintained their weights until June 1983. Thus males had an average annual growth rate of about 18 g/day (6–7 kg/year). Similar trends were found in females; their weight remained constant at 32 kg during the long dry season, rose sharply during the rains, partly as a result of pregnancy, to 37–38 kg, and then remained steady until June 1983. Their annual weight gain was thus slightly less than that of males at 5–6 kg. However, weight-changes of breeding females during the dry season were also influenced by the selection of the dry season area. Ewes and does that were taken to the *Acacia tortilis* woodlands in the south were 6 kg and 4.5 kg heavier respectively than those that remained at the ranch.

Post-partum weights of ewes and does averaged 28 kg, ranging from 25 kg in young animals to about 30 kg in old animals. Effects of breeding season and ranch were significant but small. Both sheep and goats were heavier on Mbirikani (2.0 and 0.7 kg respectively) than on the other two ranches due to a preponderance of older animals in the Mbirikani flocks. Dams that dropped offspring in January–February after the first rains were 2.2–2.5 kg heavier than those that gave birth earlier.

7.2.6 Productivity index

The overall productivity of sheep and goat flocks was low, ranging from only 29 g of weaned weight/kg of flock biomass in goat flocks on Mbirikani to 107 g/kg in sheep flocks on the northern ranches (Table 7.22). The productivity of sheep was generally higher than that of goats because sheep had lower pre-weaning mortality rates and lambs weighed more than kids at 5 months and 18 months. Smallstock on Mbirikani were less productive than those on the northern ranches, mainly because of their low reproductive rate during the minor drought in the second year of the study. Output per kg of flock biomass was depressed by the relatively large proportions of castrates in the flocks. Output per kg of breeding female was depressed by the many infertile females in the flocks.

Table 7.22. *Productivity parameters and productivity indices for sheep and goat flocks on the northern ranches (Olkarkar and Merueshi) and Mbirikani.*

	Northern ranches		Mbirikani	
Parameter	Sheep	Goats	Sheep	Goats
Births per breeding female	0.48	0.53	0.27	0.16
Litter size	1.01	1.29	1.01	1.34
Survival to weaning	0.90	0.75	0.90	0.68
Survival to 18 months	0.64	0.39	0.55	0.33
Weight at weaning (kg)	13.0	9.7	14.6	10.3
Weight at 18 months (kg)	27.5	19.4	30.6	26.5
Productivity indices				
g/kg biomass of flock:[1]				
at weaning	107	98	60	29
at 18 months	159	102	77	34
g/kg biomass of breeding females:[1]				
at weaning	201	172	110	52
at 18 months	299	179	150	61

[1]Number/biomass of old, mature and 50% of young females.

Source: Peacock (1984).

At first sight it may appear that the restriction of the breeding season to 3–4 months in the long dry season may have been a major cause of the poor reproductive performance of smallstock in the study area. It can be argued that breeding stock were in poor condition during the mating season because poor second rains in 1982 and 1983 (March–May) prevented recovery of dams following the previous breeding season. However, although Maasai attempt to restrict breeding to the long dry season, distribution of birth and parturition intervals indicate that control is only partial. At least 20% of the young were born out of season (April–September) and 40–50% of the females that did give birth had intervals of 12–18 months. Nevertheless, although not entirely effective, restriction of the breeding period seems to contribute to the poor reproductive rate in years of below-average rainfall.

As is shown in Chapter 10, the probability of failure in the long rains was high: some 55% of rainy seasons in Olkarkar lasted less than 1.5 months. The probability of poor rains increased with decreasing rainfall from north to south. Some Maasai, particularly those in Mbirikani, countered this risk by moving their flocks to areas that either were rich in browse species or had pod-bearing acacia trees. If good rains or mobility ensure high conception, then the period during which the Maasai mate their smallstock is ideal; young born during the short rains have the longest possible period of good grazing, which leads to high survival rates and good growth. Research in a semi-arid area in Isiolo District in north-east Kenya showed that the productivity of goats was highest when good grazing was available from birth to weaning, provided conception rates were high (Schwartz and Said, 1987).

Limiting the period of breeding has merit in that it produces economies of scale when guarding lambs and kids staying around the homestead and when matching dams and young for suckling in the morning and evening. This work is mainly done by women and children. If breeding was year-round these tasks would go on continuously without respite, preventing women from performing other urgent task (see Chapter 6: *Labour and livestock management*).

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Chapter 8

Livestock transactions, food consumption and household budgets

B E Grandin, Solomon Bekure and P Nestel

Pastoral systems in East Africa are dual operations which produce milk for subsistence and beef cattle and smallstock for sale. Many development projects have been criticised for emphasising beef production and for failing to realise the importance of dairying to pastoralists (Kerven, 1986; Grandin, 1988). The traditional Maasai were cited as representing the extreme of dependence on the direct consumption of livestock products, principally milk. They relied almost exclusively on cattle and only a few households kept smallstock (Jacobs, 1965). Smallstock now play a more important role but are still less important than cattle[1]. Traditionally, Maasai pastoralists did not engage in cropping and their economic system was marked by relatively little exchange for agricultural products.

However, this pattern changed throughout Maasailand as the human population increased and the number of livestock per person decreased and the Maasai became increasingly involved in the market economy (Grandin, 1988). Cash from livestock sales is spent on food, clothing, domestic utensils and luxury goods and on inputs for livestock production. Despite an increasing reliance on agricultural foodstuffs, milk and meat still play an important role in the nutrition of the people.

Milk is the mainstay of the diet in the study area. Information presented in Chapter 7 *(Productivity of cattle and smallstock)* demonstrated that milk offtake per person was almost the same across wealth classes in normal times. This chapter discusses how producers in the study site fulfil various material and social goals through livestock transactions. Decision-making about production and utilisation can be understood only in terms of these goals and the socio-economic context in which the producer operates. Pastoralists' production goals can be summed up as:

- a year-round supply of milk
- occasional supplies of meat/fat
- animals to sell to generate desired cash income
- animals to give to friends and relations
- herd accumulation for long-term survival and social success.

The first section of this chapter briefly reviews the major functions of livestock in the Maasai system. These are many and often interwoven. However, it is important to understand the multifaceted functions of livestock in order to predict producer responses to possible development pathways. Next, livestock transactions are examined, including rates and types of offtake and acquisition and inventory change. (These data, together with milk offtake data, are used in Chapter 9 *(An economic analysis of Maasai livestock production)* to analyse economic returns to land, labour and capital.) The contribution of livestock products to the diet and nutritional status are reviewed. Finally, the household budgets are analysed to determine patterns of income and expenditure.

8.1 Functions of livestock

Livestock have both short- and long-term functions. The primary functions of cattle in the short term are to supply milk throughout the year and to generate cash income (Table 8.1). The long-term objectives are highly inter-related; they relate partly to livestock accumulation itself, but more importantly to survival of and recovery from drought (Table 8.1). The most important functions of smallstock are for use in developing and maintaining social ties and for slaughter

8.1.1 Short-term objectives

Year-round milk supply

In normal times cows provide almost all of the milk used by households. Goats may be milked, by herders during the day, by poorer households and during drought and periods of post-drought re-

1. Smallstock represent approximately 7% of animals in both value and biomass terms in the north, and 12% in the south (see Section 1.2.2: *Producer heterogeneity and sampling design*, and Section 4.1: *Land, people, domestic and wild herbivores,*).

Table 8.1. *Functions of livestock in the Maasai production system.*

Function	Cattle	Sheep	Goats
Short term			
Year round milk supply	XXX		
Cash income	XXX	X	X
Social ties	XX	XXX	XXX
Voluntary slaughter	X	XXX	XX
Long term			
Wealth accumulation	XXX	X	X
Prestige/power	XXX	X	X
Build-up for next generation	XXX	X	X
Investment	XXX	X	X
Food security	XXX	XX	XX
Spreading production risks	XX	XX	XX

Degree of importance: X = low; XX = medium; XXX = high.

covery, when their milk is a major food. Sheep are almost never milked.

Cash income generation

The bulk of cash income is derived from cattle sales. Only certain areas have ready access to external markets for smallstock; in these, demand is higher for goats than for sheep because of consumers' food preferences.

Developing and maintaining social ties

Giving animals as gifts is an important social mechanism in Maasailand through which relationships are created and maintained. The type of gift depends largely on the receiver's situation. Animals may be given because a friend or relative is in need (of cash, of an animal to slaughter etc), as a present for a ceremony, for a female relative who has given birth, or purely for friendship. In many cases the gift is requested. Cattle are given only for major needs or events because of their high unit value. Gifts of smallstock are far more common and much more commonly used in cementing far-flung social ties.

Slaughter for home consumption

Animals are slaughtered either by choice for food or *in extremis*. Cattle are only rarely slaughtered by choice (e.g. for a circumcision or age-set ceremony). However, cattle slaughtered *in extremis* contribute substantially to food supplies. Most animals slaughtered by choice are smallstock, which is understandable given their lower value per head and the convenient amount of meat they provide. Meat from voluntarily slaughtered smallstock is a particularly important food during droughts, when it substitutes for milk. Sheep are generally desired for their fat, which is considered an important food for women (especially after child birth), for young infants and during certain illnesses. It is also used cosmetically. Although the Maasai eat sheep meat they prefer fatty goat meat for its flavour. Thus, goats are more commonly slaughtered for visitors, and in richer households. Soup made from goat meat and herbs is also used as a treatment for many human illnesses. Smallstock slaughtered *in extremis* contribute considerably to the Maasai diet.

8.1.2 Long-term objectives

Livestock accumulation

Maasai have many reasons for accumulating livestock, including the desire to be "wealthy", to be successful in Maasai terms. Livestock accumulation is not only an end in itself; it has important implications for the ability of a producer to marshal social and political support through the prestige that accrues to the wealthy and through his ability to help less fortunate people. In addition, animals accumulated by a pastoralist represent the main inheritance of his sons. Lastly, wealth accumulation in livestock makes economic sense given the high return to the investment and the lack of alternative investment opportunities available to the traditional pastoralist.

Because of their high unit value, cattle are the most important means of wealth accumulation. However, smallstock play an important role. Their rapid rate of reproduction makes them a major means of post-drought recovery, particularly for poor households. Young men who are actively accumulating livestock tend to do so through smallstock, especially where there is a market for smallstock. Even where there are no markets, smallstock can be exchanged for cattle. Smallstock can be sold to meet household subsistence requirements, allowing cattle to be kept until they will fetch a higher price.

Survival and security

The Maasai are threatened by periodic disasters, mainly droughts, and are subject to various external uncertainties due to political and economic forces beyond their control. Currently, a high rate of population increase strains the system. Although famine relief has been provided at several times in Maasai history, its provision is uncertain, as is the availability of agricultural foodstuffs to purchase. Maasai pastoralists have no insurance and no pensions. Their family, friends and animals are their only sources of short- and long-term security. Although cattle are less likely to survive a drought than smallstock, their value (in terms of both money and milk supply) dictates their accumulation for long-term security. Smallstock play an important role in post-drought recovery as they have higher survival rates, they multiply much more rapidly, and goats provide milk (however little) much sooner after a drought than cattle. During drought periods, smallstock provide crucial food as milk supplies dwindle. Multiple-species production makes fuller use of the environment and available labour, while spreading production risks. Factors which negatively affect one species may affect others less.

8.2 Livestock utilisation: Transactions for offtake and acquisition[2]

8.2.1 Introduction

Maasai culture provides producers with a variety of means by which they can acquire and dispose of animals. Through these, producers in different locations and of different wealth classes utilise their animals to meet the short- and long-term objectives discussed above. The transactions in which Maasai engage can be grouped into seven types, four for offtake (sale, exchange, gift and slaughter) and three for acquisition (purchase, exchange and gift)[3]. This section describes each type of transaction, discussing where relevant their relative importance by group ranch and wealth class. Annual net offtake and inventory change are also discussed.

8.2.2 Sales and purchases

Sales are particularly important as they serve as the interface between pastoralists and the wider economy, enabling the pastoral areas to support a larger population than would be possible if the pastoralists were to subsist on livestock products alone. Sales accounted for 82% of cattle offtake on Olkarkar and 76% on Mbirikani and 38% of smallstock offtake on Olkarkar and 10% on Mbirikani. However, many sales were not channelled through the market.

Animals sold were mainly young and adult males or castrates, followed by old females. With the decline in the traditional Maasai social support system in some areas, poor people may be forced to sell animals younger and at a lower price than rich producers. Rich producers on Olkarkar received 61% more per unit cattle (KSh 1167 vs KSh 724) and 29% more per unit smallstock (KSh 170 vs KSh 132) than poor producers because they sold older and heavier animals. Differences were smaller on Mbirikani (7% and 4% respectively), largely because poor producers there had stronger social support mechanisms than their counterparts on Olkarkar, which enabled them to keep animals until maturity.

The importance of smallstock sales differed between producers of different wealth classes. Sales accounted for 43% of smallstock offtake of poor producers, compared with only 26% for rich producers (Table 8.2). The ready market for smallstock available to producers on Olkarkar has led to the development of a "smallstock strategy" under which some producers sell smallstock to provide cash for family needs and to purchase cattle.

This was done primarily by younger, medium-wealth producers who had the highest smallstock-to-cattle ratio on Olkarkar and who used this strategy to accumulate cattle. It was done also by poor producers, particularly wage earners who invested a portion of their income in smallstock (Grandin, 1985).

Some 67% of smallstock sold by Olkarkar producers went to Simba, the town adjacent to the ranch (Table 8.2). However, there were marked differences between wealth classes in the destination of animals sold. Most (84%) of the smallstock sold by rich producers on Olkarkar went to butchers, compared with roughly half of those sold by poor producers; the remainder were sold to other producers (Grandin, 1985). Most animals sold to other producers were younger, smaller animals, which were bought by medium-wealth producers for fattening and sale to butchers.

2. For ease of comparison this section focuses on rich and poor households on Mbirikani and Olkarkar only. Money values (rather than number of animals) are used to aid cross-species comparisons. This section is based on Grandin (1983), Grandin (1985) and Grandin et al (1989).
3. As they do not represent final utilisation, temporary transactions (e.g. lending a milk cow or sending animals to another location to escape disease threat) are not discussed.

Table 8.2. *Smallstock sales (location, proportion of offtake and number of animals sold per household annually) by poor, medium-wealth and rich households on Olkarkar.*

	Wealth class[1]			
	Poor	Medium	Rich	Overall
Location of sales (%)				
Simba	47	72	82	67
Other town	4	1	4	3
Maasailand	49	28	13	30
Sales as a per cent of offtake	43	37	26	35
Number of animals sold/household per year	8	20	12	40

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich ≥ 13 TLU/AAME.

Commercial transactions in Maasailand commonly involved friends, neighbours and relatives and were thus influenced by existing social relationships. On Olkarkar 60% (by value) of commercial transactions occurred in markets or towns, whereas sales in markets or towns accounted for only 32% of the commercial transactions on Mbirikani. This difference was largely related to the organisation of marketing within the area. Olkarkar producers lived closer to the main market and tended to take their own animals to market and sell them themselves, whereas Mbirikani producers tended to sell stock to local Maasai traders who then took the animals to the market.

Traders, commonly local Maasai known to the producers, purchased 75% (by value) of the animals sold but were the source of only 37% of the purchases (Table 8.3).

Purchases were much less common than sales and were mostly of animals for fattening. Producers preferred to know the history of animals acquired for rearing, hence few animals were purchased for breeding stock, and these rarely from strangers. Immature animals sold by the poor were commonly purchased by richer producers who fattened and resold them. Purchases accounted for 58% of the reported cattle acquisition on Olkarkar and only 37% on Mbirikani. For smallstock these figures were 47% on Olkarkar and 39% on Mbirikani. However, as social transactions were under-reported, these are overestimates of the true importance of purchase as a mode of acquiring livestock.

8.2.3 Exchange

Producers frequently exchanged one animal for another of a different species, age or sex. Commonly one of the parties acquired an immature heifer for breeding, while the other acquired an adult steer to sell or, more rarely, to slaughter. With smallstock, large castrates were often exchanged for an immature female or a young steer.

Exchanges have two advantages: they do not require access to a market and the history of the animal is known. In addition, exchanges are seen by the Maasai as an act of sociability, of helping someone.

The market values of the animals involved in an exchange were often quite different, the adult animal being worth more than the immature for which it was exchanged. However, immature females were difficult to obtain because producers were

Table 8.3. *Relationship in livestock transactions: Percentage value by transaction type for Olkarkar Group Ranch.*[1]

Relationship	Acquisition			Offtake				Per cent of all transactions
	Purchase	Exchange	Social	Sale	Exchange	Social	Temporary	
Trader[2]	37	14		75	13			45
Relative	2	11	11	4	15	21	89	19
Clan	10	19	7	7	22	14	5	8
In-law	10	9	47	3	8	41	6	11
Friend/age-mate	8	31	30	4	27	13		9
Other[3]	15	7	5	5	8	9		5
None[4]	18	10		1	6	2		3

[1]Although certain types of transactions were selectively under-reported, the reported data are indicative of trends, particularly of the importance of the different categories of relationship.

[2]More than 25% of these traders were from Olkarkar or adjacent group ranches.

[3]Includes *boma*-mates, neighbours and very distant relatives.

[4]Some 70% of these were producers from Olkarkar or adjacent group ranches.

reluctant to dispose of them. Thus producers who were trying to build up their herds were willing to accept young females (whose market value was low) in exchange for adult castrates of higher market value. They placed considerable emphasis on the fact that they were acquiring the animal's future reproductive capacity. The other party to the exchange acquired an animal of greater immediate value but at the cost of future productivity.[4]

On Olkarkar, 5% of reported offtake and 18% of acquisition was through exchange. On Mbirikani exchanges were more common, accounting for 12% of offtake and about 35% of acquisition. As exchanges were under-reported more than other transactions, these represent minimum figures.

Exchange can be viewed as falling along a continuum from social to commercial transactions. Hence a wide range of partners is found, although friends, age-mates and clan-mates predominate (Table 8.3).

8.2.4 Gifts and other social transactions

The category gifts, as used here, includes outright gifts (for a ceremony, during illness, while visiting or often just in friendship) as well as permanent loans of animals (which the receiver or his descendants are ultimately expected to repay). The latter includes some delayed exchanges, in which the time lapse and sociability involved make them structurally similar to gifts. Gifts of cattle and smallstock are often requested[5].

The most common gifts were smallstock, mainly immature females (intended for rearing) followed by mature castrates which were commonly intended for slaughter. Steers and young female calves were occasionally given, but gifts of mature females of any species were rare.

Gifts represented 12% of reported offtake on both Olkarkar and Mbirikani, and about 30% of acquisition. In-laws were the single most common partners in gifts (see Table 8.3). Other social transactions include entrusting, lending and borrowing of animals.

8.2.5 Slaughter

As noted earlier, smallstock contributed importantly to the diet through voluntary slaughter whereas cattle only rarely did so. Dying animals or those that had broken a leg were usually slaughtered; this is referred to as forced slaughter. Voluntary slaughter was often related to a particular occasion or event such as a wedding or the birth of a child. It did, however, make an important contribution to the diet.

Voluntary slaughter of cattle was quite similar on Olkarkar and Mbirikani (KSh 44/person per year on Olkarkar compared with 50 KSh/person per year on Mbirikani) but the reported value of smallstock slaughtered on Mbirikani was more than three times that reported on Olkarkar (KSh 226 vs KSh 70). As a result, the total value of voluntary slaughter per person was almost two and half times as much on Mbirikani as on Olkarkar.[6] However, slaughter rates for smallstock were unusually high on Mbirikani to compensate for the decline in milk production during the minor drought in 1982.

Forced slaughter was an important source of food, particularly on Mbirikani. On Olkarkar, forced slaughter of cattle provided 60% of the beef consumed, whereas on Mbirikani it accounted for 95%. Voluntary slaughter was more important for smallstock, providing 60% of smallstock meat on Olkarkar and 50% on Mbirikani. Although forced slaughter occurred throughout the year it was most common during droughts and epidemics.

4. Exchanges were selectively reported; producers were happy to talk about exchanges in which they acquired immature animals but were less willing to admit to exchanging these out. Poor people were more selective in reporting exchanges; these are the people who most often had to exchange immature females for an adult animal.
5. As with exchange, cultural values led to a selected under-reporting of gifts. Generosity is stressed in Maasai culture, whereas the need to "beg" an animal is the less desirable state. Also, it is thought improper to boast about the number of animals you have or have recently acquired. As a result, producers tended to report giving more animal gifts than they received. For the same species/age/sex category, gifts given out were also appraised at a higher value than gifts received.
6. Mbirikani producers' estimates of the values of slaughtered animals were approximately 25% higher than those of Olkarkar producers. This was partly due to overestimation of value, but also reflected a real difference in size of animals slaughtered, especially for smallstock (see Section 8.2.2: *Sales and purchases*). When numbers rather than values were used, smallstock slaughter was still 2.4 times as high on Mbirikani as on Olkarkar.

8.2.6 Annual offtake and acquisition

Table 8.4 shows reported rates and values for annual offtake and acquisition of livestock per household on Olkarkar and Mbirikani, broken down by type of transaction. On Mbirikani, offtake and acquisition rates were higher and a greater percentage of transactions went through non-commercial channels than on Olkarkar. The higher rates of non-commercial transactions on Mbirikani related to several factors:

- the drought, which necessitated more sales and more slaughter for home consumption
- the greater social commitments of Mbirikani producers, which were largely manifested through gifts and exchanges of animals
- the lack of access to markets on Mbirikani encouraged exchange and home consumption and discouraged sales and purchases.

Table 8.4 also underscores the importance of investigating all of a producer's transactions, rather than just sales, purchases and slaughter. Whereas on Olkarkar reported sales and slaughter accounted for 83% of reported offtake, on Mbirikani they accounted for only 76%. Purchases accounted for only 52% of reported acquisition on Olkarkar and 38% on Mbirikani.

Sales represented the most important offtake of smallstock on Olkarkar, whereas slaughter for home consumption accounted for 54% of smallstock offtake on Mbirikani (Table 8:5).

8.2.7 Net offtake and inventory change

Although Maasai producers manipulated their herds and flocks to meet a variety of needs, they consistently attempted to accumulate animals in good years as a long-term survival strategy. Offtake can be fully understood only in connection with accumulation.

Table 8.5. *Net offtake of small stock on Olkarkar and Mbirikani group ranches.*

	Per cent of all smallstock offtake			
	Sold	Exchanged	Gifted	Slaughtered
Olkarkar	38	8	21	34
Mbirikani	10	18	17	54

Table 8.6 shows estimates of both annual net offtake and annual inventory change for Olkarkar and Mbirikani households. The most striking difference is that whereas almost all producers on Olkarkar showed net accumulation of both cattle and smallstock, on Mbirikani there was almost universal net decline in cattle inventory and many producers ended the year with a reduced smallstock inventory. This difference was due to the localised drought that affected Mbirikani but not Olkarkar. Voluntary offtake rate was higher on Mbirikani than on Olkarkar, reflecting the greater need for meat to replace milk in the diet during drought.

8.3 Milk sales

Milk sales were unimportant in the study area, accounting for less than 5% of milk offtake. However, it is useful to examine patterns of selling in order to predict possible responses to increased opportunities for milk sales.

In the study period, opportunities for milk sales were limited and varied markedly between ranches and neighbourhoods. No sample household on Mbirikani sold milk, whereas 50% of Olkarkar households and 45% of Merueshi households reported some sales. Two sample households on Olkarkar and one on Merueshi

Table 8.4. *Annual offtake and acquisition of livestock by value, rate and transaction type, Olkarkar and Mbirikani group ranches.*

	Offtake		Acquisition	
	Olkarkar	Mbirikani	Olkarkar	Mbirikani
Value (KSh)[1]	13 249	22 055	2585	6005
Rate (% of total holdings)	12	22	3	8
Type of offtake (% of total value of offtake)				
Commercial	75	64	52	38
Exchange	5	12	18	35
Gift	12	12	30	27
Slaughter	8	12		

[1] During the study period, the exchange rate fluctuated between US$ 1 = KSh 8.70 and US$ 1 = KSh 13.05, with a mean of US$ 1 = KSh 11.0.

Table 8.6. *Net offtake and inventory change (based on value) in livestock holdings of poor, medium-wealth and rich producers, June 1981–May 1983, Olkarkar and Mbirikani group ranches.*

	Olkarkar			Mbirikani		
	Poor[1]	Medium	Rich	Poor	Medium	Rich
Cattle						
Value change (%)	20[a]	13	17	-2	-8	-5
Households with net loss (%)	0	10	0	75	100	66
Net voluntary offtake (%)	17	7	5	11	22	15
Smallstock						
Value change (%)	17	19	18	-18	8	1
Households with net loss (%)	33	30	13	88	40	50
Net voluntary offtake (%)	7	6	3	16	7	5

1Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[a]Largely due to unreported gifts received.

regularly sold substantial quantities of milk. Other households, mainly poor ones, regularly sold small amounts of milk, while others sold milk only irregularly.

The issue of whether Maasai sell only milk that is surplus to their household needs is not easily resolved (White and Meadows, 1981; Nestel, 1985). The issue ignores the facts that "needs" are not absolute (above minimum nutritional requirements) and that milk offtake per cow varies substantially. Although milk sales are seasonal and some households sold milk only in the wet seasons, some households sold milk throughout the year. On Olkarkar, poor households sold proportionally as much milk (8%) as rich households, while middle-wealth households sold almost none. On Merueshi the primary seller of milk was in the middle-wealth group; some poor households sold small amounts of milk but no rich household reported any sales. These differences suggest that the notion of "milk surplus to home consumption needs" is too simplistic and requires reconsideration.

Milk sales can be an important source of income to poor households. Highly-priced milk can be "exchanged" for an amount of maize that provides much more food energy. In addition, income from milk sales accrues to women, whereas most other income accrues to men. Although some men, particularly older and wealthier ones, were opposed to milk sales out of concern for calf survival, many others were beginning to see milk as a potentially important source of income, which can delay the need to sell an animal.

In sum, these results indicate that there is an important, untapped potential for milk sales, at least the northern, better-watered part of the study area (see Section 7.1.7: *Milk offtake and lactation yield*, and Section 10.2.3: *Milk offtake*).

8.4 Milk, food consumption and nutritional status

Over the past 25 years the Maasai diet has gradually changed from consisting almost entirely of livestock products to including cereals and sugar. The major factor pushing the Maasai to diversify their staple diet has been their inability to sustain a population growing at some 3% a year on a diet of livestock products alone. Improved infrastructure and communications with neighbouring agricultural tribes has made access to maize much easier.

Today, the staple diet of the Maasai consists of cow milk, butter, maize meal and meat. Milk is drunk fresh or in tea sweetened with sugar. Maize meal is cooked to make a porridge known as *ugali*. The porridge is cooked with milk and fat or butter when available; otherwise only water is used. Meat was eaten only irregularly, as indicated by the fact that forced slaughter provided half of the meat consumed in normal times. Butter was an important food for infants, while blood was rarely drunk and was taken only during drought or on ceremonial occasions.

Notwithstanding this diversification of the Maasai diet, milk remained the dominant staple, making the diet relatively rich in fat and protein. The availability of milk strongly influenced the quantity and type of other foods purchased and the nutritional status of the Maasai. When available, milk and butter provided some two-thirds of the daily energy intake. Nestel (1985), reporting data from a 24-hour diet recall study in July 1982–June 1983, noted that, across wealth classes, women and children on Olkarkar and Merueshi consumed an average of about 1 litre of milk/active adult male equivalent (AAME) daily, which corresponds very well with "target" and actual milk offtake per person (see Section 7.1.7: *Milk offtake and lactation yield*). It was reported that men (and particularly *moran*) consumed more milk products than did women and children.

Table 8.7 summarises the results of Nestel's (1985) nutrition study. The pattern observed on Olkarkar and Merueshi represented the normal situation, whereas that on Mbirikani reflected the effect of the minor drought affecting that ranch at the time. Maize, sugar and other agricultural products supplied up to two-thirds of daily energy intake on Mbirikani, compared with roughly a third on Olkarkar and Merueshi. Rich households derived more of their energy from milk and butter than did poor or middle-wealth households, particularly during the dry season, because they had more milking cows at their disposal.

The seasonal variation in milk supplies and types of food consumed had a marked effect on energy intake. Energy intake declined during the short rains, when most dietary energy came from dairy products. Conversely, energy intake increased during the dry seasons, when crop products were the main source of energy. The reason for this is the difference in the energy content of milk and maize and the quantities of each available. The energy value of milk during the wet season fell from 77 to 59 kcal/100 g whereas that for ground maize meal was 346 kcal/100 g throughout the year. Household heads curtailed maize expenditure when the supply of milk increased, reducing the energy content of the diet.

The proportion of energy intake provided by milk varied little across wealth classes but differed markedly between seasons on Olkarkar and Merueshi (Table 8.8). Seasonal variation was similar across wealth classes, and variation was as large in rich households as in poor households.

The Maasai diet is rich in protein but relatively low in energy (Table 8.9). However, the Maasai attained normal height in adulthood though they tended to be thinner than standard measurements indicate is ideal. Pregnant women who had energy intakes of 50 to 55% of that recommended by FAO (1973) did not appear to deliver underweight babies, while lactating women who had energy

Table 8.8. *Annual, dry-season and wet-season contributions of milk to energy intake in poor, medium-wealth and rich households on Olkarkar and Merueshi group ranches, June 1982–May 1983.*

	Contribution of milk to energy intake (% of RDI[1])		
Wealth class[2]	Annual mean	Dry season	Wet season
Poor	42	25	52
Medium	44	38	50
Rich	44	33	62

[1]Recommended daily intake, based on FAO (1973).

[2]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Source: Adapted from Nestel (1985)

Table 8.7. *Dietary energy sources of women and children in poor, medium-wealth and rich households on Olkarkar/Merueshi and Mbirikani group ranches, July 1982–June 1983.*

	Proportion of energy provided by source (%)					
	Olkarkar/Merueshi			Mbirikani		
Energy source	Poor[1]	Medium	Rich	Poor	Medium	Rich
Milk	52	55	61	21	31	36
Butter	11	7	5	3	3	2
Meat	1	3	4	6	13	7
Fat	1	1	0	4	5	3
Maize	21	20	12	39	35	27
Sugar	8	8	9	13	10	13
Other	6	6	9	14	3	12
Total	100	100	100	100	100	100
No. of observations	204	283	518	399	240	250

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Source: Nestel (1985).

intakes of 55 to 60% of the recommended level breast fed their babies for up to 2 years. This raises the question as to whether FAO's recommended daily intake for energy is set too high to be applicable to Maasai pastoralists.

8.5 Household patterns of income and expenditure

8.5.1 Cash income

Sales of livestock and livestock products provided most of the cash income of households in the study area (Tables 8.10 and 8.11), although they provided a smaller proportion of income in poor households than in rich ones. Poor households derived about 23% of their cash income from gifts and wages, compared with 19% for middle-wealth households and 11% for rich households.

8.5.2 Patterns of cash expenditure

Pastoral households, being both consumption and production units, incur two types of expenditure. As consumers they buy food and non-food items and services. The level of these expenses is determined by the size of the household, its relative wealth and the attitudes of its adult members, particularly the head of the household. In their capacity as producers, pastoral households purchase acaricides, veterinary drugs and breeding and fattening stock. They may pay for watering or dipping livestock and occasionally hire labour for herding or marketing cattle. These production expenses are determined by the size of the household's livestock holding.

Data on cash expenditure of the sample households on consumption and production items were collected monthly. Despite the well known problems of recall error and respondent bias, the information obtained gives a good indication of the

Table 8.10. *Mean annual cash income per household on Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Mean annual cash income (KSh)		
Source	Olkarkar	Merueshi	Mbirikani
Livestock products			
Livestock sales	9 505	9 097	12 143
Milk sales	314	356	5
Cow and calf hides	10	1	5
Sheep and goat skins	9	28	268[a]
Subtotal	9 838	9 482	12 421
Other sources			
Wages	1 529	92	2 111
Money transactions	912	1 087	3 556
Beer brewing	41	203	8
Other income	5	12	257
Subtotal	2 487	1 394	5 932
Total cash income	12 325	10 876	18 353

[a]This high income for sheep and goat skins was due to the head of one sample household trading in sheep and goat skins.

Table 8.9. *Source of energy and adequacy of dietary protein and energy intakes of women and children in poor, medium-wealth and rich households on Olkarkar/Merueshi and Mbirikani group ranches, July 1982–June 1983.*

	Olkarkar/Merueshi			Mbirikani		
	Poor[1]	Medium	Rich	Poor	Medium	Rich
Source of energy (% of energy intake)						
Protein	13	15	15	13	14	14
Fat	46	46	46	32	38	38
Carbohydrate	41	38	38	55	48	48
Alcohol	0	1	1	0	0	0
Total	100	100	100	100	100	100
Energy intake (% of RDI[2])	69	74	69	67	65	66
Protein intake (% of RDI)	212	238	239	179	199	189
No. of observations	204	283	518	399	240	250

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[2]Recommended daily intake, based on FAO (1973).

Source: Nestel (1985).

Table 8.11. *Mean annual cash income per household by wealth class of household, Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Wealth class[1]		
Source	Poor	Medium	Rich
Livestock products			
Livestock sales	5 625	8 800	6 250
Milk sales	150	190	225
Cow and calf hides	10	0	5
Sheep and goat skins	285[a]	25	30
Subtotal	6 070	9 015	16 510
Other sources			
Wages	750	1 320	1 560
Cash gifts	1 170	780	490
Beer brewing	195	60	45
Other income	255	5	30
Subtotal	2 370	2 165	2 125
Total cash income	8 440	11 180	18 635

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[a]This high income from sheep and goat skins was due to the head of one sample household trading in sheep and goat skins.

patterns of cash expenditures. What is important to note is the relative magnitude suggested by the figures rather than their absolute values.

The mean annual reported cash expenditure of the households was KSh 9400, two-thirds of which went on household consumption (Table 8.12). These figures are in agreement with those reported by White and Meadows (1981) for Olkarkar. Households on Merueshi spent much less than those on either Olkarkar or Mbirikani. This was related to three factors:

- These households were far from trading centres and thus had less opportunity for spending money on hotel food and drinks and for making sugar beer for sale. Their expenditure on these items was only half that recorded for Olkarkar and two-thirds of that for Mbirikani households.
- Merueshi households bought only half as many animals as those on Olkarkar and Mbirikani.
- Expenditure on tick control was very low on Merueshi, where tick-borne diseases were less troublesome.

The last two factors also contributed to the low proportion of total expenditure allocated to livestock production on Merueshi (26% compared with 35–36% for the other two ranches). As expected, wealth class strongly influenced both absolute expenditure and the proportions of expenditure allocated to consumption and production (Table 8.13).

Table 8.13. *Mean annual expenditure on consumption and production by poor, medium-wealth and rich households, Olkarkar, Merueshi and Mbirikani group ranches, July 1981–June 1983.*

	Expenditure					
	Poor[1]		Medium		Rich	
	KSh	%	KSh	%	KSh	%
Consumption						
Food	2 527	39	2 677	29	3 605	30
Non-food	2 209	34	3 241	35	4 061	33
Subtotal	4 736	73	5 918	64	7 666	63
Production	1 780	27	3 330	36	4 598	37
Total	6 516	100	9 248	100	12 264	100

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Table 8.12. *Mean annual expenditure on consumption and production by households on Olkarkar, Merueshi and Mbirikani group ranches, July 1981–June 1983.*

	Expenditure							
	Olkarkar		Merueshi		Mbirikani		Weighted mean (all ranches)	
	KSh	%	KSh	%	KSh	%	KSh	%
Consumption								
Food	3 060	30	2 260	37	3 460	31	2 976	32
Non-food	3 400	34	2 280	37	3 790	34	3 220	34
Subtotal	6 460	64	4 540	74	7 250	65	6 196	66
Production	3 650	36	1 610	26	4 020	35	3 197	34
Total	10 110	100	6 150	100	11 270	100	9 393	100

Expenditure on food and beverages

Maize was a major staple in the Maasai diet and was purchased regularly, accounting for an average of about one-third of total per-caput expenditure on food and beverages (Table 8.14). However, the amount and proportion spent on maize differed markedly between ranches. Households on Mbirikani spent nearly twice as much on maize as those on the northern ranches. Expenditure on maize accounted for 40% of the expenditure on food and drink on Mbirikani but only 26% on Olkarkar. The amount spent on maize also differed markedly between wealth classes (Table 8.15), although there was little difference in this as a proportion of expenditure on food and drink.

Sugar was also an important item in the diet of the Maasai (Table 8.14). In addition to its usual consumption with tea and milk, Maasai women used sugar for brewing the local beer. Expenditure on sugar increased dramatically whenever households were preparing for major ceremonies such as a circumcision or a wedding. Some women who lived near trading centres or major water points made and sold beer and this was the cause of the high annual per caput expenditure on sugar on Olkarkar (Table 8.14).

Table 8.14. *Mean annual expenditure per person on food and beverages on Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Expenditure (KSh)				
	Ranch			Weighted	
Item	Olkarkar	Merueshi	Mbirikani	mean	%
Maize	94	96	176	125	35
Wheat	1	9	25	12	3
Sugar	101	64	70	79	22
Tea	45	28	29	34	9
Fat/oils	10	9	34	19	5
Potatoes	6	6	6	6	2
Vegetables	1	1	1	1	0
Meat	4	3	8	5	1
Other foods	15	14	6	11	3
Hotel food	35	11	34	27	8
Hotel drinks	37	15	40	32	9
Tobacco	8	9	12	10	3
Total	357	265	441	361	100

Non-food consumption expenditure

The main non-food items on which Maasai spent money were clothing, transport and medical services (Table 8.16). Together these accounted for nearly three-quarters of their non-food expenditure.

Regression analysis of the expenditure data shows that the income elasticity of expenditure on household items was about 1.0. In contrast, the income elasticity of expenditure on livestock maintenance and livestock purchases was very high (2.25), implying that the wealthier a Maasai household became the bigger its investment in livestock production. This arose from a general lack of alternative investment opportunities available to them which they can manipulate with ease. Increasingly, livestock trading was becoming an alternative mode of investment and employment for the young and wealthy. A few were becoming shopkeepers; but the scope for this was limited as the low population density led to low demand for consumer goods and not many Maasai had the exposure and wider contacts required to make a success of shopkeeping.

The information presented in Tables 8.15 and 8.16 suggests that poor households had a markedly lower standard of living than wealthier households. However, the life style of the wealth-

Table 8.15. *Mean annual expenditure per person in poor, medium-wealth and rich households, Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Expenditure (KSh)				
	Wealth class[1]			Weighted	
Item	Poor	Medium	Rich	mean	%
Maize	90	135	120	125	35
Wheat	12	12	9	12	3
Sugar	66	94	80	79	22
Tea	28	43	32	34	9
Fat/oils	22	21	10	19	5
Potatoes	8	4	6	6	2
Vegetables	2	0	0	1	0
Meat	7	5	4	5	1
Other foods	10	11	12	11	3
Hotel food	16	35	29	27	8
Hotel drinks	29	34	43	32	9
Tobacco	11	7	7	10	3
Total	301	401	352	361	100

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Table 8.16. *Mean annual expenditure per person on non-food consumption in poor, medium-wealth and rich households, Olkarkar, Merueshi and Mbirikani group ranches, 1981–83.*

	Expenditure (KSh)				
	Wealth class[1]			Weighted	
Item	Poor	Medium	Rich	mean	%
Clothing	84	133	121	118	43
Transport	40	67	49	54	19
Medical	19	32	40	30	11
Kerosene	15	16	13	15	5
Soap	10	15	12	13	5
Durable goods	8	12	10	11	4
Beads	4	7	6	6	2
Cash gift	17	52	28	30	11
Subtotal	197	334	279	277	100
Money lent	19	85	78	69	
Loan repaid	38	45	56	53	
Total cash out-flow on non-food items	254	464	413	399	

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

iest was not that much different from the average and the per caput consumption of the wealthiest group suggests they enjoyed a lower standard of living than the middle-wealth group. This may be explained by the fact that many of the wealthier households were headed by older men who were more conservative and whose main interest was in the accumulation of livestock.

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Chapter 9

An economic analysis of Maasai livestock production

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The first part of this chapter presents a discussion of the annual costs of and returns to the Maasai livestock production system, based on data collected between July 1981 and June 1983 on Olkarkar and Merueshi group ranches. As will be shown in Chapter 10, this period represents the end of a period during which the climate favoured livestock production and when the livestock population in Maasailand was at a peak. The results are therefore indicative of what the production system can achieve when rainfall is normal and stocking rates are high. The effect of drought on output is described in Chapter 10 (*The long-term productivity of the Maasai livestock production system*), which analyses the long-term productivity of the system using simulation models.

The second part of this chapter is devoted to a description and analysis of the operation and efficiency of the cattle marketing system at Emali, which to a large extent determined the cash income and terms of trade of the pastoralists in the study area.

9.1 Costs of and returns to production

9.1.1 Gross annual output

The gross annual output of the Maasai livestock production system is composed of the aggregate values of the:

- livestock and byproducts that producers sell
- livestock and byproducts producers consume
- net annual inventory change in producers' livestock holdings.

Table 9.1 summarises the gross annual output of Olkarkar and Merueshi based on data presented in Chapter 7 (*Productivity of cattle and smallstock*) and Chapter 8 (*Livestock transactions, food consumption and household budgets*). Cattle contributed 91% of the annual gross and smallstock 9%.

About 28% of the gross output could be considered commercial and 27% subsistence production. The remaining 45% was in the form of herd and flock accumulation. This is, by any standard, a high rate of capital accumulation and was made to ensure the long-term security and survival of the households (see Section 8.2.1: *Introduction*). Very little of the milk and smallstock produced were sold: the sale of cattle provided over 90% of the total sales proceeds. Milk was the major livestock product consumed by the Maasai, accounting for more than 80% of total home consumption. The value of milk consumed represented about 22% of the total value of gross output.

Table 9.1. *Summary of gross annual output of livestock production on Olkarkar and Merueshi group ranches.*

	Gross output from livestock production (KSh/household per year)			
	Olkarkar	Merueshi	Weighted mean	%
Sales				
Cattle	8 616	8 666	8 639	26
Smallstock	554	210	395	1
Milk	312	376	341	1
Subtotal	9 482	9 252	9 375	28
Consumption				
Cattle	841	500	684	2
Smallstock	928	888	910	3
Milk	7 079	8 101	7 551	22
Subtotal	8 848	9 489	9 145	27
Stock inventory change				
Cattle	15 766	10 599	13 381	40
Smallstock	2 839	142	1 594	5
Subtotal	18 605	10 741	14 975	45
Gross total				
Per household	36 935	29 482	33 495	
Per worker	4 990	3 560	4 325	
Per person	4 200	3 015	3650	
Per hectare	152	58	109	
Per TLU	332	336	333	

As noted in Chapter 8 very little beef was consumed by Maasai households. Most (55%) of the beef consumed at home was derived from cattle slaughtered *in extremis*. Small ruminants were the main source of meat for home consumption, three-quarters of the meat being supplied by voluntary slaughter (see Section 8.2.5: *Slaughter*). About a third (31%) of the gross annual output of meat from small ruminants was consumed, while sales represented only 14%. The remaining 55% was accounted for by flock accumulation, which was largely practised by the rich producers. Their smallstock accumulation represented 70% of the total value of their annual smallstock production, compared with only 39% for poor producers. A major reason for the low levels of sales offtake is the underdevelopment of the small ruminant market in the region (see Section 11.5: *Improvements in livestock marketing*).

In physical terms, the average annual output was roughly 3800 kg of milk and 7000 kg of liveweight per household (at prices of KSh 2/kg of milk and KSh 3.55/kg of liveweight). This translates to 11 kg of milk and 18 kg of liveweight (9 kg meat) per hectare or 28 kg milk and 54 kg of liveweight (27 kg meat) per TLU. There were marked differences in gross output between ranches. While output per livestock unit was similar on both ranches, the stocking rate on Olkarkar was more than double that on Merueshi and hence gross output per hectare on Olkarkar was 2.6 times that on Merueshi. Output per household, per worker and per person was also higher on Olkarkar than on Merueshi.

Table 9.2 shows both the level of output and its partitioning between sales, consumption and stock inventory change for poor, medium-wealth and rich producers on Olkarkar and Merueshi. Although the gross output of the poor households was quite small on a per household basis they had the highest gross output per livestock unit. In poor households household consumption accounted for the largest proportion (44%) of gross annual output and stock accumulation the lowest (24%), whereas in rich households stock accumulation accounted for the highest proportion (56%) and home consumption the lowest (20%). In medium-wealth households the gross output was more evenly divided between sales (32%), home consumption (30%) and stock accumulation (38%).

The overriding cause of the differences between producers was in the size of livestock holdings (see Section 1.2: *Research methods*). Although poor producers owned only 9% as many livestock as rich producers, their gross output was 22% of that attained by the latter, mainly because poor producers extracted as much milk as possible from their cows. Milk sold and consumed accounted for 40% of the gross output of poor households, compared with only 16% for rich producers. This implies that rich producers could extract more milk and sell it if there were a market and if shortage of labour for milking were not a constraint (see Section 7.1.7: *Milk offtake and lactation yield* and Section 8.3: *Milk sales*).

Table 9.2. *Summary of gross output of livestock production by poor, medium-wealth and rich households, Olkarkar and Merueshi group ranches, 1981–83.*

	Annual gross output of livestock production per household					
	Poor[1]		Medium		Rich	
	KSh	%	KSh	%	KSh	%
Sales						
Cattle	4 419	29	7 708	29	15 863	23
Smallstock	274	2	438	2	478	1
Milk	219	1	382	1	429	1
Subtotal	4 912	32	8 528	32	16 770	25
Consumption						
Cattle	164	1	370	1	1 929	3
Smallstock	634	4	900	3	1 290	2
Milk	5 982	39	6 979	26	10 639	15
Subtotal	6 780	44	8 249	30	13 858	20
Stock inventory change						
Cattle	3 107	20	9 395	35	34 047	49
Smallstock	582	4	873	3	4 216	6
Subtotal	3 689	24	10 268	38	38 263	55
Total						
Per household	15 381		27 045		68 891	
Per TLU	460		334		159	

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

9.1.2 Net annual output

Maasai producers spent little cash on their livestock production since they did not pay directly for the major inputs of the system, i.e. family labour and land. Land was held communally and each ranch member had free access to grazing, the amount of access being determined by the size of the member's livestock holding. Cash expenditure on production related to the purchase and maintenance of livestock, including purchase of drugs, acaricides and salt, and paying fees for dipping and wages for hired labour (Table 9.3). Purchase of breeding and fattening cattle accounted for 38–52% of total cash expenditure on livestock production (see Section 8.2: *Livestock utilisation: Transactions for offtake and acquisition*). Large-scale producers spent proportionally less on buying livestock (about 33% of their total production expense) than poor and medium-wealth households (47% and 45% respectively).

Tick control accounted for 40% of total production expenses on the northern ranches but only 18% on Mbirikani, while expenditure on drugs was much higher on Mbirikani (25%) than on Olkarkar (11%) and Merueshi (9%). The mean annual cash expenditure on livestock maintenance was about KSh 12 per TLU. Rich producers spent less (KSh 9 per TLU) than medium-wealth and poor producers (KSh 18 and KSh 14 per TLU respectively).

After deducting the direct livestock production expenses, the net output of the system was about KSh 30 300 per household, KSh 4070 per worker or KSh 3100 per person per year, which compares favourably with the average gross product of KSh 3117 per person for the Kenyan economy as a whole during 1981 and 1982. Even the poor Maasai producers obtained a mean net income of KSh 1868 per person, compared with KSh 509 farmers in lowland Machakos District (Rukandema et al, 1981) and KSh 724 for agropastoralists in southern Kitui District (Rukandema et al, 1983).

These net returns to family labour and management were calculated (a) assuming that land was free and therefore its cost to the individual producer was virtually zero and (b) without deducting the cost of capital invested in livestock. The effect of different rates of interest, i.e. the cost of capital, on returns to family labour is shown in Figure 9.1. When the opportunity cost of capital in the Kenyan economy (which was 12% per annum during the study period) is charged, the Maasai livestock production system yields, in normal times, an average wage of KSh 2100 per worker per annum.

If family labour is not charged for, the average net return to capital was about 35% on both Olkarkar and Merueshi but was inversely related to scale of production. Poor producers achieved a net return of 48% on their capital while the medium-wealth and rich producers obtained returns of 33% and 20% respectively. Net returns per livestock unit, per person and per worker for the three wealth classes exhibited similar patterns to those for gross output.

If the cost of capital is not charged, rich producers obtained 2.9 times the net return per worker obtained by poor producers and twice that of medium-wealth producers.

9.2 Cattle marketing

Kajiado District is quite close to Nairobi and is thus in a position to supply livestock to this major centre of meat consumption. However, the marketing system in Kajiado District is well developed only for cattle. Only the western and northern parts of Kajiado seemed to supply small ruminants to the Nairobi market. Trade in smallstock in the southern and eastern parts of the District was confined to supplying local butchers and itinerant buyers at small trading centres.

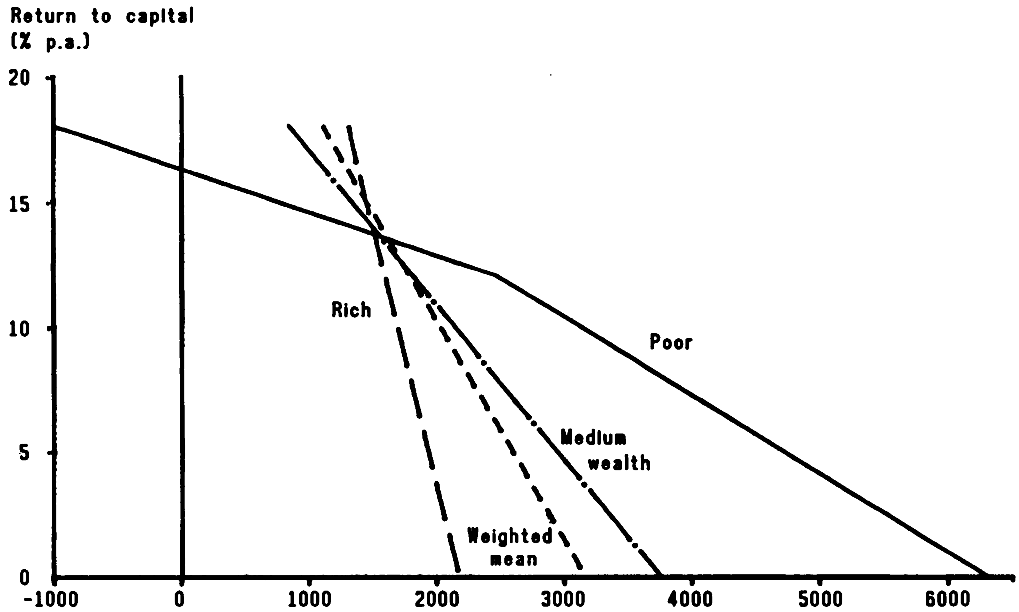
Table 9.3. *Mean annual expenditure on livestock production by ranch, 1981–83.*

	Mean expenditure on livestock production (KSh/household per year)				
	Olkarkar	Merueshi	Mbirikani	Weighted mean	%
Dipping[1]	1475	115	460	710	22
Acaricide[2]	35	505	260	255	8
Drugs	380	140	990	540	17
Salt	160	20	25	70	2
Subtotal health care	2050	780	1735	1575	49
Hired labour	50		5	20	0
Livestock purchase	1330	750	2100	1480	47
Others	105	30	170	120	4
Total expenditure	3535	1560	4010	3195	100

[1]Includes mainly dipping fees.

[2]Acaricide mainly used for spraying animals.

Figure 9.1. *Relationship between net returns to capital and to family labour in poor, medium-wealth and rich households, Olkarkar and Merueshi group ranches, 1981–83.*



9.2.1 The Emali cattle market

Emali is the only place in eastern Kajiado where cattle were regularly traded in sufficient volume to warrant being called a market. Trading centres such as Simba, Olandi and Mbirikani were only links in a chain of staging points collecting cattle destined for the Emali market.

A preliminary survey of the Emali market was undertaken during the last quarter of 1980 and the first quarter of 1981. Information was solicited from 60 cattle sellers and buyers on general cattle trading activities and specific transactions that took place on the day of the interview. This survey provided background information on how the Emali cattle market operated and a description of the activities of traders who purchase cattle in the surrounding areas.

Time-series data were collected between September 1981 and August 1984. Each Friday, the total number of cattle offered and the numbers of suppliers and buyers were recorded. Additional information was recorded for a sample of transactions: age of animal (adult, immature, calf); sex (male, castrate, female); and breed (Small East African Zebu, Sahiwal or Boran-cross). Sellers were identified as traders or producers and were asked where they had bought the cattle and the prices they paid. Buyers were asked the purpose of their purchase, the prices paid, the destination of the animals and the mode of transportation. A total of 7644 transactions were recorded.

9.2.2 Transactions

The Emali market was not organised as an auction. Individual sellers or groups of two or three traders congregated their cattle in small herds and stood nearby. The market might have 15 to 20 such herds. Buyers of cattle inspected these herds and identified the animals they wanted; then they approached the owners to negotiate prices. Many transactions occurred simultaneously, making it difficult to spot when agreement on a sale had been reached. Reselling of cattle bought on the same day also contributed to this difficulty.

It was estimated that about 80% of the cattle offered at Emali were actually sold. About two-thirds of the cattle that were not sold at Emali were later brought back for sale. The remaining unsold cattle were trekked to the Ong'ata Rongai, Dagoretti or Athi River markets close to Nairobi.

9.2.3 Sources of cattle

A total of 7644 cattle transactions were recorded. The origins of the animals could be determined for only 60% of these animals, of which almost all (96%) came from producers in Kajiado District (Table 9.4). Commercial ranchers in Kajiado District rarely sold their cattle at Emali; they sold directly to butchers, the Kenya Meat Commission (KMC) and traders in the Ong'ata Rongai and Dagoretti markets, where they could obtain better prices.

Table 9.4. *Source of cattle supplied to the Emali market, 1981–84.*

Source of supply	Number	%
Group ranches	3628	79
Trading centres		
Kajiado District	600	13
Machakos District	132	3
Commercial ranches		
Kajiado District	186	4
Machakos District	61	1
Total	4607	100

The type of seller of cattle at the Emali market was clearly identified for only 6756 head. Intermediate traders were the main sellers, supplying 95% of all animals. The remaining 5% were supplied directly by producers. The traders reported that they obtained only 42% of the cattle directly from pastoralists: the remaining 58% were bought from bush traders. This shows that despite knowing that they could obtain better prices at the market Maasai pastoralists tended to sell their animals at their *bomas* or at water points to itinerant traders rather than spend a lot of time trekking animals to markets.

9.2.4 Sellers and buyers

The number of traders supplying cattle to the Emali market varied from week to week, ranging from 25 to 75 with each trader supplying between 5 and 20 head. Although these suppliers considered cattle trading to be their occupation, all of them were also producers. For many, cattle trading was a part-time job and the distinction between trader and producers was rarely clear-cut. Trading was entered into and left as circumstances allowed or required, temporary or long-term labour shortages at home being a major determinant. Trading activities were reduced during periods of drought, when herds had to be split with consequent additional labour and management requirements (Grandin et al, 1989; Grandin and Lembuya, 1987). Even the most regular traders interrupted their trading activities for weeks or longer if circumstances involving their personal herds so required.

The number of buyers also fluctuated, with up to 50 buyers being present at a weekly market. However, there were generally between 7 and 15 major buyers from Ong'ata Rongai, Dagoretti and Athi River. There were thus enough market participants to afford a fair degree of competition.

9.2.5 Buying in the hinterland

Although traders could buy cattle from anywhere in Maasailand, they seemed to concentrate their efforts in particular areas, often around their own residences, where kinship and familiarity with the producers commanded a degree of trust and credence in their transactions (Evangelou, 1984; Solomon Bekure and McDonald, 1984). Many Maasai were suspicious of traders they did not know. Familiarity facilitated credit transactions, which were common. Transactions took place at the producer's *boma*, at water points and at small trading centres in the livestock-producing areas.

A strong degree of camaraderie was exhibited by the traders. Of the traders interviewed in the preliminary survey, 30% indicated that they helped each other by forming loose partnerships. Profits might be shared or, more frequently, earnings were loaned back and forth between partners as needed. Cattle traders also coordinated the movement of their animals to market. Usually, a group of traders collected their cattle at one site and arranged to have them trekked to Emali as a single herd, with arrival timed for the evening before the market day. This tended to facilitate handling, decrease costs and reduce the risks associated with trekking cattle to Emali.

9.2.6 Destination of cattle traded

The destination of cattle traded at the Emali market depended upon the purpose for which they were bought. Of the 7407 transactions for which a purpose was recorded (Table 9.5), 62% were clearly destined for slaughter. The remaining 38% were mainly bought by producers and traders for rearing and other transactions.

The markets at Ong'ata Rongai and Dagoretti were the main destinations of slaughter cattle bought at Emali. The dominance of the KMC has declined markedly since the early 1960s. Between 1961 and 1967 the KMC supplied 75–85% of the beef consumed in Nairobi (Aldington and Wilson, 1968), whereas in 1977 it supplied only 26% (Matthes, 1979). Traders at Emali ascribed their reluctance to sell to KMC to several factors, including low prices, delayed payments and the risk of carcass condemnation, in which event, the loss was completely absorbed by the trader. These reasons also were given by traders who bought livestock from the high-potential areas in Kenya (Gatere and Dow, 1980).

Table 9.5. *Destinations of cattle sold at Emali, 1981–84.*

Purpose/destination	Number	%	Per cent of total
Slaughter			
Ong'ata Rongai	1105	24	15
Dagoretti	1016	22	14
KMC–Athi River	732	16	10
KMC–Mombasa	242	5	3
Mariakani	716	15	10
Emali	25	1	0
Machakos	305	7	4
Others	474	10	6
Subtotal	4615	100	62
Production			
Machakos District	1348	48	18
Kajiado District			
Group ranch	1073	39	15
Individual ranch	371	13	5
Subtotal	2792	100	38
Total	7407		100

9.2.7 Characteristics of cattle traded

Small East African Zebu (SEAZ) was the predominant breed traded at Emali. Of 7644 head of cattle recorded in the study, 97% were SEAZ. Only 3% were identified as Sahiwal crosses, while there were only 24 Boran crosses. This reflects the fact that Sahiwal and Boran breeds formed an insignificant part of Maasai herds and the few that Maasai had were kept for breeding (see Section 7.1.3: *Breeds and weights*).

Sex and age

Forty-two per cent of the animals sold were castrates, 39% were male and 19% were female. Since immatures and adults were classified by visual assessment, the figures may reflect observer bias; however, the number of immature males (1873) appeared to be almost double the number of adult males. A majority of these immature males (69%) were bought as draught animals by farmers in Machakos District. The number of mature castrates was about 48% more than that of immature castrates. An analysis of the pattern of sales by Maasai households showed that poorer households were forced to sell immatures to generate cash for their subsistence requirements (see Section 8.2.2: *Sales and purchases*). The fact that 87% (1459) of the females marketed were adult cows suggests that Maasai hold on to their heifers for breeding and cull only old and barren cows. A detailed disaggregation of the characteristics of cattle marketed at Emali by breed, sex, and age is given in Table 9.6.

About 77% (1302) of the cattle bought at Emali that were destined for Machakos were males purchased as draught animals. Castrates constituted about 18% (303 head) of the animals destined for Machakos and females only 5%. In contrast, those destined for the Kajiado group and individual ranches were mainly castrates (62%; 938 head) purchased for fattening. Males represented 26% and females only 12%. Some cattle traders, especially those with access to private water connections on the Loitokitok–Sultan Hamud pipeline, were engaged in buying immature steers for fattening and sale. Some reported having bought young steers for KSh 700 per head and selling them about a year later for KSh 1500 per head.

9.2.8 Cattle supply and prices

The mean number of cattle brought to Emali for sale was 374±102 head a week over the first 2 years of the study. The data show an upward trend in the supply of cattle, increasing from 287 head a week over the first 12 months (September 1981 to August 1982) to 417 head a week over the following 12 months. This can be ascribed to a combination of two factors: a general increase in cattle numbers and a rise in cattle prices during 1982 and 1983. Prices paid for males and castrates increased by about 8% and those for cows by about 1.6%. Data on livestock production for Olkarkar and Merueshi show that the population of cattle increased 13% and the population of small ruminants increased 10% between 1982 and 1983 (see Section 8.2.7: *Net offtake and acquisition*).

The supply of cattle to the Emali market varied markedly between seasons. It increased as the long dry season progressed, beginning from June when fodder availability and hence milk supplies decreased sharply (see Section 7.1.7: *Milk offtake and lactation yield*). Peaks in supply occurred between mid-November and mid-December 1982 and in mid-July 1983, after a poor rainy season in southern Kajiado during March–May 1983.

Prices of cattle also fluctuated seasonally but generally increased, in keeping with the higher prices gazetted by the government during 1982 and 1984. With gazetted prices and a fairly constant demand for beef, fluctuations in cattle prices

Table 9.6. *Mean prices of cattle at Emali by breed, sex and age, 1981–84.*

	Immature		Mature			
	Price (KSh/head)	No.	Price (KSh/head)	No.	Mean price (KSh/head)	Total number of animals
Small East African Zebu						
Male	751	1840	1572	1016	1043	2856
Castrate	952	1296	1660	1805	1369	3101
Female	789	187	986	1245	960	1432
Mean price	831		1436		1164	
Total number of animals		3323		4066		7389
Sahiwal-cross						
Male	1174	26	2278	45	1874	71
Castrate	1409	28	2640	105	2239	133
Female	1060	5	1363	23	1307	27
Mean price	1276		2382		2018	
Total number of animals		59		172		232
Boran-cross						
Male	1186	7	2597	7	1872	14
Castrate	1029	7	1840	3	1272	10
Mean price	1108		2342		1622	
Total number of animals		14		10		24
All breeds						
Male	758	1873	1608	1068	1067	2941
Castrate	962	1331	1723	1913	1403	3244
Female	796	192	993	1267	966	1459
Mean price	840		1476		1193	
Total number of animals		3396		4248		7644

per head are explained more by the condition of the cattle supplied in the market rather than by the number on offer. In general, cattle prices showed a marked tendency to peak in July and again during December or January. Following the rains in March–May cattle tended to put on weight and improve their body condition so that during June and July they commanded higher prices. During the long dry season cattle lost condition and fetched low prices. The cycle was repeated again following the October–December rains.

During the 3 years of the study, mature castrates fetched the highest price with a mean of KSh 1723 per head, about 7% more than that for mature males (Table 9.6). Cull cows fetched substantially lower prices, averaging KSh 993 per head, reflecting their poor body condition and low carcass quality. While the average price of all classes of livestock traded at Emali was KSh 1193 per head, producers in the study area, who were within 40 km of Emali, received an average of KSh 1012 per head. Producers near the Tanzanian border received much less. During the same period the mean cattle price at Ong'ata Rongai, where most of the slaughter cattle were finally sold, was KSh 1919 per head. The average price of mature cattle at Emali was KSh 1476 per head.

Although their numbers were low (231 head or 3% of the sample), Sahiwal crosses commanded premium prices. The mean price for mature Sahiwal male castrates was 45% more than that for mature SEA Zebu castrates, while Sahiwal cows fetched 54% more than SEA Zebu cows. Mature Boran bulls fetched the highest mean price of KSh 2597, 14% more than Sahiwal bulls and 65% more than SEA Zebu bulls.

9.2.9 Efficiency of the cattle marketing system in eastern Kajiado

Comparisons of prices received by producers and intermediate traders and prices paid by wholesale butchers at final markets, adjusted for marketing costs of moving the animals through the market chain, provide a good indication of the efficiency of the livestock marketing system. For the purpose of this analysis, the Ong'ata Rongai market was considered to be the final market.

Producers in the study area received a mean price of KSh 1012 per head or KSh 3.97 per kg liveweight, traders at Emali obtained KSh 1396 per head or KSh 5.48 per kg liveweight (Table 9.7). Traders obtained an average gross margin of about KSh 320 per head, or about 23% of their selling price per head, which is high.

Table 9.7. *Prices and costs of cattle trading at Emali and Ong'ata Rongai, September 1981 to August 1982.*

	KSh per head	KSh/kg liveweight
Emali		
Mean purchase price from producers	1012	3.97
Marketing costs up to Emali	65	0.25
Mean sales price	1396	5.48
Trader's mean gross margin	319	1.25
Ong'ata Rongai		
Mean purchase price	1396	5.48
Marketing costs up to Ong'ata Rongai	119	0.47
Mean sales price	1919	7.60
Trader's mean gross margin	394	1.55

Traders interviewed about the margins they normally realised indicated a range from KSh 100 per head on animals in poor condition to about KSh 600 per head on heavy steers in excellent body condition.

Traders buying cattle at Emali and selling at Ong'ata Rongai incurred marketing costs of about KSh 120 per head. The mean price they received was about KSh 1920 per head or 7.60 per kg liveweight, compared with KSh 4.00, 5.50 or 7.25 per kg liveweight paid by the KMC for animals graded commercial, standard or high. These low prices are an additional reason why traders were reluctant to sell to the KMC. Traders' gross margins at Ong'ata Rongai averaged KSh 394 per head. This represents a gross margin of about 20% of their selling price, which is also high.

9.2.10 Problems of the livestock marketing system

The main problems of the livestock marketing system were:

- lack of good market outlets for smallstock
- absence of market infrastructure along trek routes and livestock markets
- lack of market information
- shortage of working capital for livestock traders in the hinterlands
- low livestock prices.

The effect of low livestock prices on the terms of trade of Maasai pastoralists is discussed here in detail. The other marketing problems and suggested improvements to ameliorate the situation are fully covered in Chapter 11 (Section 11.5: *Improvements in livestock marketing*).

9.3 Terms of trade for Maasai pastoralists

If prices of all commodities and services rise and fall by the same proportion, the terms of trade for all groups will remain the same. Unfortunately, prices of commodities and services change independently and in different proportions, particularly if some prices are controlled to protect particular interest groups. Terms of trade are a useful index of how a group of producers is affected by changing prices for what they sell and what they buy. The terms of trade index is a ratio of the relative prices of a basket of the goods and services producers sell and those they buy. An index of greater than 100% indicates producers' income (i.e. their purchasing power) has increased in real terms while an index of less than 100% shows their purchasing power has fallen.

A terms of trade index was constructed for Maasai pastoralists using the ILCA household budget data and the price series published by the Republic of Kenya. The basket of goods and services Maasai purchased and their relative weights are given in Table 9.8. Maasai spent up to 35% of their annual cash expenditure on livestock inputs (acaricides, veterinary drugs and salt). However, these were excluded from the construction of their consumption basket for two reasons; first, the price series for these commodities was not available and secondly their inclusion would have ren-

Table 9.8. *Derivation of Maasai terms of trade, 1975–85.*

		Value relative to 1975										
	Weight[1]	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Maize	0.191	100	117	127	126	124	266	413	406	415	486	615
Wheat	0.012	100	101	110	112	115	125	138	168	180	205	234
Sugar	0.177	100	129	129	129	129	129	138	164	180	197	206
Tea	0.074	100	99	110	100	103	105	119	171	196	200	200
Oil	0.018	100	100	104	113	122	127	130	158	173	190	195
Other food	0.094	100	105	123	139	150	174	206	227	246	285	323
Beverage	0.056	100	118	129	143	158	166	187	243	253	273	293
Transport	0.097	100	116	130	135	139	169	202	238	239	246	274
Medical	0.071	100	103	109	117	121	128	163	210	218	260	289
Clothing	0.212	100	103	123	161	178	204	236	262	321	332	354
Price index[2]												
Maasai	1.00	100	112	123	134	140	179	227	252	275	303	344
Beef		100	104	113	140	131	152	159	187	206	206	253
Lower-income Kenya		100	108	127	144	157	178	212	241	264	293	323
Maasai terms of trade		100	93	92	104	94	85	70	74	75	68	73

[1]Relative weight of Maasai pastoralist consumption basket (1981–83).

[2]Source: *Statistical Abstract*, 1980 to 1986, Central Bureau of Statistics, Ministry of Planning and National Development, Nairobi, Kenya.

dered comparison with the consumer price index very difficult. Nonetheless, prices of livestock inputs were reported to increase more sharply than the general consumer price index (Chemonics International, 1977).

Figure 9.2 shows that there is a close fit between the lower income consumer price index and that derived for the pastoral Maasai. The terms of trade for the Maasai, computed using the Kenya Meat Commission minimum producer price series to represent their income index, generally declined from 1975 to 1985 (Figure 9.2). The main reason for this was that beef prices did not increase at the same rate as prices for other commodities.

It is well known that livestock and meat prices, which were administered and controlled by the government[1], were declining in real terms over this period and had a deleterious effect on the livestock industry in Kenya (Fuglie, 1973; IBRD, 1977; Chemonics International, 1977; Cronin, 1978; Matthes, 1979). Chemonics International (1977) warned that if past livestock and meat prices were maintained the annual supply of meat in Kenya would decline by 7000 tonnes by 1990. Kenyan wholesale beef prices were below those of the major world suppliers, i.e. Argentina, Australia, the United States of America and the European Community, between 1978 and 1982 (Evangelou, 1984).

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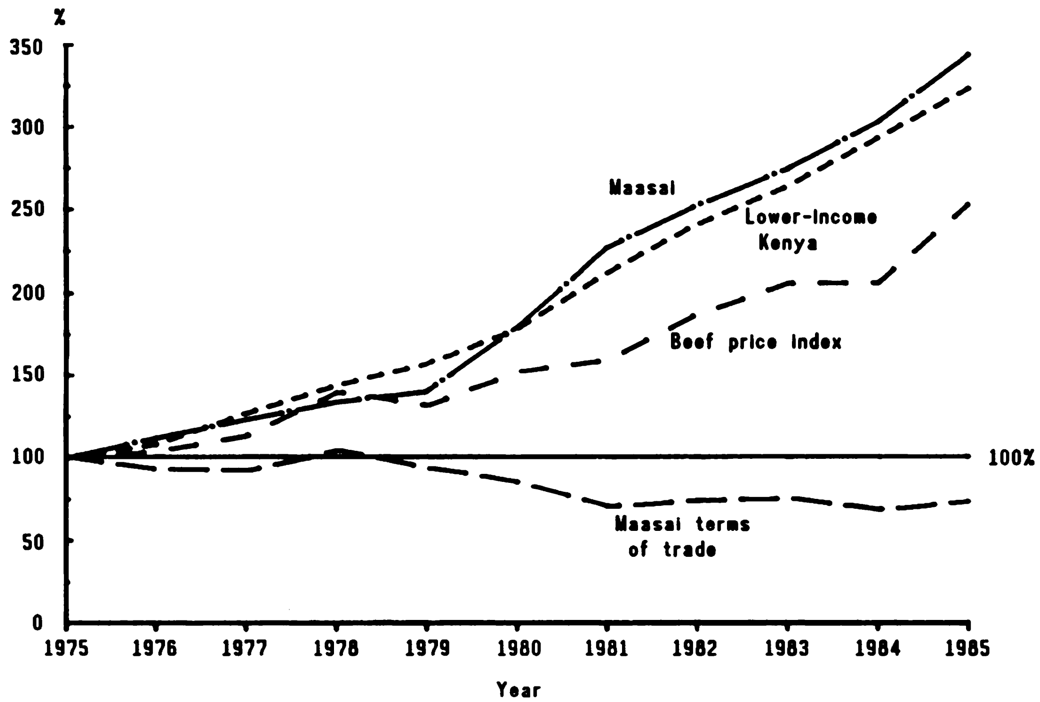
1. The Government of Kenya deregulated the price of livestock and meat on 20 February 1987.

Figure 9.2. *Maasai terms of trade, 1975–85.*



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Chapter 10

The long-term productivity of the Maasai livestock production system

Solomon Bekure, P N de Leeuw and R Nyambaka

In extensive rangeland systems, livestock production is highly dependent on the availability of natural grazing, the quantity and quality of which are primarily determined by the amount and distribution of rainfall, given the temperature regime, soil-type and topography of a particular rangeland site. In eastern Africa, rainfall fluctuates widely from year to year.

The results reported in the preceding chapters were recorded mostly during a 2-year period following a succession of years in which rainfall was relatively favourable to primary production. However, over the past 100 years severe droughts have occurred at least once in every 8–12 years. This causes enormous fluctuations in the productivity of pastoral systems. Thus short-term studies, such as that conducted by ILCA in Maasailand from 1981 to 1984, cannot provide a complete picture of the dynamics of pastoral livestock production. This chapter attempts to examine the long-term variation of the Maasai livestock production system by using forage and livestock production models.

The strong linkage between herd productivity and the quality and quantity of the fodder supply has been commented upon throughout this study. What is less easy to establish is the range of variation for each cattle productivity parameter, particularly calving rate and mortality. These parameters have been predicted with biological herd simulation models for several pastoral production systems (Sullivan et al, 1981; de Leeuw and Konandreas, 1982). However, it is difficult to apply such biological models to pastoral systems (see Wagenaar and Kontrohr, 1986; de Leeuw, 1986). Stochastic models have also been used to predict primary productivity of rangelands using probabilities of annual rainfall distributions. However, linking such a stochastic model with a biological livestock production model was considered too complex and impractical.

The approach taken here was to use actual climatic data to estimate lengths of growing seasons. Forage production was estimated from these lengths of growing seasons. Estimates of cattle productivity were then based on these estimates of forage production.

Herd projection models were developed for the three wealth classes of producers on a 10 000-ha group ranch using the data for Olkarkar. The models were applied to herds of 30, 60 and 300 head of cattle, representing the mean holdings of poor, medium-wealth and rich producers. The models generated changes in herd size, stock losses and saleable stock and simulated annual and long-term livestock and milk offtake for these three herd sizes; they also identified changes in these parameters according to year type.

The results of the herd models were then aggregated to arrive at the output for the entire Olkarkar Group Ranch by weighting them in accordance with the frequency distribution of these herd sizes in the ranch. Two assumptions were made for aggregating the output in this fashion. The first was that the 30 years for which the future projections were made (1983–2012) would have a similar pattern of growing seasons as that observed between 1957 and 1986. The second assumption was that the proportions of poor, medium-wealth and rich producers on the ranch would remain the same as those observed during the 1981–83 period, which will of course not be the case as households will change as household heads grow old and sons divide the herd.

10.1 Inputs for the simulation models

10.1.1 Fodder resources

Growing-season duration was calculated using a soil moisture balance model developed by Musembi (1984; 1986). This model is similar to that used by Potter (1985). Estimation of herbage production in relation to the length of the growing season was based on an analysis of data from several range areas in semi-arid eastern Africa (de Leeuw and Nyambaka, 1988).

There are two marked growing seasons in eastern Kajiado, the first rains from October to January and the second rains from March to May. There is a dry season of variable length between these two rainy seasons, and the second rains are followed by a long dry season lasting from June to early October. In the short term, grazing resources are determined by the combined durations of the two growing seasons, while longer-term trends depend on the variability of annual growing period over longer time-spans.

Growing-season durations were calculated from data covering a 50-year period (1935–84) from two rainfall stations (Makindu and Simba) representative of the eastern portion of Kajiado District. The frequency distributions of the length of the two seasons were markedly different. For the first season, growing periods of 2 months or more occurred in 44% of the 50 years, while short seasons of one month or less prevailed in another 28% of the years (Figure 10.1). The mean over the 50-year period was 1.7 months. For the second rains the proportion of short seasons was much greater: in 54% of the years the growing season lasted 1 month or less whereas seasons of 2 months or more occurred only in 1 year in 3 (Figure 10.1). The mean duration of the second rainy season was 1.2 months.

Roughly 1 year in 3 had an annual growing period of 2 months or less, whereas 1 year in 4 was wet with at least a 4-month growing season (Figure 10.2). The mean annual growing period was 2.9 months for the whole 50-year period.

Using year-types as single events to predict resource conditions ignores carry-over effects from previous years. A very dry year after a series of wet years would have much less effect on livestock productivity than if the same dry year followed several years of below-average rainfall. Year-types as defined by the length of the annual growing season were plotted for a 30-year period (Figure 10.3).

Herbage yields per annum were estimated using durations of the total annual growing season as predictors (Table 10.1) (Potter 1985; de Leeuw and Nyambaka, 1988). Production was 1.5 t DM/annum or less in about a third of the years and 3.0 t DM/ha or more in about a third of the years (Figure 10.4).

10.1.2 The herd-projection model

This section discusses the various inputs used in this model, together with the assumptions for culling, sales and livestock purchasing policies.

Herd composition

The initial herd composition specified at the start of the model was derived from the data for Olkarkar Group Ranch (King et al, 1984). The composition of the two smaller herds was similar, while

Figure 10.1. *Frequency distribution of the length of growing seasons in eastern Kajiado District, 1935–85.*

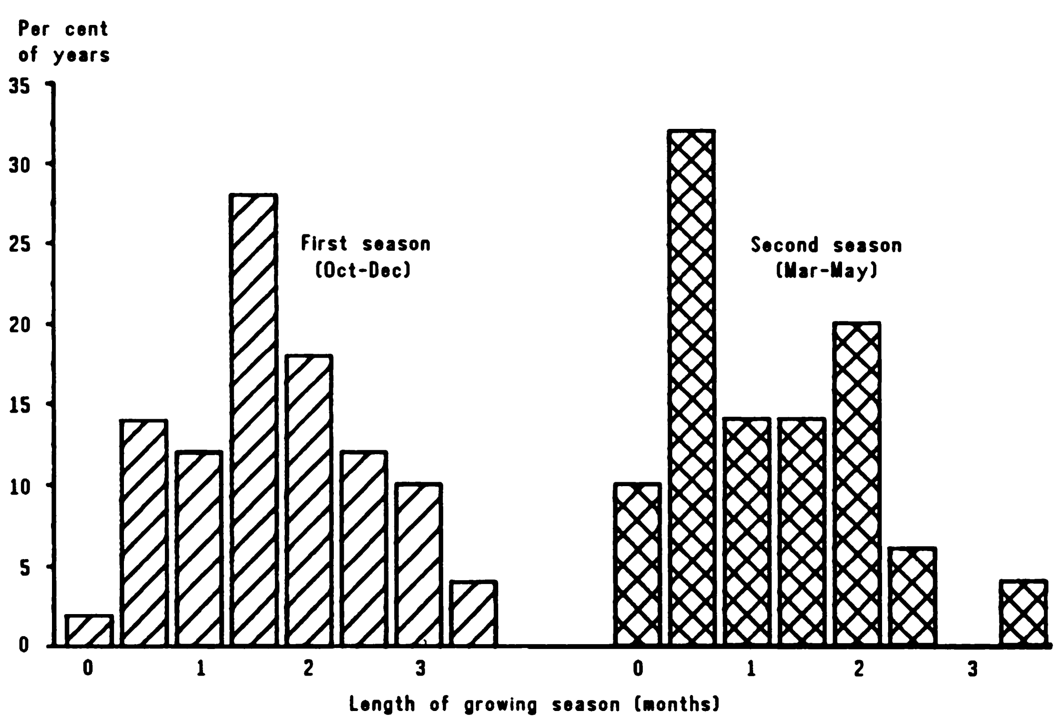


Figure 10.2. *Frequency distribution of the total length of annual growing periods in eastern Kajiado District, 1935–85.*

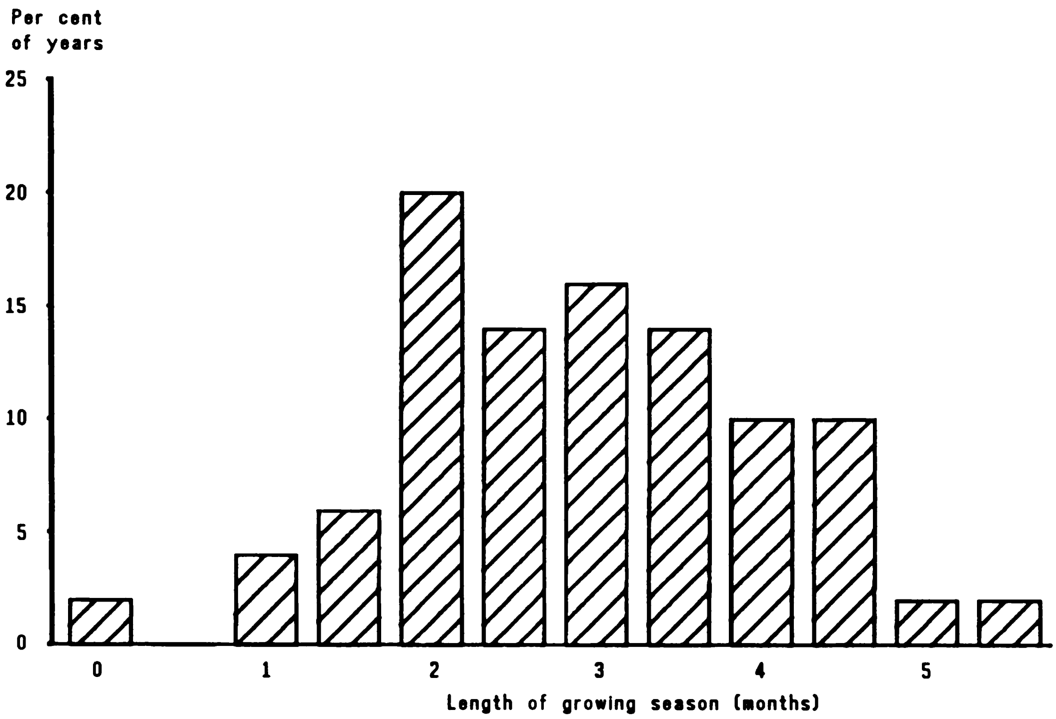
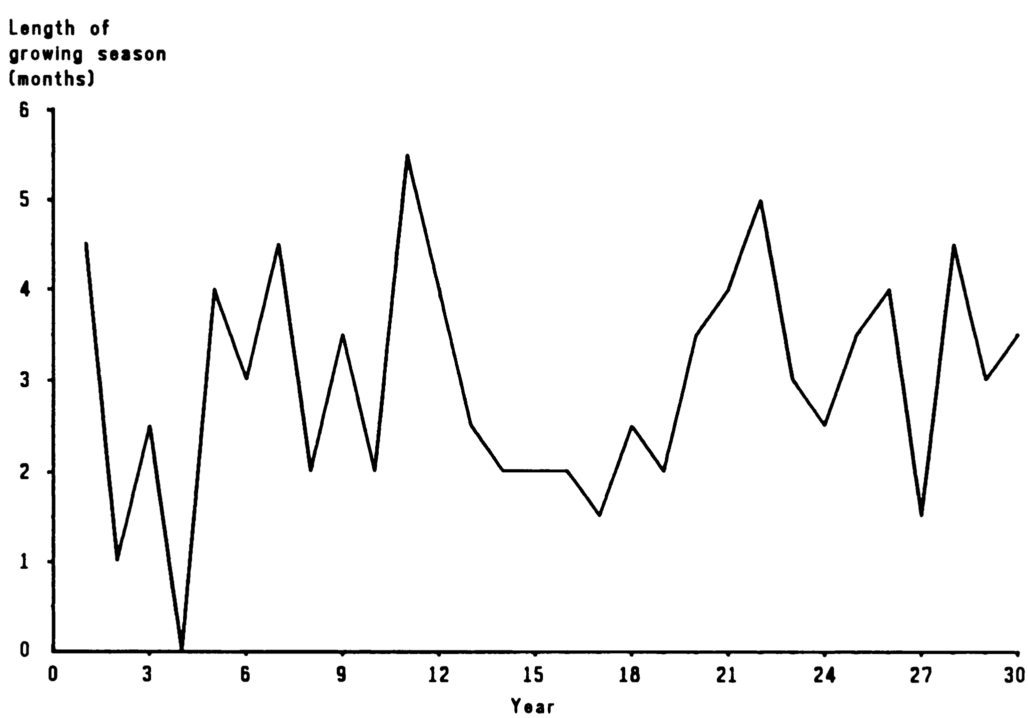


Figure 10.3. *Simulated length of total annual growing period over a 30-year period, semi-arid eastern Kenya.*



that of the herd with 300 head had a smaller proportion of young females and adult cows and three times as many steers more than 3 years old (Table 10.2).

Calving percentage

Breeding females were defined as all adult cows and a varying proportion of 3- to 4-year-old heifers.

Table 10.1. *Expected daily herbage growth rates and seasonal productivity for rangelands in eastern Kajiado.*

Duration of growing season (months)	Growth rate (kg DM/ha per day)	Seasonal yield (t DM/ha)
0.5	13	0.2
1.0	17	0.5
1.5	22	1.0
2.0	25	1.5
2.5	30	2.3
3.0	30	2.7
3.5	28	2.9
4.0	27	3.1

In drier years none of these heifers conceive, whereas in good years 10–20% of them do. The calving percentage is governed mainly by year-type. During dry years, conception rates are low, causing a small calf crop in the next year, while high calving percentages mostly prevail immediately after drought because many of the surviving cows are open and likely to conceive once forage conditions improve. Overall mean calving rate was 51%.

Mortality

Mortality rates were specified for each animal class for each year, assuming that mortality rate is primarily determined by feed availability rather than disease incidence.

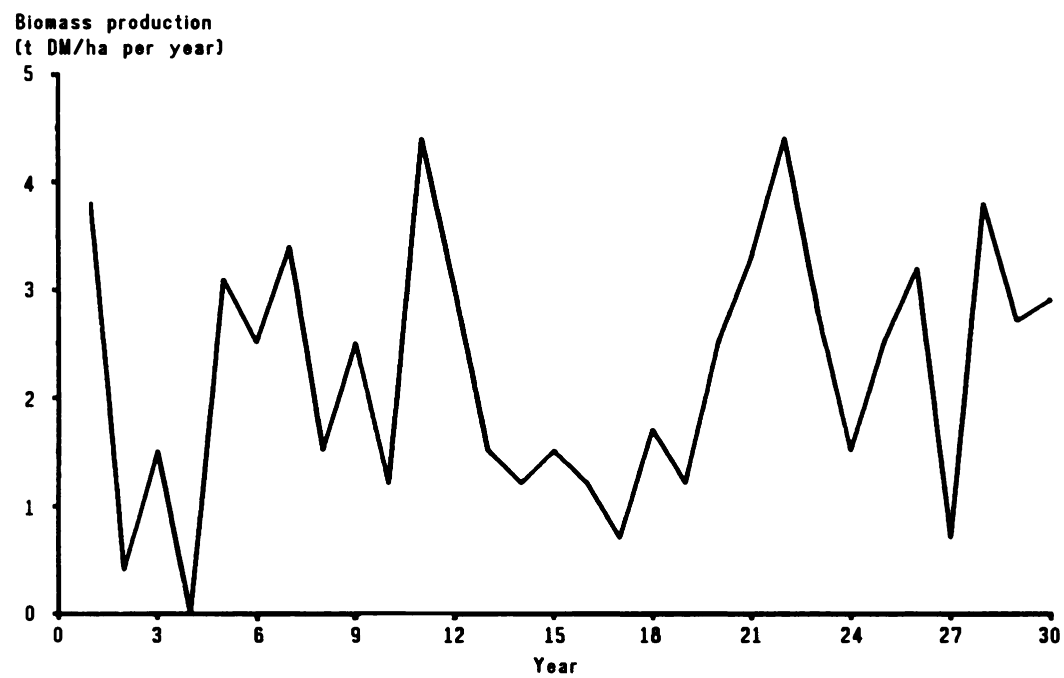
Table 10.2. *Initial composition of herds comprising 30, 60 and 300 head.*

	Herd size (no. of animals)		
	30	60	300
	Herd composition (% of herd)		
Males			
Calves 0–1 year	9	8	8
Steers 1–2 years	8	10	7
2–3 years	8	6	9
3–4 years	3	3	9
>4 years		1	2
Breeding bulls	3	5	3
Total males	31	33	38
Females			
Calves 0–1 year	9	9	9
Heifers 1–2 years	8	11	8
2–3 years	8	10	8
3–4 years	11	8	8
Adult cows	33	29	29
Total females	69	67	62

See Tables 7.I and 7.2 for comparison.

The 30-year mean, minimum and maximum mortality rates for each of the 10 stock classes are

Figure 10.4. *Simulated total annual biomass production over a 30-year period, semi-arid eastern Kenya.*



shown in Table 10.3. Minimum rates were applied during favourable periods whereas the peak rates were applied during drought periods. Heifers and steers had mortality rates ranging from 4% to 30%. In most years death rates were below 10%, and in four of the years between 10% and 20%. The range of mortality rate in cows was much larger than in growing stock over 1 year old. In 7 out of 10 years less than 10% died, but in drier years the death rate was 11–20%, reaching 40% in drought years. Calves had a minimum mortality of 10% in half the years and higher rates in the other half, up to a maximum of 60% during drought.

Table 10.3. *Mean, minimum and maximum mortality rates and liveweights by age/sex class.*

	Mortality (% per annum)			Weight (kg)		
	Mean	Min	Max	Mean	Min	Max
Cows	9	4	40	266	230	300
Calves	15	10	60	59	40	75
Heifers 1–2 years	9	4	30	135	100	150
Heifers 2–3 years	8	4	25	180	130	210
Heifers 3–4 years	7	4	20	220	170	260
Steers 1–2 years	8	4	30	145	110	170
Steers 2–3 years	8	4	25	200	150	230
Steers 3–4 years	7	4	20	250	200	290
Steers >4 years	6	4	20	340	300	380
Breeding bulls	6	4	15	340	300	380

Weight changes

Mid-year weights of all age/sex classes in the simulated herds were required for each of the 30 years to calculate herd biomass production and aggregate grazing pressure. These weights were derived from King et al (1984), who weighed some 5000 cattle in all three group ranches in 1980–81. Minimum and maximum weights were indicative of those that would occur in very dry and very wet years (Table 10.3). These weight changes were taken into account in calculations concerning the balance between grazing resources and their utilisation by herbivores (see Section 10.2.1: *Herd size and stocking rate*).

10.1.3 Long-term milk supplies

The model estimated the potential availability of milk in relation to year-types. The factors that affect the actual milk supplies for household subsistence were discussed in Chapter 7 (Section 7.1.7: *Milk offtake and lactation yield*) and Chapter 8 (Section 8.4: *Milk, food consumption and nutritional status*). Milk supply depends foremost on herd size and in particular on the potential number of lactating cows, i.e. cows with a calf at foot. The number of lactating cows was generated by the herd-projection models, based on the number of calves in the herd in the middle of each year. The reduction of milk yield due to calf and cow mortality was thus accounted for by apportioning the mortality equally over the first and the second halves of the year.

The annual potential milked-out yield per cow was derived from monthly milk offtake data with adjustments for the number of cows milked and milking frequency (see Section 7.1.7: *Milk offtake and lactation yield*). Subsequently, monthly offtakes were aggregated for each rainy season and for each year for the entire 30-year period.

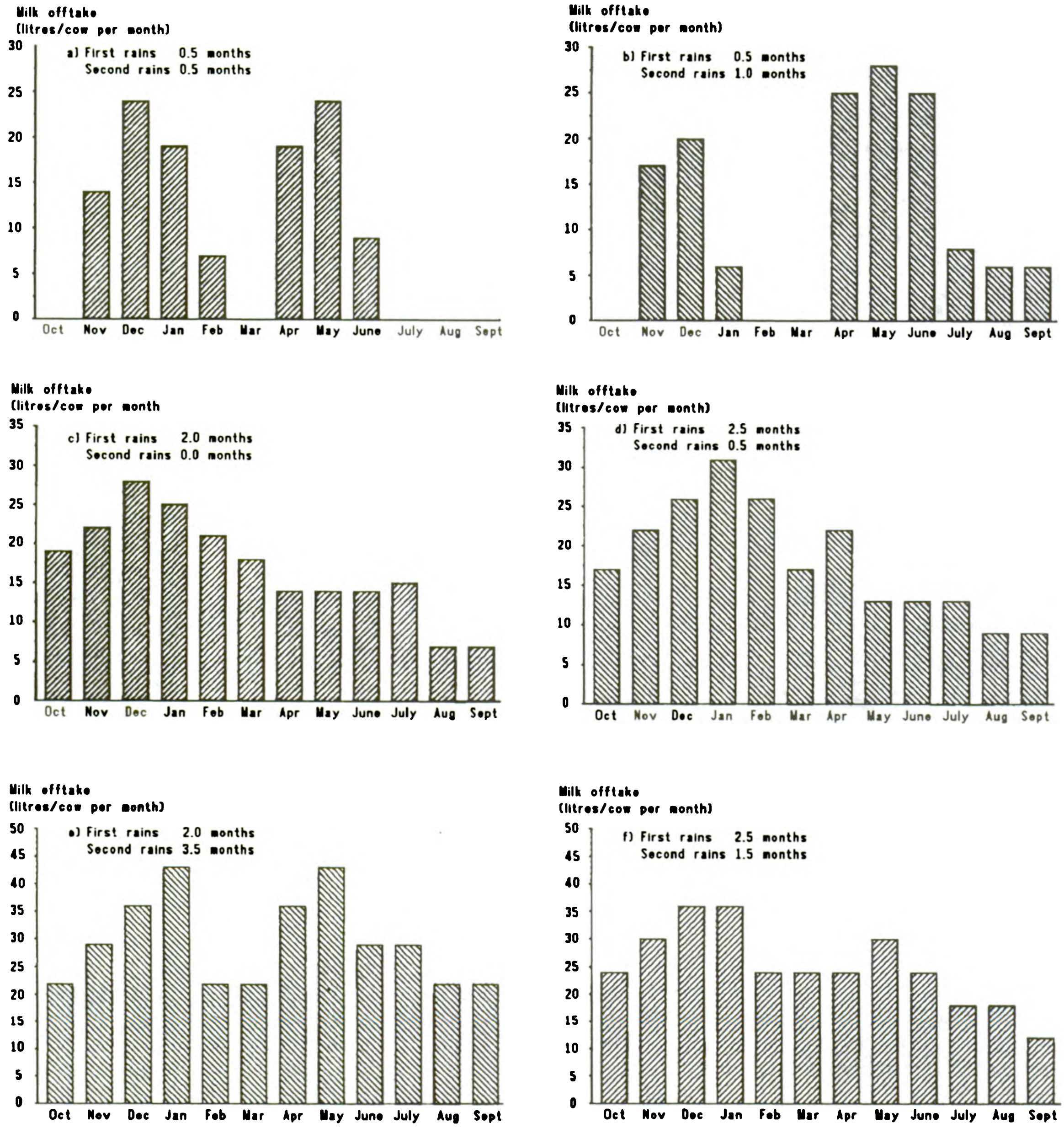
Milk-offtake profiles per cow by month are illustrated in Figure 10.5 for six selected year-types, ranging from very dry to wet. Bars represent average monthly yield per cow taking into account the fact that in dry months some cows are not milked at all or are milked less than twice a day. Potential milk production for each month varies with the length of each growing season and thus by year-type. Years with short growing seasons, totalling less than 2 months, have short periods with reasonable offtake and up to 5 months with no milk at all (Figures 10.5a and 10.5b). When the total annual growing period was between 2 and 3 months long, monthly milk yields exceeded 15 litres per cow for 6 months (Figures 10.5c and 10.5d), whereas in good years (annual growing period of more than 4 months) yields exceeded 20 litres per cow per month throughout the year (Figures 10.5e and 10.5f).

Annual milk yield per lactating cow ranged from about 60 litres in the worst year to 360 litres in the best year.

To summarise the impact of year type on the herd productivity parameters, year-types were grouped in four forage resource classes (Table 10.4). Three of the 30 years were classed as very low, 12 as low, 10 as medium and 5 as high. Over this range, annual rainfall rose from 307 mm to 830 mm, with a mean of 550 mm, and the annual growing period increased from 1 month to almost 5 months.

The mean values of the cattle productivity parameters that were used in the projection model are given in Table 10.5 for each of the forage resource classes. The largest differences between resource classes were in annual milk yield and mortality rates. Average calving percentage in a

Figure 10.5. *Monthly milk offtake profiles for six year-types.*



given year was less influenced by forage resources during that year because of the time-lag between conception and parturition.

10.1.4 Culling, sales and purchase policies

The Maasai cull cows when they are 8 to 12 years old. For the model a policy of culling and selling 10% of the cows yearly was adopted. Breeding bulls were culled at a faster rate of 25% per year to avoid in-breeding. Since sales policies materially affect the long-term productivity of a given herd, it was decided to hold constant the total number of animals sold across years in order to minimise the effects of differential sales policies. The actual mean numbers of animals sold as observed during the 1981–83 study (4, 7 and 17 head per year for poor, medium-wealth and rich producers, respectively) were initially used in the model. A sensitivity analysis of different sales strategies was conducted on the 60- and 300-head herd models, and this is discussed in Section 10.5 (*Effects of increased offtake of steers on herd and ranch productivity*). The types of animal sold was determined by a decision rule that first sold all the cull cows and bulls. If there were fewer of these than the fixed number required for sale the dif-

Table 10.4. *Rainfall, length of growing season and forage yield for year-types grouped by resource classes.*

	Resource class[1]				
	Very low	Low	Medium	High	Mean
Rainfall (mm)					
1st season	178	221	431	550	340
2nd season	129	183	233	280	210
Total	307	404	664	830	550
Length of growing season (months)					
1st season	0.5	1.4	2.4	2.6	1.9
2nd season	0.5	0.8	1.2	2.2	1.1
Total	1.0	2.2	3.6	4.8	3.0
Forage yield (t DM/ha)					
1st season	0.2	1.0	2.0	2.2	1.5
2nd season	0.2	0.4	0.8	1.7	0.8
Total	0.4	1.4	2.8	3.9	2.3
No. of years	3	12	10	5	30

[1]Very low = <1 t DM/ha per year; low = 1.0–2.0 t; medium = 2.1–3.4 t; high = >3.4 t.

Table 10.5. *Characterisation of cattle productivity parameters for year-types grouped by resource class.*

	Resource class[1]				
	Very low	Low	Medium	High	Mean
Calving (%)	36	54	54	48	51
Milk yield per cow with calf (litres/annum)	113	190	268	348	234
Liveweight (kg/head)	169	183	196	211	190
Mortality (%)					
Cows	40.0	9.1	5.2	5.4	10.3
Stock <2 years	45.0	11.9	8.1	7.8	12.2
Stock 2–3 years	25.0	7.6	5.2	5.2	8.2
Stock >3 years	18.3	6.4	4.9	4.6	6.8

[1]Very low = <1 t DM/ha per year; low = 1.0–2.0 t; medium = 2.1–3.4 t; high = >3.4 t.

ference was made up by selling steers of 4 years old or older or, if there were too few of these, younger steers.

The Maasai occasionally bring into their herds heifers, bulls and steers they obtain by exchange or purchase and a provision was made in the model for such acquisitions. Again, the number acquired was fixed as observed during the study period, except that none were acquired during drought periods.

10.2 Results

10.2.1 Herd size and stocking rate

The modelled long-term fluctuations of population in the three herd sizes and for the entire Olkarkar ranch are shown in Figure 10.6. Two cycles of herd growth and decline are apparent.

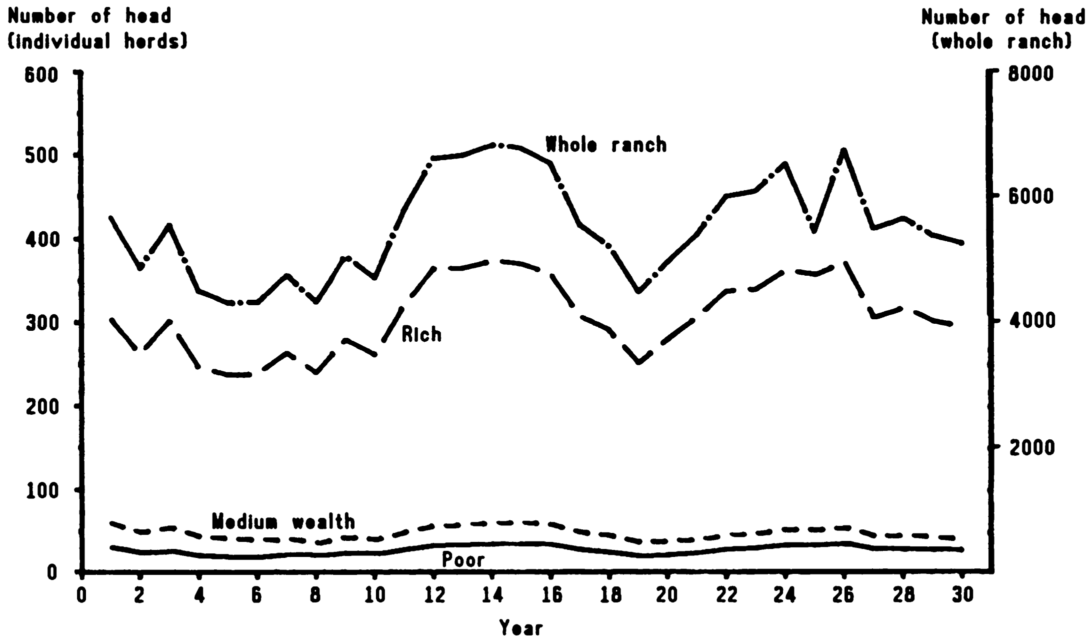
In general, the mean rate of herd decline during drought periods was 14% per year. Thus if a drought persists for 2 years the cattle population will be reduced by 26%. If the drought continues for a third year the herd size will decline to 63% of its pre-drought level. In the serious drought that occurred in years 27 and 28 the cattle population was reduced to 68% of its pre-drought level in only 2 years. Mean herd growth during the recovery periods was 7.5% per annum.

Forage supplies fluctuate more rapidly and more widely than the cattle population, hence imbalances between available grazing resources and cattle population can be expected. The magnitude and duration of periods of overstocking and understocking depend on the average herd size and the assumed safe stocking rate.

A safe stocking rate was calculated by assuming a daily forage demand of 10 kg DM/TLU or a rate of utilisation of about 60% of the standing herbage biomass, given a daily intake of 2.5% of bodyweight or 6.25 kg DM (see Section 4.4.3: *Carrying capacity*). Individual years do not occur in isolation as there is a carry-over of forage supplies from the previous to the current year. Thus, moving averages over 2 years were used to estimate the safe stocking rate. The livestock biomass in TLU for the entire ranch in each year was derived from the mid-year aggregated herd size, its age/sex/class composition and the liveweight of each class.

The long-term balance between forage supply and stocking rate for the 10 000-ha ranch is shown in Figure 10.7. This shows a pattern of periods of understocking alternating with periods of overstocking. During drought periods, the amount of forage available fell to 4.5–5.7 kg DM/TLU per day, which is less than the minimum required intake. However, the ranch was correctly stocked or understocked for 22 out of 30 years, and was seriously overstocked for only 5 years. Over the entire 30-year period, forage supply and demand were in balance, with both the safe stocking rate

Figure 10.6. *Long-term changes in herd size of poor, medium-wealth and rich producers on Olkarkar Group Ranch and for the whole ranch.*

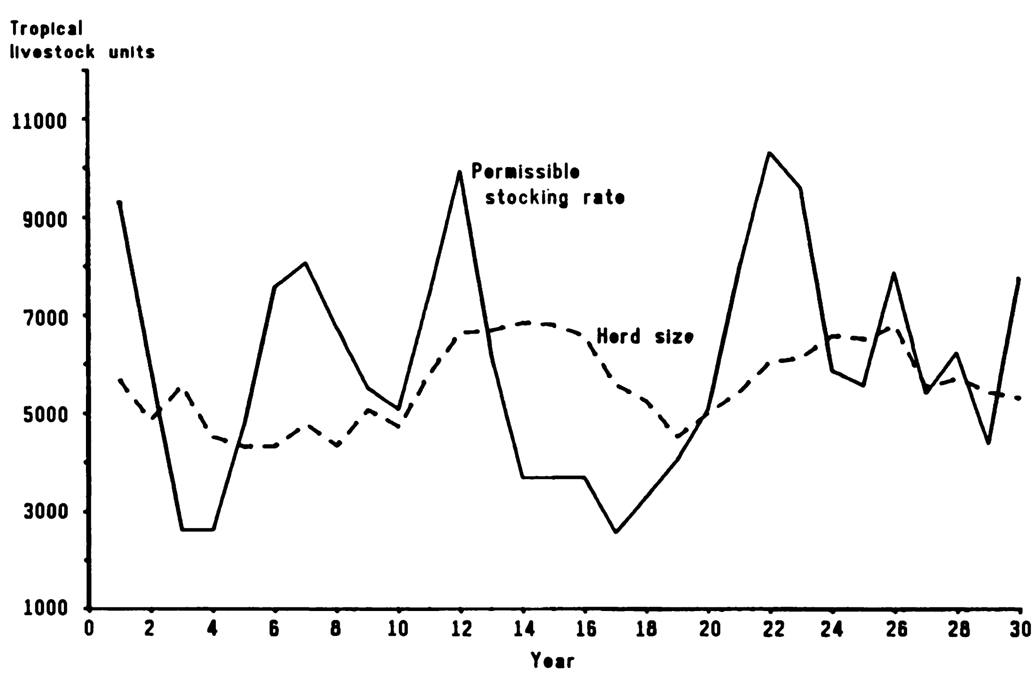


and the herd size showing a median value of 5600 TLU for the 10 000-ha ranch. Given the fairly conservative forage utilisation rate adopted, it can be concluded that the long-term carrying capacity of the ranch was about 0.6 TLU/ha (1.7 ha/TLU), which is similar to the actual stocking rate of Olkarkar ranch during the 1981–83 period (see Section 5.3.2: *Grazing patterns and stocking rates in the northern ranches*).

10.2.2 Herd productivity

Herd productivity can be measured in several ways, including stock biomass production, milk

Figure 10.7. *Simulated permissible stocking rate and simulated herd size for a 10 000-ha group ranch over a 30-year period.*



offtake, net output expressed in monetary terms and rates of return on labour, land and capital invested in livestock. These measures are largely influenced by herd size, which fluctuates from year to year. The overall productivity of the ranch was dominated by the dynamics of the large herds belonging to the rich producers as these constitute nearly 80% of the total cattle population of the ranch. Although, proportionally, changes in the herd sizes of the poor and medium-wealth producers were more pronounced than changes in large herds, their effect on the fluctuations in the total ranch cattle population was minimal. In the three droughts that occurred during the 30 years modelled, poor producers lost an average of 43% of their herds during each drought, medium-wealth producers lost 39%, while rich producers lost only 34%. The poor producers had proportionally more cows and calves in their herds than did medium-wealth and rich producers, and these classes of stock were more likely to die during drought than other stock classes (Table 10.3).

Biomass production

Cattle biomass production is defined as the total change in herd biomass during the year. It includes the weight gain of all classes of animals remaining in the herd at the end of the year plus the weight of animals sold and slaughtered for home consumption. In normal years this is a positive value, but was negative in drought years because of high mortality rates and weight losses.

The simulated long-term (30-year) mean annual liveweight production for both the poor and medium-wealth producers was 43 kg/TLU, compared with only 19 kg/TLU for rich producers (Table 10.6). This is explained by the low level of offtake, particularly sales, practised by rich producers (Table 10.7). The low sales offtake of the rich producers depressed liveweight production per TLU for two reasons: first, animals did not gain much weight beyond the age of 5 years and low sales resulted in an increase in the proportion of older animals in rich producers' herds; and second, many of the animals accumulated in good years died or lost weight during drought periods.

Simulated mean liveweight production for Olkarkar as a whole was 24 kg/TLU (13 kg/ha), ranging from a loss of 102 kg/TLU (-30 kg/ha) in drought years to a gain of 42 kg/TLU (42 kg/ha) in the best years (Table 10.6).

The mean annual liveweight production of 13 kg/ha compares favourably with the 9 kg produced by Boran pastoralists in southern Ethiopia and the 4.3 kg produced on Australian cattle stations (Cossins and Upton, 1987), but is considerably less than that achieved on some commercial ranches in Kenya.

Table 10.6. *Simulated long-term livestock productivity of poor, medium-wealth and rich producers and for the ranch as a whole under different year-types.*

Period type	No. of years	Livestock productivity: kg/TLU per year, Wealth class[1]: Poor	Medium	Rich	Ranch	kg/ha per year
Long term	30	43	43	19	24	13
Drought	3	−127	−96	−101	−102	−30
Poor	7	35	31	10	15	75
Fair	9	55	50	28	33	17
Good	8	57	55	31	37	21
Best	3	61	60	37	42	42
Study period	(1981–83)	73	74	48	54	33

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

Table 10.7. *Annual sales offtake by poor, medium-wealth and rich producers under different year-types.*

Wealth class[1]	Drought years: Offtake in per cent of No.	Biomass	Best years: Offtake in per cent of No.	Biomass	Long term: Offtake in per cent of No.	Biomass
Poor	15	19	11	13	12	16
Medium	15	19	11	14	12	17
Rich	6	8	5	6	5	7

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

10.2.3 Milk offtake

The modelled results of milk availability for human consumption showed wide fluctuations across years. The long-term mean availability of milk for poor and medium-wealth producers was 1563±143 and 2348±211 kg per household per year respectively (Table 10.8). In most years poor producers did not produce enough milk to meet their target of obtaining 65–70% of their energy from milk (Nestel, 1985). Rich producers had far more milk than their households needed in all years except during the first drought, when they

Table 10.8. *Simulated milk offtake of poor, medium-wealth and rich producers and for the ranch as a whole under different year-types.*

Period type	No. of years	Annual milk offtake (litres/household)			Group ranch	
		Wealth class[1]				
		Poor	Medium	Rich	Litres/TLU	Litres/ha
Long term		1563	2348	5000[a]	24	12
Drought	2	565	825	3525	25	7
Poor	7	1090	1663	5000	22	11
Fair	9	1488	2262	5000	23	12
Good	8	2116	3143	5000	24	14
Best	3	2415	3608	5000	22	15
Study period	(1981–83)	2480	3550	5000	26	15

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

[a]Only the first 5000 litres of production was considered.

had only 1992 litres of milk available, compared with the long-term average of 10 836±968 litres per year. Since there was no ready market for the excess milk of rich producers it was largely left for the calves. Rich producers also gave milk to poorer relatives and friends. For purposes of economic analysis, only the production of 5000 litres of milk per year is assumed to have economic value.

Milk availability per person in households of different wealth class is shown in Table 10.9. Rich producers have more than enough milk for their household (target of about 360 litres/active adult male equivalent (AAME)) in all years except during droughts, when milk availability dropped below 200 litres/AAME. In contrast, medium-wealth producers achieved the target level of production only in good and the best years and poor households only in the best years.

Table 10.9. *Simulated milk offtake per person by poor, medium-wealth and rich households under different year-types.*

Period type	Milk offtake (litres/AAME[1])		
	Wealth class[2]		
	Poor	Medium	Rich
Long term	233	272	>500
Drought	84	96	191
Poor	162	193	>500
Fair	221	262	>500
Good	315	365	>500
Best	359	419	>500
Study period	370	507	>500

[1]Active adult male equivalent.

[2]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

10.2.4 Net output

The net values of output for the three types of producers were computed using constant 1981–83 prices (Table 10.10). The long- term mean annual net output per household of large-scale producers was 3.3 times that of poor producers and 2.3 times that of the medium-wealth producers. However, these differences narrowed to 2.0 and 1.9 times respectively when expressed on a per caput basis because of the larger number of people in rich households.

During drought years all producers sustained a net loss of output, with rich households suffering much greater losses than poor and medium-wealth households (5.6 and 3.9 times as large, respectively, on a per caput basis). In contrast, the net output of rich producers in the best years was only 2.4 times that of poor producers and 2.1 times that of medium-wealth producers on a per caput basis.

The long-term mean net output for Olkarkar as a whole was KSh 59/ha per year or KSh 1535 per person. The net loss during severe drought periods was KSh 109/ha and KSh 2645 per person. During the best years net output per person was 2.4 times the long-term mean.

A comparison of net returns accruing to capital invested in livestock for the three producer wealth classes and for the ranch as a whole during three year-types is shown in Table 10.11. Again, productivity was inversely related to wealth class. The

Table 10.10. *Simulated net output of poor, medium-wealth and rich producers and the ranch as a whole under different year-types.*

Wealth class[1]	Net output (KSh/year)			
	Year-type			
	Long term (30 years)	Drought (4-year mean)	Best (3-year mean)	Study period (1981–83)
Per household				
Poor	7 425	–6 397	13 827	12 990
Medium	10 309	–11 800	19 761	24 075
Rich	24 495	–58 708	53 513	60 880
Weighted mean	17 463	–24 925	33 725	33 260
Per person				
Poor	1 105	–952	2 058	1 930
Medium	1 196	–1 369	2 292	2 790
Rich	2 237	–5 362	4 887	5 560
Weighted mean	1 535	–2 645	3 753	3 790
Per TLU				
Poor	238	–437	322	380
Medium	184	–345	268	320
Rich	86	–342	149	195
Weighted mean	168	–377	245	152
Per ha				
Ranch	59	–109	122	230

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

long-term mean net return was 17%, ranging from 9% for rich producers to 24% for poor producers.

The high net returns realised by poor and medium-wealth producers were the result of their intensive milking practices. As was noted earlier, rich producers extracted less than 40% of the milk potentially available and their long-term annual offtake of animals was only 5%. The productivity of rich producers could be markedly increased by increasing their offtake of both milk and animals. However, there was no ready market for milk in the study area. The effects of higher offtake rates of animals for sale by medium-wealth and rich producers is discussed in the next section.

Table 10.11. *Simulated net return on capital invested in livestock of poor, medium-wealth and rich producers as a whole under different year-types.*

Wealth class[1]	Net return on capital invested in livestock (%)			
	Year-type			
	Long term (30 years)	Drought (4-year mean)	Best (3-year mean)	Study period (1981–83)
Poor	24	–32	34	39
Medium	18	–30	28	32
Rich	9	–30	16	21
Weighted mean	17	–31	26	25

[1]Poor = <5 tropical livestock units (TLU) per active adult male equivalent (AAME); medium = 5–12.99 TLU/AAME; rich = ≥13 TLU/AAME.

10.2.5 Effects of increased offtake of steers on herd and ranch productivity

Pastoralists tend to keep their herds as large as practically possible as a way of coping with the effects of droughts, on the basis that the larger one's herd at the beginning of a drought, the more likely one will have a viable herd at the end of the drought. However, pastoralists often delay selling stock as long as possible, with the result that the animals when sold are in very poor condition and fetch very low prices. Furthermore, flooding of the market with such animals also severely taxes the capacity of the market to absorb the increased supply. Consequently, many animals die despite pastoralists' belated willingness to sell in distress (Grandin and Lembuya, 1987). This results in a considerable economic loss both to the producers and the nation. One way of avoiding such losses is to increase sales of animals during favourable periods.

Since steers are not part of the breeding herd, their presence or absence does not affect the regeneration of the herd after drought or milk supplies. It was therefore postulated that increased offtake of steers would not reduce herd viability. The long-term productivity analysis kept sales of animals constant at 4, 7 and 17 head for poor, medium-wealth and rich producers respectively. A sensitivity analysis was performed using the long-term herd-projection model to determine the effect of a higher level of steer offtake on herd productivity. In the high-level offtake model, all steers of the medium-wealth and rich producers were sold upon reaching 5 years of age, in addition to the cull cows and bulls ordinarily sold.

The results indicate that there was little scope for the medium-wealth producers to increase their sales offtake from the 7 head per year they sold during the study period. There were only 2 years out of the 30 that sales of steers could be increased, and then only to 8 head in one year and 9 head in the other.

In contrast, rich producers could increase their sales in 25 of the 30 years modelled and could achieve a mean sales offtake of 25 head per year. This represents a 47% increase in the sales offtake of this class of producer.

The aggregate result of such a policy of increased sales offtake of steers would be to increase the long-term mean sales of the ranch from 395 to 510 head per year. Table 10.12 shows that such a sales policy could substantially increase the long- term annual productivity of both the rich producers and the whole group ranch. It would also reduce grazing pressure on the ranch by reducing the mean cattle population by 19% to 4692 head, which is about the 1981–83 level of stocking on Olkarkar. Increased offtake increased liveweight production on the ranch by about 80% per TLU and 30% per ha (Table 10.12). The return on capital invested in livestock increased from 9% to 14% per annum for the rich producers and from 11% to 16% per annum for the ranch as a whole (Table 10.13). The discounted net output over the whole 30-year period was increased by 29% for the rich producers and by about 19% for the whole ranch.

Conclusion

On the whole, poor producers with 30 head of cattle extracted as much milk and meat as possible from their cattle. Their long- term animal offtake was about 16% of biomass, compared with only 7% for rich producers with 300 cattle or more. In terms of milk offtake, across the entire period

Table 10.12. *Impact of increased sales offtake on annual herd productivity of rich producers on Olkarkar Group Ranch and of the ranch as a whole.*

	Sales offtake					
	Rich producers[1]			Ranch		
Parameter	Normal	Increased	Change (%)	Normal	Increased	Change (%)
No. of animals sold	17	25	70	395	510	28
No. of animals died	36	32	–9	691	626	–10
Herd size (head)	392	312	–20	5776	4692	–19
Stocking rate (ha/TLU)				1.9	2.3	21
Liveweight offtake						
kg/TLU	39	72	85	20	36	80
kg/ha				11	14	30

[1]Rich = ≥13 tropical livestock units (TLU) per active adult male equivalent (AAME).

Table 10.13. *Impact of increased sales offtake on long-term annual net output of rich producers on Olkarkar Group Ranch and of the ranch as a whole.*

	Sales offtake					
	Rich producers[1]			Ranch		
Parameter	Normal	Increased	Change (%)	Normal	Increased	Change (%)
Net output						
KSh/household	24 495	29 775	12	17 463	18 640	9
KSh/caput	2 237	2 719	12	1 635	1 823	9
KSh/TLU	86	138	62	168	184	45
KSh/ha				59	66	29
Return to capital invested in livestock (%)	9	14	56	11	16	50
Discounted net output @ 12% p.a. (KSh '000)	189	243	29	4 208	5 021	19

[1]Rich = ≥13 tropical livestock units (TLU) per active adult male equivalent (AAME).

the rich producers extracted about 70% of the potential of their cows, compared with nearly 100% by the poor producers. The aggregate result of the high exploitation of production by the poor producers was a long-term mean return on their capital in livestock of 24% p.a., compared with a mere 9% for rich producers.

The low rate of return obtained by owners of large herds is explained by the fact that up to 55% of their annual biomass production is saved in the form of stock accumulation, much of which is lost when major droughts occur. This implies that the scope for increasing the productivity of rich households, which constitute 40% of the human population of the ranch but control nearly 80% of the livestock biomass, does not lie in improved technology but rather in greater exploitation of what is already being produced. On the other hand, the livestock productivity of poor households could be increased only by intensifying production via forage conservation, establishment of feed gardens, improved calf rearing and animal health care (see Section 11.2: *The improvement of cattle productivity*).

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Chapter 11

The potential for improving the livestock production and welfare of the pastoral Maasai

Solomon Bekure and P N de Leeuw

The preceding chapters tried to shed light on the short- and long-term productivity of the Maasai livestock production system. This final chapter examines ways to improve the livestock production and welfare of the Maasai, with emphasis on the primary (vegetation) and secondary (animal) productivity of the rangelands. In addition, it examines how inequities among producers constrain the system as a whole and recommends ways to reduce these. Intensification of rural development efforts and strengthening of the extension service are also suggested, together with recommendations on the future of group ranches.

A few considerations need to be kept in mind in formulating possible improvements to the production system. The first is where potential improvements can be made. The rangelands differ in their potential for improvement depending on rainfall, soil fertility and the distribution of water sources. The northern part of the study area is better endowed in these respects; primary productivity in this area could be improved through planted forage and secondary productivity could be increased by improving the distribution of temporary water points. The south of the study area is much drier and opportunities for intervention are more restricted.

The second consideration is the rapid growth of the human population in the study area, which reduces the availability of livestock and natural resources per person. This will call for intensification of land use and removal of surplus labour.

The third consideration is improvement for whom? Many studies and development efforts have treated pastoralists of the same ethnic origin as a monolithic homogeneous group (Sutter, 1987). Among the Maasai there are marked differences in livestock ownership and productivity between owners of large and small herds. Small-scale ("poor") producers are poor in stock but rich in manpower, while the opposite is true for large-scale ("rich") producers. Potential improvements will need to address each situation. How can poor producers gain access to more livestock? How can their operation be intensified to increase the use of their most abundant resource, labour? Innovations that are capital-intensive and increase the producer's vulnerability will not interest poor producers unless the required capital is made available and the risks are minimised. Conversely, rich producers will not be interested in improvements that require more labour.

Rich producers, with a mean holding of 300 cattle, constitute about 40% of the producers but own nearly 80% of the cattle in the study area. However, they do not exploit the full potential of their herds. Their long-term milk offtake is about 70% of the potential of their lactating cows, compared with almost 100% for poor producers. Their animal offtake is about 6% per annum, which is less than half of that of poor producers (14% per annum). The annual return on their capital invested in livestock is a mere 9%, compared with 24% achieved by poor producers. They will therefore not be interested in innovations that increase production of milk or meat per unit of livestock but incur additional costs and risks. What will appeal to them are innovations that decrease livestock losses and reduce production costs.

A fourth consideration is the organisational level at which these potential improvements can be made. There are improvements that can be adopted directly by the individual household, e.g. hay-making. There are other improvements that can be made only at the group-ranch level, e.g. developing new water resources; and there are improvements that can only be made through the decision and support of district and national agencies, e.g. improving livestock marketing, veterinary services, community development and research in range livestock problems.

Hence there is no single way to improve the livestock production and welfare of Maasai pastoralists; rather a variety of approaches will be needed. This chapter first considers ways to increase the productivity of the range and ways to improve the use made of the range. It then identifies opportunities for increasing livestock productivity and offers suggestions as to how to achieve a more equitable distribution of wealth among the pastoralists. Issues that need further research are also highlighted. Finally, strategies for improving the overall efficiency of Maasai livestock production and improving the welfare of the people are discussed.

11.1 Improvements in feed resources

11.1.1 Introduction

The availability of feed can be increased or feed utilisation can be improved by:

- improving the distribution of water points and reducing overgrazing
- increasing primary production by intensifying land use and conserving forage
- balancing the livestock population and the available feed resources.

The first two points are discussed here. Since the third requires group and institutional decisions it is dealt with in Section 11.5 (*The equity issue*).

11.1.2 Improvement of grazing and watering management

Differences in the distribution of water points on the three group ranches lead to different patterns of range resource utilisation and variation in grazing pressure within ranches (see Chapter 5: *The study area: Socio-spatial organisation and land use*, and Chapter 6: *Labour and livestock management*). In addition, the frequency at which animals are watered is influenced by distance to water and the grazing resources available between the homestead and the water point.

In Olkarkar grazing pressure decreased radially from Simba Springs and about 70% of the ranch was heavily grazed. Reliance on one water point by some 6000 cattle and 6000 smallstock has resulted in serious range degradation along the many stock routes leading to the Springs. Development of additional water points would alleviate the pressure on the range near the Springs.

In the mid-1970s a pipeline was constructed to divert water from the Springs towards the interior of the ranch, creating two additional water points. The pipeline and facilities subsequently fell into disrepair, but could be restored. This would benefit about 70% of all stock on the ranch and would shorten treks to water by some 10 km for those households dwelling in the eastern and central portions of the ranch. Herds could stay closer to the less heavily used hinterland and stock distribution would be more uniform.

Utilisation of grazing resources would be improved if, in each neighbourhood, new *bomas* were established closer to the less heavily used land. It is possible that the ongoing process of land privatisation will lead to the creation of single household *bomas* and additional producers may decide to settle in the under-utilised south-western part of the ranch and water their stock from the pipeline in Mbilin Group Ranch.

If no additional water points are developed a better stock distribution could be achieved if more households opted for alternate-day watering. During the study period, households within 5 or 6 km of the main water point watered their stock daily. These households generally had much smaller herds than households further from the water point (see Section 5.2.2: *Neighbourhoods and reserved grazing areas*). Households that lived further from water tended to practise alternate-day watering and their herds grazed up to 15 km from the water points on the non-watering day. For households that live near a water point, changing to alternate-day watering would reduce the proportion of the herding day spent on trekking and watering and increase access to better grazing areas, but it might reduce milk production and calf growth (see Section 7.1.7: *Milk offtake and lactation yield*).

On Merueshi most households and water points are located around the periphery of the ranch and most households water their stock daily. As a result, grazing pressure decreases towards the centre of the ranch and, due to the steep rainfall gradient, from the north-east to the south-west. A large area in the south-east is underused in normal years and is grazed only during dry periods as a fall-back resource (Grandin et al, 1989). A change to alternate-day watering would allow more use to be made of this part of the ranch. Most of Merueshi lies within 5 km of a permanent water point and hence no further development of permanent sources is needed.

On Mbirikani the situation differed markedly from the northern ranches in that most herds left the ranch during dry seasons. Hence, grazing pressure was high during good years and seasons and low during dry ones. Also, a well-regulated, seasonally adapted grazing system has been retained (except for a short chaotic period between 1981 and early 1983). Given the distribution of water points, this system optimises the distribution of stock over as wide an area as possible.

The eastern part of Mbirikani is grazed only when the temporary waterholes along the Chyulu foothills fill up. This happened briefly in early 1981, for a few weeks in December 1982 and again during 6 weeks in early 1985. A 15-km pipeline from Makutano village would open up this area, but extensive use by livestock would interfere with the wet season dispersal of wildebeest and zebra (see Section 5.3.3: *Grazing patterns and stocking rates in the southern ranch*).

It should be stressed that the behaviour of rich households has the greatest effect on grazing resources and their use, e.g. on Merueshi five households control 60% of all cattle (see Section 5.3.2: *Grazing patterns and stocking rates in the northern ranches*). This is discussed below in greater detail.

11.1.3 Rehabilitation of degraded areas

Reference was made in Chapter 4 (*The study area: Biophysical environment*) and Chapter 5 (*The study area: Socio-spatial organisation and land use*) to degraded land in the group ranches. Actions required to rehabilitate the degraded areas include moving *bomas* to other sites and re-aligning stock routes to water points.

Short-term protection from grazing would go a long way toward restoring plant cover, particularly in the north, where there are good soils (deep Nitosols over volcanic rocks). Further south, longer periods of protection would be needed because rainfall is lower and vegetation is less resilient. Such protective measures could be enforced by the group-ranch members and should be adopted as part of a general management plan that includes other measures such as reducing the size of rich producers' herds (see Section 11.5: *The equity issue*).

11.1.4 Intensification of land use and feed gardens

With increasing population pressure on land resources, rangeland is being cropped where climatically possible. There has been a rapid spread of wheat farming in the Loita plains, and in better-watered parts of Narok District Maasai pastoralists have established large-scale, mixed-farming enterprises on their better grazing land. There has been similar pressure on the better-watered portions of Kajiado District. In the south of this District, intensive irrigated farming (onions, maize, market gardening) is increasing rapidly. Especially since the 1984 drought, Maasai are increasingly trying to get land along water courses and swamps so as to engage in irrigated farming. Along the pipeline, small irrigated plots (with maize, bananas and vegetables) have sprung up and this trend will likely continue following the installation of several more private water connections (see Section 4.5: *Water resources*).

Rainfed cropping has been tried by several Maasai households, in particular along the northern fringe of the study area. Some farm plots were started by Kamba women married to Maasai; others were established to reinforce claims to land (Grandin, 1987). However, this is a marginal cropping area and maize crops generally failed except in the first rains in 1982, and in 1984 and 1986.

In view of this drive to bring more land under cultivation, the question arises as to whether rainfed cropping can be combined with forage production in feed gardens.

Feed gardens could provide supplementary feed for young stock and act as a day-time holding area for them. Their role as a protective holding area would particularly benefit smallstock, especially on Olkarkar where 43% of young smallstock deaths were caused by predators and another 10% were due to animals straying.

In 1986, several demonstration gardens were established close to *bomas*. Each covered about 0.1 ha and was planted with a mixture of perennial grasses (*Panicum maximum, Pennisetum purpureum*), pigeonpea and *Leucaena*, together with maize, sorghum, millet and cowpea. They were manured with smallstock dung at a rate of about 8 t/ha. Due to the good rains in the first growing season in November 1986, plant establishment and growth were promising. The perennial grasses produced 2–3 t DM/ha in February 1987 but were grazed heavily when protection against stock encroachment was slackened during the short dry season. Cowpea produced about 7 tonnes of air-dry hay per hectare, together with up to 3.0 tonnes of air-dry feed from the interplanted millet and sorghum. These seasonal crops produced an average 0.8 tonnes of conserved feed from 0.08 ha of fenced land, in addition to about 30–50 kg of cowpea grain and 30 kg of sorghum grain. Pigeonpea and *Leucaena* established reasonably well, but were heavily browsed when feed gardens were opened for grazing. However, *Leucaena* appeared very persistent and survived 3 years of continuous browsing by smallstock and wildlife. The second rains following the establishment of the feed gardens were poor and all seasonal crops failed.

The good rains at establishment were the exception rather than the rule and occur in 1 year in 3, while favourable second rains occur only in about 1 year in 10. The feed gardens should thus be planted with a mixture of perennial grasses and legumes together with annual crops to ensure that some feed is available even if the rains are poor.

Feed gardens are only likely to be feasible in the wetter northern part of the study area, where fertile volcanic soils are common. The Maasai are relative newcomers to arable cropping and it is unlikely that forage production combined with cropping will be widely adopted.

In conclusion, feed gardens are feasible if Maasai producers are willing to supply labour for fencing, planting and manuring and will buy seed and other inputs. They also have to realise that the management is rather complex as it requires continuous protection against stock during the growing season, followed by timely harvesting, feed conservation and controlled grazing. Shortage of labour may also be a constraint, as the women who would be primarily responsible for maintaining these gardens already work a 14-hour day.

11.1.5 Forage conservation

A primary constraint on increasing the productivity of livestock in pastoral systems is the acute shortage of feed during the dry season and the poor quality of what feed is available. The feed available from reserved calf pastures (*olopololis*) (see Section 5.2.2: *Neighbourhoods and reserved grazing areas*) also loses quality rapidly since the standing grass is conserved *in situ*. Making good-quality hay could provide supplementary feed for calves and young smallstock during the dry season and ease feed shortages, in particular for poor households.

A trial was conducted at the end of the second rains in 1986 to determine labour requirements for hay-making. The grass was sun-dried and baled manually using a small wooden box press. The average standing crop at the time of the trial was 3.5 t DM/ha. Three man-days of 6 hours/day were needed to make six bales of hay each weighing 20 kg, sufficient to feed one calf over 4 months (July–October). Thus hay-making is technically feasible, requiring a lot of labour but few other inputs. The amount of labour required depends largely on herbage availability and would thus be higher in dry years and in the south of the study area.

11.2 The improvement of cattle productivity

11.2.1 Introduction

Since the late 1930s, when the British colonial administration introduced veterinary vaccination programmes, Maasai pastoralists have been exposed to and have successfully adopted innovations that have led to improved management of their cattle. New water sources were developed and dips were constructed under the livestock development project that accompanied the adjudication of group ranches in the late 1960s, and the veterinary and extension services were active in the initial stages of the project. The Maasai are now able to water their animals more frequently, use acaricides to control ticks, administer drugs to sick animals and purchase salt licks. Some have introduced improved cattle breeds, particularly Sahiwal and Boran (see Section 7.1.3: *Breeds and weights*), while others are involved in commercial fattening of steers.

The productivity of cows on the northern ranches (Olkarkar and Merueshi) is somewhat higher than that of cows in other pastoral and agropastoral systems in sub-Saharan Africa, while the productivity of cows on Mbirikani is similar to that of cows in West Africa (de Leeuw and Wilson, 1988). Calf growth up to one year was better than in most other systems, but very much lower than in Kenyan ranching operations using Boran cattle (Trail et al, 1985).

Two factors are believed to be responsible for the good performance of Maasai herds. First, the bimodal rainfall and generally fertile soils result in good-quality herbage being available for more of the year than is the case in West Africa (see Section 4.4: *Rangeland production*). Second, Maasai manage their calves separately from other stock until they are 12 months old, providing shelter during the first months and reserved grazing later in life, their aim being to ensure calf survival (Semenye, 1987).

Given this situation, what can the individual Maasai producer do to increase the productivity of his herd? Innovations fall mainly into two categories: those that require more labour and those that demand more inputs, usually in terms of cash. Many households had too little labour even for current management practices and thus there is little scope for improvements at the household level that require additional labour inputs.

Improvements requiring inputs are linked mainly with feed supplementation, better breeds and health care. The first two are discussed in this section; health care is discussed in Section 11.4 (*Improvement in livestock health care*).

11.2.2 Supplementary feeding of calves

Before examining the feasibility of calf supplementation, the objectives of such intensification of husbandry practices need to be specified. Two major objectives are considered here:

- to minimise mortality in calves and cows during droughts

- to increase the amount of milk available for human consumption during the dry season by replacing suckled milk with high-quality supplementary feed.

The long-term benefits of calf supplementation during droughts were studied using a simulation model. The results indicated that supplementation would hasten post-drought recovery by reducing calf and dam mortality. The model was based on a pre-drought herd of about 40 head. It was assumed that supplementing the calves in the drought year would reduce calf mortality from 80% to a low level of 40% or a medium level of 60% and cow mortality from 50% to a low level of 30% or a medium level of 40%. The effects of these reductions in mortality on milk and livestock sales over the subsequent five post-drought years were examined using herd parameters as described in Chapter 10 (*The long-term productivity of the Maasai livestock production system*) for years 11–16. Over this 5-year period low and medium mortality rates increased cumulative income by 44% and 33% respectively over the (high-mortality) control. In the fifth year after the drought, the low-mortality herd had 31 head of cattle producing 4.9 litres of milk a day while the control herd had 23 head with a daily output of 3.7 litres. Differences in livestock sales averaged KSh 600 per year.

The calf supplementation would have to rely on purchased concentrates. Cost/benefit analysis of feeding sufficient calf pellets (15% digestible protein and 2.5 Mcal of energy; KSh 3/kg) to meet all the calf's protein requirements and half its energy needs indicated a benefit/cost ratio of 2.95 for the low-mortality herd and 1.58 for the medium-mortality herd.

These ratios indicate that calf and cow mortalities have to be reduced drastically to make supplementary feeding during drought attractive, in particular in respect of the labour demands of such feeding. During droughts labour demands (for watering and grazing, rescuing starving cattle and slaughtering cattle and skinning dead ones) are very high, so that extremely high benefit/cost ratios are required to make the extra effort attractive (Grandin et al, 1989).

11.2.3 Breed improvement

The first phase of the Kenya Livestock Development Project (KLDP) promoted the use of improved cattle breeds by providing bulls (mainly Sahiwal) either free or at subsidised prices. However, these crossbreds suffered much higher mortalities than pure local zebus during the long drought of the early 1970s. Crossbreds were less resistant to drought-induced stress and were much more susceptible to tick-borne diseases. In addition, their milk production under ranch conditions was not high enough relative to the local zebu to offset the higher costs of disease control (White and Meadows, 1981).

Breed improvement through the introduction of exotic breeds should be left to the Maasai, who have cattle breeding strategies aimed at maintaining the genetic diversity of their herds.

11.3 Improvement in smallstock productivity

11.3.1 Introduction

In contrast to the relatively high productivity of their cattle, the productivity of Maasai sheep and goats during the study period was lower than that of small ruminants kept by other African pastoralists, even those in less favourable rangeland areas (Wilson, 1982). The main reasons for this poor performance were long parturition intervals, high mortality rates and the large proportion of unproductive females in the Maasai flocks (see Section 7.2: *Smallstock productivity*).

Smallstock have only recently become an important component of the Maasai livestock enterprise, and are still of much less importance than cattle in most households. The Maasai have thus not yet developed the same level of skill in smallstock husbandry that they have achieved in cattle rearing. In addition, the management of smallstock is generally relegated to women and their herding to young children. However, as rapid population growth increases the pressure on grazing land, overgrazing will likely increase, leading to replacement of perennial grasses by bush, dwarf shrubs, forbs and ephemeral annual grasses which are more effectively exploited by smallstock than by cattle. This will encourage Maasai producers to keep more smallstock. As the number and importance of smallstock increase so will the desire to improve their productivity.

11.3.2 Improvement in reproductive performance

The main factor that seemed to influence the reproductive performance of sheep and goats was nutrition (see Section 7.2.3: *Reproductive performance*). Better feeding, especially immediately before the mating period, could substantially increase conception rate and hence birth rate.

11.3.3 Improvement in management

Better supervision of suckling could help reduce the high pre- weaning mortality rate, especially in kids, by improving their nutrition. Lambs and kids should be housed during cold and wet conditions to prevent pneumonia.

Predation accounted for roughly 20% of mortality in both young and adult smallstock, while unrecovered "lost" stock accounted for another 10–11% of losses (see Section 7.2.4: *Mortality and disease incidence*). Greater care in herding could substantially reduce these losses. This would require assigning some of the responsibility for the care and management of smallstock to older children and men. However, many households did not have enough labour for herding (see Section 6.1.5: *Labour sufficiency*) and smallstock take lower priority than cattle. It is thus unlikely that the Maasai will adopt improved smallstock herding practices under current circumstances.

11.3.4 Improvement of breeding stock and health care

The predominant breeds of sheep in the study area were the Red Maasai on the northern ranches (65–75% of animals) and the Blackheaded Somali on Mbirikani (65% of animals). Almost all the goats were of the Small East African breed. Goat production could be improved by introducing the Somali, or Galla, breed, which has a larger body frame, weighs more and produces more milk than the Small East African. It is also the breed preferred by the Nairobi meat market, which is now dominated by stock originating from as far away as Garissa and Moyale. The sheep and goat improvement project, which was terminated in 1985 when FAO funding was ended, should be resumed to supply breeding stock to producers.

11.4 Improvement in livestock health care

The Maasai treat their animals themselves and rarely have access to a veterinarian. The animal health care in the study area could be improved by training educated Maasai in the correct use and application of veterinary drugs.

Tick control was introduced with the development of the group ranches, but the desirability of strict dipping regimes is being questioned. Tatchell (1987) suggested a return to greater reliance on enzootic stability (which previously existed among indigenous stock) by allowing small numbers of ticks to be present on stock, rather than relying on intensive (up to twice a week) and very expensive dipping regimes aimed at 'perfect' tick control which encourage acaricide resistance in ticks.

The suggested approach is to dip or spray according to tick burden, not with the aim of eliminating ticks completely but to keep the tick burden low. This would encourage the build up of natural immunity, reduce tick damage to udders and other sensitive areas, yet reduce costs. Trials are required to define more precisely the thresholds above which tick control is required.

Efforts to improve the health of smallstock should initially be directed at reducing pre-weaning mortality, particularly that due to scouring, which was associated with coccidiosis, enterotoxaemia and enteric colibacillosis (see Section 7.2.4: *Mortality and disease incidence*). Some households administered anthelmintics, in particular to pregnant females and youngstock. Peacock (1984) advocated drenching dams twice, 2–3 weeks before and after parturition, and young stock once at about 3 months old.

11.5 The equity issue

11.5.1 Introduction

The overall productivity of each group ranch is determined largely by a few rich producers, since 20% of the households control some 60% of the cattle (see Section 1.3.2: *Producer heterogeneity and sampling design*). Herds of rich producers are much less productive than those of poor producers because rich producers do not need to exploit the full potential of their herds. The size of rich producers' herds will have to be reduced if the productivity of the group ranches is to be increased.

Traditionally, some East African pastoral societies have had strong redistributive mechanisms, whereby within a social group (e.g. clan) owners of large herds were socially compelled to share their livestock with those who had few animals. However, social control and support networks have diminished greatly in Maasailand (see Chapter 3: *The Maasai: Socio-historical context and group ranches*). Previous attempts to limit livestock holdings have failed, e.g. the voluntary-quota system introduced by the Kenya Livestock Development Project in the late 1960s and the forced destocking measures of the colonial administration in the 1940s and 1950s (see Section 3.2: *Kajiado District: An historical overview of land use and policy*). However, rich producers might be persuaded to reduce their herd sizes if their security against drought could be ensured in some other way, if alternative investment opportunities were available or if they were taxed on the number of animals owned.

11.5.2 Reducing drought insecurity

The overriding reason why the Maasai want to keep large herds is for security against severe droughts, which recur every 8 to 12 years. The Maasai realise that they would lose fewer animals if they started selling animals at the beginning of a drought, but there is no early warning system to identify when a real drought is starting. Onset of rains varies considerably. When the rains are later than usual, Maasai are unable to predict the likelihood of their failure and they tend to wait until there is no chance of rain rather than risk disposing of animals prematurely, especially cows. Unfortunately, by the time they start selling animals the markets are already overburdened (Grandin et al, 1989). If rich producers adopted a policy of a sustained high rate of sales offtake of steers the cattle population of the ranches would be reduced by 20%. This would reduce the impact of droughts on the remaining livestock and increase the productivity of the rich producers and the ranch as a whole (see Section 10.2.5: *Effects of increased offtake of steers on herd and ranch productivity*).

The increased sales offtake would generate a considerable amount of cash. This would necessitate development of banking facilities, e.g. a mobile bank could be operated on livestock market days, and educating the rich producers in the use and benefits of bank accounts.

If the average rich producer adopted the high rate of steer offtake and paid the incremental proceeds of his additional steer sales into a savings account with an interest rate of 10% p.a. he would accumulate a total of about KSh 200 000 over a 12-year period that included a drought (Table 11.1). However, if he did not adopt the high rate of steer offtake, he would have 91 more steers at the end of the 12 years. These would be worth about KSh 100 000. Thus the high rate of offtake would result in a net benefit of some KSh 100 000 which could be used to buy household goods, supplementary feed for calves during the drought and stock for restocking after the drought.

A savings plan would provide security against drought. A target-level deposit could be determined in consultation with the individual, who would be encouraged to accumulate this sum over time. Such a savings plan would be an entirely new concept for pastoralists and might, in

Table 11.1. *Accumulated savings of incremental proceeds from increased rate of steer sales by the average large-scale producer.*

Year	Incremental sales kg	Incremental sales KSh	Accumulated fund at 10% p.a.
6	2176	7 834	7 834
7	864	3 110	11 727
8	–250	–900	12 000
9	–312	–1 123	12 077
10	2720	9 792	23 076
11	2844	10 238	35 622
12	3990	14 364	53 549
13	1925	6 930	65 834
14	3978	14 321	86 737
15	3424	12 326	107 738
16	5766	20 758	139 270
17	3008	10 829	197 759

Source: Based on the model discussed in Chapter 10 (*The long-term productivity of the Maasai livestock production system*).

the short term, be unprofitable for the financial institution, but an active educational campaign and, perhaps, an initial subsidy to the financial institution would increase the likelihood of its success. There would undoubtedly be an initial reluctance from both parties to get involved in the scheme, but this could be overcome by the involvement of the government and non-governmental organisations (NGOs). While a financial institution could be responsible for the banking and accounting, an NGO could help in assuring the pastoralists that their money would be safe and in teaching them how to operate their accounts. Government, bilateral aid organisations and NGOs spend a lot of money on drought relief and recovery programmes, some of which could be invested in the savings plan, which would shift at least part of the responsibility for coping with drought to the pastoralists themselves. It will take at least one major drought to show the merits of the savings plan so patience and perseverance will be required on the part of those promoting the plan.

The plan would have several advantages. It would give pastoralists the opportunity to save production that they would otherwise lose during the next drought. It would lower the livestock population on the range thereby alleviating grazing pressure and reducing the impact of the drought on the remaining livestock. Pastoralists would have money during the drought to meet their cash needs, which are much greater than in normal times because of reduced milk production and increased cereal prices, and money to restock after the drought.

For the nation, a savings plan would reduce the amount of meat that would be lost due to drought and, more importantly, would provide a regular supply of stock to markets, reducing fluctuations in livestock and meat prices. It would reduce the amount of money spent on drought relief. The savings themselves will increase funds available to the national banking system for investment.

Goldschmidt (1975) proposed a national livestock bank aimed at increasing offtake and reducing overgrazing of rangelands. The scheme would establish livestock holding grounds and feedlots. Pastoralists would submit stock in exchange for redeemable certificates or tokens. When pastoralists wished to redeem animals they would either receive their cash value or similar animals. However, it is unlikely that such a scheme could be operated efficiently for several reasons. First, it would require a parastatal to operate the holding grounds and feedlots and to handle the large amount of cash involved, and the track record of parastatals in managing such operations has been poor (Solomon Bekure and McDonald, 1984). Second, the livestock held would be affected by drought just as are those in the rangelands. In essence, the scheme would shift a large part of the burden of loss from the pastoralists to the government treasury and ultimately to the taxpayer. The proposed savings plan avoids these pitfalls.

11.5.3 Creating alternative investment opportunities

One of the reasons why rich producers continue increasing their herds is the lack of alternative investment opportunities. However, livestock trading could be stimulated if fathers converted part of their livestock wealth into working capital to establish their sons as traders.

Transport is another venture for investment. Minibuses, and pick-ups could be purchased by the sons of rich households and used to transport people and goods. Help would be needed in arranging credit and training in handling vehicles and money. Investment in real estate is unknown to many rich producers. Educating them in the advantages of keeping part of their assets in real estate in urban and trading centres is another avenue for opening alternative investment opportunities. Finally, encouraging Maasai children to acquire a good education and skills to go into white- and blue-collar jobs, however limited these may be, in the major urban centres will create opportunities for alternative investment of their fathers' livestock capital.

11.5.4 Taxing large-scale producers

Rich producers exploit a major part of the communal grazing resource and were the main contributors to the imbalance between resources and stock (see Section 10.2.1: *Herd size and stocking rate*). Currently, they do not pay for the extra grazing they use, nor do they pay any taxes to the treasury. One way to induce greater offtake by these rich producers would be to impose a tax based on the number of animals kept.

The minimum tax should be about 1% of their holdings. This represents a taxation of 12% on the long-term mean annual net income of rich producers. For a 10 000-ha group ranch like Olkarkar the additional offtake generated by this taxation would be about 60 head a year. If one assumes a similar distribution of ownership in Kajiado District, the additional annual offtake generated by taxation would be of the order of 5600 head or over KSh 10 million a year.

The unpopularity of such taxation could be minimised if the revenue from the tax were used for community development activities either within the District or, preferably, within the group ranch from which it was obtained. In this case it would be difficult for the rich producers to evade the tax because their livestock wealth is very well known within the community.

11.5.5 Steer fattening

Currently the Agricultural Finance Corporation (AFC) operates a loan scheme for growing-out steers on group ranches. This was initially devised as a means for AFC to recoup the loans made to the group ranches for infrastructural development. Under the scheme the AFC bought immature steers and placed them in the care of Group Ranch Committees that had borrowed money. The steers were grazed for up to 1 year and then sold. The profit was retained by the AFC as partial payment of the loan. This scheme demonstrated to the Maasai the profitability of steer fattening.

In 1985, Olkarkar Group Ranch borrowed KSh 496 900 from the AFC and bought 386 immature steers. The steers were kept on the ranch for 21 months, during which 23 died. After paying 10% interest p.a. on the loan the ranch made a profit of KSh 685 per steer, a net return of over 50%. However, at that time the ranch was relatively understocked after the 1984 drought and rainfall during 1985 was favourable.

AFC is making loans of up to KSh 50 000 available to individuals who have the permission of their group ranch committee to purchase steers for growing-out on their ranches. This facility could help owners of small herds generate additional income and avoid their current practices of selling immature steers at low prices to cover their cash needs and exchanging heifers for mature steers with rich producers. However, owners of small herds will not be able to take advantage of the AFC loan unless the extension service and the AFC exclude rich producers from the scheme. If this is not done, those with access to information and those who can lobby and influence the group ranch committees will monopolise the credit facility, further exacerbating the inequitable distribution of livestock wealth. Already, group ranch committees are insisting that a producer must have paid off his share of the original group ranch development loan before he can qualify for an AFC loan, thus excluding the poor.

Steer fattening by poor producers is only feasible when a number of pre-conditions are fulfilled. First, extra livestock can only be brought onto the ranch when it is understocked, which occurs in about 4 years in 10 (see Section 10.2.1: *Herd size and stocking rate*). However, if rich producers reduce their livestock holdings, as suggested, there would be much more scope for steer fattening operations. Instead of buying steers from outside, loan money could be used to purchase immatures from rich producers on the ranch. Such internal transfers might become common if the process of privatisation of group ranch land accelerated and land (or grazing rights) were allocated on an equal basis instead of on a stock-ownership basis (see below).

11.6 Improvements in livestock marketing

This section proposes improvements to the livestock marketing system that would facilitate access of pastoralists to markets, increase competition by traders, increase the supply of stock to the market and reduce marketing costs, all of which combined would benefit both producers and consumers. These improvements fall in the areas of promotion of smallstock markets, provision of facilities along trek routes and at livestock markets, improving market information and making credit available to livestock traders.

11.6.1 Promotion of smallstock markets

Despite its proximity to the major meat consumption centres of Nairobi and Mombasa, Maasailand provides little smallstock meat to these markets. Traditionally, Maasai pastoralists kept only a few smallstock for home consumption and considered them unimportant for marketing. However, the smallstock population has increased rapidly over the past 20 years and is expected to continue growing.

Although there is a potential supply of smallstock, cattle traders report that it is extremely difficult to purchase enough smallstock to be worth trekking long distances to markets and that cattle trading is much more profitable. Trade in smallstock is confined to supplying local butchers and itinerant buyers at small trading centres. Smallstock offtake in the study area was found to be positively correlated with market accessibility rather than with flock size (Grandin, 1985). This suggests that the offtake of small ruminants could be substantially increased by establishing markets at strategic locations in Kajiado District.

A sheep and goat development project succeeded in promoting such smallstock offtake in Baringo District, Kenya (Airey, 1981). Livestock auction yards were constructed and regular, well-advertised auctions were held. The number of animals offered at these auctions was sufficiently high to attract buyers from as far away as Nairobi (250 km) and mean prices per head were raised by the increased competition (Peacock, 1984; Chabari, 1986).

Organising such auction markets will require the initiative and support of both the central and local government. The county council of Kajiado should be encouraged to take the lead with technical and financial backing from the Marketing Division of the Ministry of Livestock Development. The experience of the Baringo District County Council, which collects fees from both smallstock and cattle auctioning, shows that operating auction markets can generate revenue once the facilities are set up (Chabari, 1986; Chabari and Solomon Bekure, 1986a, 1986b).

11.6.2 Improvements in cattle marketing infrastructure

Although some cattle are transported by rail to the Kenya Meat Commission's abattoirs at Athi River and Mariakani, trekking remains the major means of transporting cattle to market. Stock are trekked for up to 10 days before they reach final markets and slaughter houses, such as those at Dagoretti and Ong'ata Rongai. There are very few watering facilities or holding grounds either along the trek routes or at the markets. Stock are lost to predators and night stops are determined by water points, forcing trekkers to stop earlier or continue longer than they would by choice. Traders are forced to sell their animals within a couple of days of reaching the final markets, because of the lack of holding facilities. This limits the number of animals that traders bring to the market on each trip.

Frequent outbreaks of foot-and-mouth disease and the closure of whole districts to livestock movement pose hardships to both livestock traders and producers. Traders have to move to non-quarantined areas or temporarily halt trading. The lack of holding grounds means that livestock cannot be quarantined and screened before moving to disease-free areas. This spawns illegal trade and trekking of animals out of the quarantined areas. This inevitably increases marketing costs.

The number of commercial and cooperative ranches in the semi-arid zones, which are currently the most important suppliers of slaughter steers, will shrink as they continue to be subdivided and used for crop farming. As Kenya becomes increasingly dependent on more distant pastoral areas for supplies of slaughter stock, the need to improve the infrastructure both along the trek routes and at the major markets will become more urgent. Trek routes and holding grounds should be gazetted as public property so that they will not be alienated to private use.

11.6.3 Improving market information

Gatere and Dow (1980) stated that "the lack of market information is perhaps the weakest link in the beef marketing chain in Kenya." Government policy-makers fixed floor prices to producers and wholesale meat prices until February 1987, when Kenya deregulated livestock and meat prices, yet such price-fixing could not have been done effectively in the absence of accurate information on supply and demand, prices and production and marketing costs. The notoriously dismal record of Kenya's meat- pricing policy, which discouraged beef production in the face of a declining supply, is a telling testimony to this fact (Fuglie, 1973; IBRD, 1977; Chemonics International, 1977; Cronin, 1978; Matthes, 1979).

Time-series data on livestock supply, demand and prices could be collected at various regional livestock markets by the Ministry of Livestock Development at a marginal cost by deploying already existing field staff to collect this information as part of their routine work, e.g. veterinarians who inspect meat at slaughter houses could record data on species, sex and condition of the animals they inspect. They could easily add weight and purchase price to their records and pass on a copy to the Ministry's Marketing Division. The recommendations of Matthes (1979) and Gatere and Dow (1980) for a livestock-market information system, hitherto unheeded, should be implemented. The need for this has increased with the deregulation of livestock and meat prices. It is now vital that the Ministry acquire and disseminate the information so that participants in the livestock industry have a guide for their decision-making. The establishment and operation of supervised livestock auction markets at strategic locations, such as those operated by the Baringo County Council, would help generate such time-series data.

11.6.4 Making credit available to livestock traders

Itinerant livestock traders who buy cattle from the hinterland for sale at intermediate markets, such as Emali, handle very few animals (5 to 20 head) at a time, partly because they lack working capital. At present the only source of credit for these traders are the producers, who allow them to take their livestock on the basis of partial and deferred payments. Other possible sources of credit are the big traders at the intermediate and final markets, and financial institutions. In West Africa, big traders commonly finance "collecteurs" who purchase cattle from herders in the remote hinterlands (Josserand and Sullivan, 1979). Perhaps a feasible beginning in Kenya would be to make credit available to big traders who in turn could finance the "collecteurs" in the bush by advancing them money to buy livestock on their behalf.

11.7 Improvements in group ranch management and the extension service

Initially, the extension service for pastoralists in the group ranches was tailored to the implementation of the Kenya First Livestock Development Project, which aimed at transforming nomadic subsistence livestock production into a sedentary and more commercially oriented system (see Section 3.2.3: *Origins of the group ranches*).

Group ranch members were supposed to graze their animals exclusively within their ranch boundaries. Grazing quotas were supposed to be allocated by the extension service to each member in order to match animal numbers to the carrying capacity of the ranch. Whenever animal numbers exceeded the prescribed limit, the group ranch committee (which was elected by the members) would force those holding livestock in excess of their quota to dispose of them. The group ranch committee would oversee all communal (group ranch) affairs, in essence replacing the traditional authority of the elders and chiefs (see Section 3.3.5: *Group ranch functioning*).

Traditionally, authority is vested in Maasai elders. As a major departure from this the group ranch constituted a new social formation for the Maasai involving an alien political concept of decision-making and enforcement by a committee of elected representatives. It required a group ranch committee of 10 people to manage the affairs of the ranch. It called for making prompt and binding decisions about shared natural resources, individual livestock holdings, the development of resources, the management of ranch properties and servicing the collective debt. This they generally could not do. Nothing in their previous decision-making experience, in their cultural values, or in the existing production organisation prepared them to make, let alone enforce, such binding commitments. Decision-making in traditional pastoral systems is based on decision-avoidance until the point where the options are so few and the need for action so urgent that voluntary and collective response is assured. Attempts to force a decision prior to that point simply led to individual producers breaking away and seeking solutions on their own. There is thus a tendency for the committee not to meet; or if it meets to discuss only non-controversial generalities. If it addresses specific topics or problems, it is often unable to reach a decision or if it reaches a decision it may be unable to enforce it.

Membership of group ranches has been limited to those registered originally. This has had negative effects on the quality of committee membership. It is common to find that none of the members of a group ranch committee have any formal education. It is obvious that no cooperative can function properly if all of its executives (chairman, vice-chairman, secretary and treasurer) are illiterate, no matter what other qualities they may possess.

The ranch committee is assumed to represent the collective interests of the producers who are the ranch members. The actual situation is more complex because the committee members represent variable ties of age-set and clan within the ranch, are individually subject to age-set, clanship and friendship pressures from outside the ranch (see Section 3.1: *Maasai social structure*) and are variably subject to regional and national political pressure according to their own beliefs and ambitions. There are thus many reasons for disagreement and few organisational options for resolving it and group ranch committees have generally been ineffective in discharging their duties and responsibilities. They have been unwilling to manage and maintain dips, water pumps and engines properly. They have failed to allocate and enforce stock quotas. They have not attempted to organise or control grazing patterns effectively, nor have they managed to enforce the group ranch boundaries. They have been unable to collect repayment of the AFC loans. In short, they have failed to manage the affairs of the group ranches in the manner envisaged by the planners.

Some of the problems found on group ranches now are attributed to the fact that the close communication between the Maasai and the supervisory personnel originally envisaged never materialised. The AFC was understaffed; those staff it had were not experienced in dealing with traditional pastoralists. For most of the life of the project the office of the Registrar of Group Representatives was staffed by only one senior person, a completely inadequate provision for the task of supervision. No group ranch has had a qualified manager. Although the Range Management Division had staff qualified to provide technical information for planning purposes they were ill-equipped to give extension advice on how to run a group ranch or on how to improve its livestock production.

Senior elders on group ranch committees complained that extension officers sent to work with them were too young, lacked a pastoral background, did not speak the Maasai language and had nothing new to teach them. They indicated that the only useful service they received from the extension service was the vaccination programme.

What the Maasai pastoralists need is:

- assistance in the general management of group ranch affairs
- provision of veterinary drugs, vaccines and acaricides
- instruction in repair and maintenance of borehole engines and water pumps
- stimulus to mobilise their ideas, energy and resources towards the development of their own community and welfare.

11.8 Subdivision of group ranches

The complex issues behind the pressure for the subdivision of group ranches were discussed in Section 3.3.7: *Pressure for subdivision of group ranches*. Just as the majority of Maasai did not grasp the ramifications of the group-ranch approach when these were introduced in the late 1960s, so too the implications of subdividing group ranches into smaller holdings do not seem to be well understood. The haste with which the issue has been handled may have far-reaching consequences. If the group ranches subdivided their land equally among their members each member would receive an average of about 100 ha (Jacobs, 1984).

Pastoral livestock production on such small tracts of land is much less viable ecologically than on the larger group ranches. Some mechanisms will have to evolve to deal with this problem. Maasai with large herds and flocks will have to sell off their animals or buy or rent land to make up for lack of grazing areas. Those with few animals will be able to rent out grazing and will likely purchase more livestock with the rental income. The young and adventurous may sell their land, squander the money and render themselves landless and unemployed. This may also allow rich producers to increase their land holdings, worsening the inequitable distribution of wealth.

Both the Maasai and the government should exercise caution in dealing with the question of subdividing the group ranches. A government commission made up of scholars (Maasai and non-Maasai), Maasai elders and knowledgeable government officers should investigate the issues involved and advise both the government and the Maasai on whether or not the remaining group ranches should be subdivided, and if so how, and how to alleviate the difficulties adjusting to the new land tenure arrangements will entail.

11.9 Rural development

Currently, Maasai and other pastoralists in Kenya seem to be bypassed by most rural development activities, which have taken place mainly in the higher potential areas in the country. The government and NGOs have built schools, dispensaries and hospitals in a few locations and pastoralists are using these facilities and services at their own initiative and pace, but there seems to be a lack of promotional campaigns to make adults aware of such development efforts. There should be stronger efforts to help the Maasai appreciate the value of educating their children, improving their health care, housing and material comforts and improving their livestock productivity and marketing techniques.

There is an urgent need for an integrated rural development effort that can inspire the Maasai and mobilise their energies and resources. One approach would be to create a series of community development centres sited at convenient locations serving several group ranches. These centres would be the contact points between government and NGO development services and the local community. Each centre should have a development committee, chaired by a representative of the District Commissioner, with members drawn from the community and development agencies. This committee would plan development activities in the community, drawing on outside expertise as necessary

Development workers should as much as possible be recruited from the pastoral community itself as they will understand the people, their thought processes and their way of life; more importantly, they are more likely to be committed and dedicated to the difficult and challenging tasks of developing their own community. The training of these development workers should be practical so that they can effectively impart skills to the pastoralists. For instance, the range/livestock extension agents should be trained in basic and practical animal production, animal health and range science as well as in the mechanics of servicing water facilities and equipment.

These community development centres could help promote the banking plan and environmental protection, and sponsor activities toward those ends. Each community centre could have its own school, dispensary and a store, where consumer goods and production inputs such as acaricides, veterinary drugs and vaccines would be sold. The operation of the store would be based on the principles of a cooperative, with the ultimate aim of handing it over to the community.

A locally-run, integrated, regional rural development project with its own extension programme in livestock production, livestock marketing, practical adult education, infrastructural development and maintenance, though costly at the beginning, could be cheaper and much more effective in the long run than single-purpose projects run by the various ministries from Nairobi. Poll taxes could be introduced to help finance such projects, as the community will have participated in them and will have seen their benefits.

A strong commitment will be needed on the part of both the national and local governments to develop the lagging pastoral communities. In Kenya the District Focus Approach and the Arid and Semi-Arid Lands (ASAL) programmes provide this policy framework. What is required is a workable, integrated community development programme that effectively mobilises the efforts and resources of the government, NGOs and the local communities.

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Printed at ILCA, Addis Ababa, Ethiopia

ISBN 92-9053-176-2

Price: US$ 37